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Research Article

Bridging the digital divide: Promoting inclusive education for students with disabilities in Ethiopian schools

Merih Welay Welesilassie [1,2*]
0009-0004-9500-7017

Berhane Gerencheal [2]
0000-0001-6520-0423

Seifu Berihu [2]
0009-0009-0142-7747

[1] University of Szeged, Szeged, HUNGARY
[2] Aksum University, Aksum, ETHIOPIA
[*] Corresponding author: merih.welay.welesilassie@edu.u-szeged.hu

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ABSTRACT

Digital inclusion is crucial for providing equitable educational opportunities for students with disabilities. However, significant barriers remain prevalent in low-resource contexts. This study is a beacon of understanding, examining the acceptance, perceptions, and obstacles related to educational technology engagement among young Ethiopian students with physical disabilities. Utilizing an explanatory sequential mixed-methods design, quantitative data were collected from 87 students, followed by in-depth interviews with 12 participants to gain deeper insights into their experiences. The results indicated a strong acceptance and perceived usefulness of digital tools for promoting independent learning and productivity. Nevertheless, students encountered substantial challenges, including a lack of digital readiness support, inadequate infrastructure, high costs, and insufficient teacher training. Structural equation modeling analysis revealed that digital readiness support, acceptance, and trust were significant predictors of students' willingness to adopt digital technologies. Qualitative findings further illuminated socio-cultural barriers, such as stigma and social exclusion, which hinder effective digital engagement. Utilizing the technology acceptance model in conjunction with the digital divide theory, the findings of this study provide significant insights into the challenges of digital access in Ethiopian educational institutions. The proposed inclusive framework seeks to address critical infrastructural and cultural barriers, thereby promoting equity for students with disabilities. This research underscores the importance of developing and implementing strategies that enhance digital accessibility and inclusion within the educational landscape.

Keywords: digital inclusion, students with disabilities, technology acceptance model, digital divide theory, inclusive education

INTRODUCTION

Digital inclusion has emerged as a crucial element of modern education, providing unprecedented opportunities for learning and engagement for all students (Welesilassie & Gerencheal, 2024, 2025). For young learners with disabilities, access to digital technologies is not just a tool but a lifeline. These technologies play a vital role in overcoming traditional educational barriers, enhancing their learning experiences, and promoting independence. In Ethiopia, where educational disparities are often exacerbated by socio-economic, geographic, and infrastructural challenges, ensuring digital inclusion for students with disabilities is a pressing necessity and a multifaceted concern (Dabi & Golga, 2023).

Ethiopia's digital education policy, as outlined in key frameworks including the education and training roadmap-2030, the general education quality improvement program (GEQIP), and the education sector development program VI (ESDP-6), is aligned with the research agenda focused on "Bridging the digital divide: Promoting inclusive education for students with disabilities." This alignment is evidenced by the emphasis on the integration of information and communication technology (ICT), the development of digital content, and the promotion of equitable access at all educational levels. Notably, ESDP-6 underscores the importance of leveraging e-learning, online courses, and the establishment of digitally intensive secondary schools to foster inclusivity. Concurrently, GEQIP aims to diminish disparities through enhancements in infrastructure, teacher training, and the provision of digital resources.

However, a current study examining Ethiopian high schools reveals that despite the commitment to promoting digital inclusion outlined in these policies, significant implementation gaps remain. These gaps are largely attributable to inadequate infrastructure, insufficient technological knowledge among teachers (TK and TPACK), and a scarcity of localized digital resources. Such barriers disproportionately impact students with disabilities who require adaptive technologies and specialized digital content to fully engage with the educational system. Addressing these challenges necessitates targeted policy interventions, including the integration of accessibility standards into ICT procurement processes, the allocation of funding for adaptive devices, and the establishment of mandatory digital literacy training grounded in universal design principles. These measures are essential for translating the inclusive aspirations of national strategies into actionable outcomes and ensuring that the inclusion of students with disabilities is not overlooked in Ethiopia's ongoing digital transformation in education.

Despite global progress in technology and a growing acknowledgment of its potential to enhance inclusive education, young students with disabilities in Ethiopian schools encounter significant barriers to accessing and effectively utilizing digital tools. These obstacles include the limited availability of assistive technologies, insufficient infrastructure, and teacher training and awareness regarding using digital resources for inclusive education. Recognizing these challenges is essential for developing strategies that ensure all students, regardless of their abilities, can take advantage of digital advancements (Franck & Joshi, 2016).

This study explores the access to and barriers facing young students with disabilities regarding digital technology in Ethiopian schools. By investigating the primary challenges they encounter, the influence of digital tools on their learning outcomes, and their views on the effectiveness of these technologies in addressing their educational needs, this research seeks to contribute to the ongoing conversation about digital inclusion and equitable education in Ethiopia.

Research Questions

To tackle the complex challenges and opportunities related to digital inclusion for students with disabilities, this study aimed to explore their experiences with digital technologies in Ethiopian schools comprehensively. By analyzing the factors that affected technology acceptance and adoption and the barriers that impeded access, this research intended to offer valuable insights into the dynamics of digital readiness and inclusion. The following research questions (RQs) guided this inquiry:

- **RQ1:** What was the status of students with disabilities regarding digital readiness support, perceived usefulness, ease of use, and trust in digital tools?
- **RQ2:** How did digital readiness support, perceived usefulness, ease of use, and trust influence the willingness of students with disabilities to adopt digital tools?
- **RQ3:** What were the perceptions of young students with disabilities regarding the effectiveness of digital technologies in supporting their educational needs in Ethiopian schools?
- **RQ4:** What were the critical barriers to young students with disabilities accessing digital technologies in Ethiopian schools?

REVIEW OF RELATED LITERATURE

Digital inclusion has emerged as a fundamental aspect of contemporary educational frameworks, especially during the COVID-19 pandemic. Researchers globally have investigated the impact of digital tools

and inclusive education on enhancing the learning experiences of students, particularly those with disabilities. This literature review consolidates existing studies on digital inclusion, assistive technologies, and the barriers to implementing inclusive education. It emphasizes both international perspectives and the specific context of Ethiopia, aiming to provide a comprehensive understanding of the challenges and opportunities in these domains.

Global Perspectives on Digital Inclusion and Assistive Technologies

The intersection of digital inclusion and assistive technologies has gained significant attention in recent years, particularly as the COVID-19 pandemic has accelerated the reliance on digital tools for educational access. Peruzzo and Allan (2024) conducted a comprehensive study examining this phenomenon across six countries, revealing how digital and non-digital technologies are reshaping the landscape of inclusion in education. Their research challenges traditional binary definitions such as included/excluded and modern/colonial by presenting a framework that emphasizes five crucial concepts: accessibility, affectivity, presentness, interdependency, and relatedness. These concepts serve as foundational pillars for reforming inclusive education practices, suggesting that technologies designed with community involvement and local knowledge in mind are vital for creating equitable educational environments.

Expanding upon the theme of digital inclusion, Mavrou et al. (2017) investigated factors influencing the utilization of information and communication technology and assistive technology (ICT-AT) across five European nations. Their findings illustrate the transformative potential of ICT-AT in fostering independence, social integration, and employment opportunities for individuals with disabilities. Nonetheless, the study identifies various persistent challenges, including insufficient training, limited resource availability, and barriers to digital competence. In response, the authors strongly advocate for customized policy responses to bridge the digital divide, suggesting that targeted interventions are essential to enhance the inclusion of people with disabilities in the digital realm.

In a complementary analysis, Tsatsou (2019) explored the diverse digital experiences of various disability groups, underscoring the need for a nuanced understanding of how individuals with disabilities interact with technology. By focusing on the individuality and selectiveness of user experiences, Tsatsou (2019) argues for a departure from broad disability classifications in research. This approach fosters a more profound comprehension of personal agency and its influence on digital inclusion, promoting a more tailored perspective in developing assistive technologies.

Moreover, Manzoor and Vimarlund (2018) conducted a thorough literature review that contextualizes the broader implications of technology within social frameworks. Their examination of digital technologies and social inclusion reveals a growing array of ICT-based applications to support individuals with disabilities. However, they note that the overall effectiveness of these technologies is often indeterminate, emphasizing the need for further empirical investigation. Their work highlights the importance of understanding the audience's potential contributions in determining which technologies can most effectively facilitate social integration, thus framing an agenda for future research.

Pérez-Escolar and Canet (2023) undertook a systematic review examining the interplay between vulnerable populations and digital inclusion. Their research encompassed an analysis of 331 scholarly publications, revealing that demographics such as older adults, individuals with disabilities, and low-income groups are significantly affected by digital exclusion. The authors emphasize the necessity of enhancing digital literacy, providing equitable access to technology, and developing tailored support systems to effectively bridge the digital divide and promote social inclusion for these at-risk populations.

In a complementary study, Hoyos Muñoz and Cardona Valencia (2023) performed a bibliometric analysis to assess digital divide and inclusion trends. Their findings highlighted persistent disparities in technology access, digital skills, and usage patterns among vulnerable groups. Hoyos Muñoz and Cardona Valencia (2023) advocate for comprehensive policy initiatives that improve technical access and address the broader socio-economic determinants contributing to digital inequality. Their recommendations aim to foster sustainable development and empower marginalized communities through enhanced digital engagement.

To substantiate these findings, it is pertinent to consider real-world examples of successful initiatives that effectively integrate assistive technology into educational settings. For instance, programs that employ

community collaboration to introduce assistive technologies in schools demonstrate practical applications of theoretical concepts and highlight the significance of localized solutions in overcoming barriers to digital inclusion. This holistic approach reinforces the idea that effective policies must prioritize collaborative methodologies, customized training, and resource allocation to address the unique needs of individuals with disabilities.

The literature underscores a critical need for an interdisciplinary approach that merges technological innovation with community engagement to enhance digital inclusion. By prioritizing actionable solutions and recognizing the diversity of user experiences, stakeholders can contribute to creating a more inclusive and equitable digital landscape for individuals with disabilities. Future research should continue to explore practical strategies, ensure robust empirical validation, and advocate for policies that truly reflect the complexities of digital inclusion in a rapidly evolving technological landscape.

Relationships Between Technology Acceptance and Willingness to Adopt

The relationships between technology acceptance and the willingness to adopt new educational tools, particularly artificial intelligence (AI), are multifaceted and warrant a systematic exploration. This section critically evaluates the literature regarding various determinants influencing technology adoption, particularly emphasizing the context of students with disabilities.

Nouraldeen (2023) provides a foundational understanding of how technology readiness and perceived ease of use are critical determinants of students' adoption of AI. The study highlights that perceived usefulness significantly impacts students' willingness to engage with digital tools. While the focus does not explicitly address students with disabilities, the findings have broader implications. They suggest educational institutions must enhance technology readiness and formulate strategies to meet diverse accessibility needs. This emphasizes the necessity of addressing not only the technical readiness of students but also ensuring that educational tools are designed to be user-friendly and effectively address individual requirements.

Building on the importance of perceived usefulness, Abdul-Kareem and Oladimeji (2024) investigate the role of trust and digital literacy in e-government adoption. Their research uncovers that trust enhances users' perceptions of usefulness and ease of use, facilitating higher adoption rates. This finding is particularly significant for students with disabilities, who often face unique challenges related to privacy and accessibility. The inclusion of trust as a central component underscores the need for reliable technological systems that cater to diverse student needs. This perspective builds a critical argument that without addressing issues of trust and creating dependable systems, efforts to enhance digital engagement among students with disabilities may fall short, leading to further exclusion in educational contexts.

In a quantitative analysis, Sudaryanto et al. (2023) explore the factors influencing AI adoption among students, focusing on technology readiness and perceived ease of use. Although the primary demographic consists of accounting students, their conclusions resonate with students across various fields, particularly those with disabilities. The study reiterates that perceived ease of use and usefulness are critical to driving technology adoption. However, it raises a pressing question: Are the tools being developed adequately customized to meet the specific needs of disabled learners? The authors suggest that fostering an inclusive educational landscape hinges on developing tools uniquely designed to align with usability and accessibility principles. This assertion is crucial, as it illuminates the gaps in current practices concerning adopting AI and other assistive technologies.

In summary, the literature reveals a complex interrelationship between technology acceptance, perceived usefulness, ease of use, and trust, particularly concerning students with disabilities. A critical analysis of these studies indicates that while significant strides have been made in understanding these dynamics, there remains a pressing need for research and development to focus on creating inclusive educational environments. Future investigations must prioritize the unique challenges faced by students with disabilities, ensuring practical and equitable technological solutions, thereby fostering a genuinely inclusive educational experience.

Barriers to Digital Inclusion: Economic, Infrastructural, and Attitudinal

Digital inclusion remains a critical area of inquiry as societies increasingly rely on technology for daily functions, education, and social participation (Welesilassie & Nikolov, 2024a). This section synthesizes recent literature that addresses the multifaceted barriers affecting digital inclusion, mainly focusing on economic, infrastructural, and attitudinal dimensions.

Economic factors play a vital role in determining access to digital technologies. Kaarakainen and Saikkonen (2023) illuminate how educational disparities significantly affect digital skills among Finnish adolescents. Their research underscores that students who have experienced interruptions in their education face more significant challenges in acquiring digital competencies. Those with learning difficulties mainly exhibit lower proficiency in digital tools, highlighting a cyclical relationship where educational disadvantage perpetuates digital exclusion. The authors argue for systemic interventions to mitigate educational inequalities, which could foster more significant levels of digital literacy and inclusion. This finding reflects a broader theme in the literature, indicating that economic constraints, such as the cost of devices and the Internet access, remain formidable barriers that exacerbate existing inequities.

Infrastructural limitations present further obstacles to achieving digital inclusion, as evidenced by the study by Khanlou et al. (2020). Their scoping review pinpointed significant barriers faced by young adults with developmental disabilities (DD) in accessing digital technologies. The lack of adequate training programs, prohibitive costs related to necessary technologies, and insufficient infrastructure are critical barriers delineated in their findings. These limitations restrict the ability of individuals to engage fully in the digital landscape, undermining efforts to promote their autonomy and social integration. The authors advocate for developing targeted policies to enhance accessibility and support systems, emphasizing that marginalized groups will continue to experience heightened exclusion in the digital domain without these measures.

Newman et al. (2016) provide valuable insights into the attitudinal barriers that hinder digital inclusion for young people with disabilities in South Australia. Their research indicates that, despite the potential of digital tools to enhance social participation, several challenges impede access. These include inadequate family support and insufficient digital skills, which often stem from pervasive societal attitudes towards disabilities. The authors propose a need for personalized and sustained support mechanisms to address the challenges faced by this demographic effectively. This signifies that attitudes towards disability can significantly affect individuals' opportunity and motivation to engage with digital technologies. The intersection of these attitudinal and structural factors suggests that fostering a more inclusive digital culture requires a comprehensive approach that addresses mindset and resource allocation.

The literature underscores the complex interplay between economic, infrastructural, and attitudinal barriers that impede digital inclusion for various populations, particularly those with disabilities. Addressing these barriers is not merely an issue of improving access to technology; it involves a broader commitment to social equity, highlighting the need for systemic changes in educational and policy frameworks. Future research should focus on longitudinal studies that evaluate the effectiveness of policy interventions designed to enhance digital inclusion, ensuring that all individuals, regardless of their circumstances, can engage meaningfully in our increasingly digital world.

Ethiopian Context: Challenges and Opportunities in Inclusive Education

The pursuit of inclusive education in Ethiopia has garnered attention in recent years, with several studies shedding light on the multifaceted challenges and opportunities present within this educational framework (Welesilassie & Gerencheal, 2025). A common theme across the literature is the recognition that while there is a favorable disposition towards inclusive education among educators, substantial barriers continue to impede its effective implementation.

Ginja and Chen (2021) investigated the role of teacher training and attitudes in shaping inclusive education practices. Their research indicates that while teachers generally possess a favorable understanding of inclusivity, the lack of adequate preparation and instructional resources presents significant challenges. The authors call for a systemic overhaul, arguing that comprehensive teacher training programs and improved resource allocation are critical for advancing the inclusion of students with disabilities. This perspective

highlights the necessity of fostering a positive attitude among educators and providing them with the tools and support essential for actualizing inclusive practices in the classroom.

Building on this discourse, Hankebo (2018) evaluates the implementation of inclusive education at Jegnoch Metasebiya Primary School, emphasizing the school's efforts to enhance enrollment among children with disabilities. Despite these efforts, Hankebo (2018) underscores a troubling gap in training and systemic support, suggesting that mere enrollment does not equate to meaningful inclusion. The research advocates for robust teacher training and resource provisions to cultivate an environment conducive to inclusivity. This finding aligns with Ginja and Chen's (2021) recommendations, reinforcing that systemic reforms are imperative for fostering equitable educational opportunities.

Geleta (2019) further expands the conversation by examining the perspectives of school principals and teachers in Sebeta Town. The study reveals a persistent optimism among stakeholders towards inclusive education; however, it identifies resource limitations and inadequate training as primary obstacles. The suggestion that smaller class sizes and continuous professional development could enhance the implementation of inclusive education resonates with the findings of Ginja and Chen (2021), suggesting a broader consensus on necessary interventions. This finding is consistent with phenomenological evidence showing that students with disabilities face a range of interrelated barriers and enabling conditions that shape their participation in physical activity and sports (Mawena & Sorkpor, 2025)

Similarly, Franck and Joshi (2016) address the dichotomy between positive attitudes toward inclusion and the practical challenges faced in Ethiopia's urban and rural contexts. Their study emphasizes that societal stigma and insufficient training and resources often undermine the potential for effective inclusion. The authors advocate for targeted efforts to improve teacher competencies and resource availability, reiterating the importance of a multifaceted approach to overcome barriers to inclusive education.

In summary, the literature reveals that while there is a significant acknowledgment of the importance of inclusive education in Ethiopia, numerous systemic challenges persist. The findings underscore the critical need for enhanced teacher training, adequate resource allocation, and broader societal support to foster an educational environment that genuinely includes all learners. Future research should explore the effectiveness of these proposed interventions and consider the voices of students with disabilities to create a more holistic understanding of inclusive education in Ethiopia.

Digital and Assistive Technologies in Ethiopia

In recent years, the discourse on inclusive education and digital accessibility for students with disabilities has gained traction, particularly in Ethiopia. This literature review critically examines studies on students' experiences with visual impairments and stakeholders' perspectives regarding inclusive education for children with DD.

Dabi and Golga (2023) conducted a pivotal study highlighting students' experiences with visual impairments (SVIs) navigating web-based information within Ethiopian higher education institutions. Their findings reveal that the accessibility challenges stem from poorly designed web interfaces, incompatible assistive technologies, and inadequate technical support. These barriers impede SVIs' access to crucial educational resources, exacerbating educational attainment inequalities. Despite the significant challenges identified, the determination exhibited by these students underscores a resilient spirit that is both commendable and concerning. It suggests a systemic neglect of the necessary provisions for accessible education–an issue that calls for immediate attention from educational institutions and policymakers. The authors argue convincingly about the urgent need to enhance web accessibility and bolster the technical infrastructure to foster a more inclusive digital environment. This aligns with global best practices in educational accessibility and highlights a critical area for intervention in Ethiopian higher education.

In a complementary study by Burningham et al. (2024), the focus shifts to the perspectives of various stakeholders regarding inclusive education for children with DD in Addis Ababa. The research outlines the potential benefits of inclusive education, notably enhanced social outcomes for children with DD. However, the study does not shy away from addressing the multifaceted challenges that practitioners face, including bullying experiences and inadequate support mechanisms. This dual focus on the benefits and challenges presents a nuanced view essential for developing a comprehensive strategy for inclusive education. The

authors make a compelling case for targeted enhancements in teacher training, infrastructure, and community awareness, indicating that success in inclusive education necessitates a collaborative approach that extends beyond the classroom into the wider community.

Abebe et al. (2023) expand upon the discourse by examining the broader challenges and supports related to inclusive education for students with disabilities in Ethiopia and Ghana. This study identifies various psychosocial, physical, systemic, and resource-related barriers that hinder educational access. Such a thorough categorization of challenges illustrates the complex interplay of factors in the educational ecosystem. Interestingly, the authors emphasize the role of personal coping strategies and the importance of emotional and material support as critical facilitators in overcoming these barriers. This finding highlights the resilience of students and the potential for grassroots solutions that rely on community and familial support while also advocating for a comprehensive multisectoral approach.

These studies portray a landscape fraught with challenges yet characterized by resilience and potential for growth within Ethiopia's inclusive education framework. The highlighted need for improving technical infrastructure, enhancing teacher training, and fostering community awareness resonates across the research. Therefore, stakeholders, including educators, policymakers, and community organizations, have a compelling impetus to collaborate to address the systemic barriers and individual support necessary for promoting inclusive education. In conclusion, Ethiopia's educational reforms must integrate these insights to advance towards a more equitable and inclusive educational system for all students, particularly those with disabilities.

Digital Inclusion and Vulnerable Populations in Ethiopia

Several research gaps persist in the literature regarding digital inclusion for students with disabilities, particularly in low-income contexts such as Ethiopia. Firstly, while studies by Ginja and Chen (2021) and Franck and Joshi (2016) address inclusive education in Ethiopia, they neglect the specific challenges associated with digital inclusion. These studies often lack detailed empirical data on the engagement of Ethiopian students with disabilities with digital tools, especially considering the infrastructural and economic constraints present in the region. Additionally, future research should aim to move beyond generalized classifications of disabilities to understand better the role of personal agency in influencing digital inclusion and its implications for social inclusion.

Secondly, the literature on the availability and implementation of assistive technologies in low-resource settings is sparse. Although studies like those of Dabi and Golga (2023) and Mavrou et al. (2017) acknowledge the significance of assistive technologies, they fall short of addressing the challenges of underutilization and inaccessibility in Ethiopian schools. Factors such as technical incompatibilities and the absence of localized digital content further complicate the effective integration of these tools within low-resource environments, leaving a critical gap in understanding how assistive technologies can be utilized in Ethiopia.

Moreover, Ethiopia's economic and financial barriers to digital inclusion have not been sufficiently explored. While research by Abebe et al. (2023) and Burningham et al. (2024) alludes to financial constraints, there is a lack of detailed examination into how issues of affordability–particularly the high costs of digital devices and the Internet access–specifically affect students with disabilities. Furthermore, the impact of inadequate school funding on these challenges has not been thoroughly investigated in existing literature.

Additionally, the existing research inconsistently addresses teachers' preparedness and cultural attitudes toward disability and technology usage. Although Ginja and Chen (2021) report generally favorable attitudes toward inclusion, other findings do not universally support this perspective. This highlights educators' resistance and a lack of training in utilizing digital tools for students with disabilities. Additionally, studies like Yeshanew et al. (2023) identify significant cultural barriers, yet empirical research examining how these attitudes specifically obstruct digital inclusion remains limited.

Finally, the existing literature predominantly explores the nexus between technological acceptance and the willingness to adopt digital tools, yet it frequently neglects the perspectives of students with disabilities. Most studies focus on variables such as perceived ease of use, utility, and digital readiness within broader student populations, failing to adequately address the unique accessibility and usability challenges faced by this group. Moreover, most of the research utilizes single-method approaches, primarily quantitative, which

limits the depth of understanding regarding the nuanced experiences and barriers encountered by students with disabilities. This emphasis on a narrow methodological framework highlights a critical gap in the literature, indicating the necessity for research that combines quantitative and qualitative methodologies. Such an approach would facilitate a comprehensive analysis of the specific accessibility requirements of students with disabilities in the context of technology adoption.

Theoretical Frameworks of Digital and Inclusive Education

The technology acceptance model (TAM) is an essential framework for individuals' technology acceptance and utilization. This model is predicated on two principal constructs: perceived usefulness, which refers to the extent to which an individual believes that technology will enhance performance, and perceived ease of use, signifying the belief that the technology will require minimal effort to operate. In this study, TAM is applied to evaluate how students with disabilities perceive and adopt technology quantitatively, thus illuminating the factors contributing to their engagement with digital tools.

In parallel, the digital divide theory (DDT), articulated by van Dijk (2005), addresses the disparities between individuals who have access to and can effectively utilize digital technologies and those who face barriers. This divide is influenced by many factors, including socioeconomic status, geographic location, educational attainment, and, notably, physical or cognitive disabilities. van Dijk (2005) delineated three distinct levels of the divide: the access divide, which pertains to the physical availability of digital devices and the Internet connectivity; the skills divide, focusing on the capacity to employ technology proficiently; and the usage divide, which encompasses variances in technology utilization often correlated with levels of digital literacy. Such discrepancies can exacerbate social inequalities, limiting individual opportunities, particularly within educational contexts (Hoyos Muñoz & Cardona Valencia, 2023; Tsatsou, 2019). The theory has been instrumental in investigating the disproportionate impact of digital exclusion on vulnerable demographics, including students with disabilities, underscoring the necessity for targeted policy interventions aimed at fostering equitable access (Mavrou et al., 2017).

The integration of TAM and the DDT within this study yields significant insights. TAM provides a quantitative lens through which the acceptance of technology by students with disabilities can be assessed, drawing particular attention to their perceptions regarding ease of use and usefulness. Concurrently, the DDT facilitates a qualitative examination of the barriers faced by these students, such as inadequate access to technology, insufficient digital skills, and limited opportunities for practical technology use. By synthesizing these two theoretical frameworks, the study not only elucidates how students perceive and engage with technology but also emphasizes the broader societal and structural impediments that may obstruct their capacity to realize the benefits of digital inclusion fully. This comprehensive perspective enhances the understanding of attitudinal and systemic factors influencing technology utilization among students with disabilities.

METHODOLOGY

Research Design

This study employed an explanatory sequential mixed-methods research design (Creswell & Guetterman, 2020) to investigate the access and barriers to digital technology for young students with disabilities in Ethiopian schools. The research was conducted in two phases: a quantitative phase followed by a qualitative phase. This approach allowed for a comprehensive understanding of the challenges faced by these students and the factors influencing digital inclusion.

Phase 1. Quantitative method

A sample of 87 young students with disabilities was selected from secondary schools in the Tigray region of Ethiopia. Using stratified random sampling (Creswell & Guetterman, 2020), participants were chosen to ensure representation across different types of disabilities, school settings (urban vs. rural), and socio-economic backgrounds.

Phase 2. Qualitative method

A purposive sample of 12 students with disabilities from the quantitative phase was selected for in-depth interviews. These participants were chosen based on their survey responses to capture diverse experiences related to digital access and use.

Data Collection Methodology

Upon securing the necessary approvals from the research committee at Akusm University, the second author informed potential participants about the study's objectives, methodologies, benefits, and associated risks. The research employed a mixed-methods approach, utilizing structured questionnaires and semi-structured interviews as data collection instruments. A comprehensive content validation procedure was implemented to ensure the questionnaire's reliability and relevance, drawing on established methodologies (Creswell & Guetterman, 2020; Dörnyei & Taguchi, 2009).

Structured questionnaires

A structured questionnaire was formulated to collect data about students' digital readiness support, perceived ease of use, perceived usefulness, digital trust, and willingness to use digital tools. The items included in the questionnaire were adapted from validated instruments from prior studies and underwent expert reviews to affirm their clarity and relevance. Consultation with experienced English as a foreign language (EFL) educators and educational researchers was integral to aligning the items with the constructs they were intended to measure. Following this, a pilot study with a select group of students was conducted, resulting in refinements aimed at improving the clarity and precision of the instrument.

The questionnaire comprised six main sections:

1. **Basic background information:** This section collected crucial demographic and educational data from Ethiopian students with disabilities. Information gathered included age, gender, grade level, school location, type and duration of disability, and details regarding the assistive technologies employed and any specialized support or training services received.
2. **Digital readiness support:** This construct assessed the support mechanisms available to students with disabilities for digital readiness, utilizing five items adapted from Teo (2011). An example item reads: "When I encounter difficulties using technology, a specific person is available to assist."
3. **Perceived ease of use:** This construct aimed to evaluate how easily students with disabilities can use AI technologies. Five items were adapted from sources, including Teo (2011), Venkatesh and Bala (2008), Davis (1989), and Zhang et al. (2019). An illustrative item states: "Learning to use technology is easy for me."
4. **Perceived usefulness:** This construct measured students' perceptions of AI technology's impact on teaching effectiveness. Five items were derived from the work of Teo (2011), Venkatesh and Bala (2008), Davis (1989), and Zhang et al. (2019), with one example item being: "Using technology enhances my effectiveness."
5. **Digital trust:** This aspect assessed the level of trust that students with disabilities place in AI technologies, incorporating five items from established researchers such as Choung et al. (2023), Zhang et al. (2024), Choi and Ji (2015), and Zhang et al. (2019). An example item in this category is: "Smart technologies keep their commitments and deliver on their promises."
6. **Willingness to adopt AI:** This construct gauged educators' openness to integrating AI technology into their pedagogical and research practices. Five items were adapted from the literature, including Venkatesh and Bala (2008), Venkatesh and Davis (2000), and Lu et al. (2024). An illustrative item states: "I am willing to use AI technology for assisted teaching and research."

Participants completed the structured questionnaire using pencil-and-paper formats. They indicated their level of agreement or disagreement on a six-point Likert scale, ranging from "strongly disagree" to "strongly agree," facilitating quantitative data analysis.

Semi-structured interviews

This study employed semi-structured interviews to comprehensively understand participants' experiences with digital technology, the barriers they encounter, and their perceptions of the efficacy of digital tools in addressing their educational needs. To ensure participant comfort and accuracy, interviews were conducted in the participants' preferred languages and settings. The primary focus of the interviews was to address two key RQs.

1. **Attitude towards digital effectiveness:** This interview segment explored the perspectives of young students with disabilities regarding the effectiveness of digital technologies in meeting their educational requirements within Ethiopian schools. The responses garnered valuable insights into students' perceptions of digital tools' role in enhancing their learning experiences and supporting their academic advancement.
2. **Barriers to accessing digital technologies:** This section aimed to identify the principal barriers faced by young students with disabilities in accessing digital technologies within Ethiopian educational contexts. Findings highlighted the challenges that limit their ability to utilize these digital tools to fulfill their educational needs effectively.

Data Analysis

Data analysis was conducted using IBM SPSS 25, where descriptive statistics were employed to evaluate the quantitative data, and structural equation modeling (SEM) was utilized to examine the predictive relationships between independent and dependent variables. Participants responded to six open-ended interview questions regarding their attitudes toward digital effectiveness and barriers to accessing digital technologies. Qualitative data were meticulously organized, transcribed, and analyzed manually. Following Creswell and Guetterman's (2020) methodology, the data were read, annotated, and segmented into manageable parts. Manual analysis was selected over computer-based methods due to the relatively small size of the dataset (less than 500 pages of transcripts) and the desire for an in-depth, hands-on engagement with the material. The data were systematically distilled into multi-level categories, encompassing primary and subcategories. Ultimately, the findings were synthesized into significant themes, accompanied by comprehensive narrative discussions and interpretations.

Integration of Quantitative and Qualitative Data

This study employed a mixed-methods approach, combining quantitative data from structured questionnaires with qualitative insights from semi-structured interviews. This methodology aimed to provide a comprehensive understanding of the experiences of Ethiopian students with disabilities in their engagement with digital technologies. The quantitative component yielded measurable trends concerning critical variables such as digital readiness, perceived ease of use, usefulness, and trust. In contrast, the qualitative data illuminated these students' experiences and challenges, offering a richer narrative context. By systematically comparing and contrasting these two data sets, the study facilitated a nuanced and multidimensional interpretation of the findings, enhancing the overall analysis and contributing to a deeper understanding of the subject matter.

Ethical Considerations

Ethical approval for this research was obtained from the Institutional Research Ethics Committee of the College of Social Sciences and Language at Aksum University (Approval No. AKU/CSSL/419/11/21). The study adhered to established ethical protocols, and formal permissions alongside informed consent were secured from all participants in accordance with these ethical guidelines. Approval reference: AKU/CSSL/419/11/21, Institutional Research Ethics Committee, College of Social Sciences and Language, Aksum University, Ethiopia.

RESULTS

This section comprehensively examines the principal findings related to our research inquiries. It includes a presentation of descriptive statistics, such as means (Ms), standard deviations (SDs), and outcomes from the Shapiro-Wilk test. It applies to inferential statistical methods through SEM to investigate the interrelations

Table 1. Status of digital readiness support, usefulness, ease of use, trust in digital tools, and willingness to use

Variable	Minimum	Maximum	M	SD	Shapiro-Wilk test statistic	p-value
Digital readiness support	1	4	2.3	0.90	.97	.11
Perceived ease of use	1	4	2.4	1.00	.96	.08
Perceived use	2	6	4.5	1.40	.96	.10
Perceived trust	1	5	4.2	1.01	.95	.09
Willingness to use digital tools	2	6	4.7	1.50	.96	.08

Table 2. Fit indexes for the measurement models of the six variables

Variable scales	X2/df	CFI	TLI	GFI	RMSEA	α
Digital readiness support	2.04	.96	.96	.98	.03	.81
Perceived ease of use	2.11	.97	94	.99	.05	.79
Perceived use	2.24	.98	.98	.98	.04	.82
Perceived trust	1.89	.96	.99	.96	.05	.71
Willingness to use digital tools	2.67	.97	.96	.99	.06	.90

among the variables. Additionally, the qualitative aspect employs thematic analysis to identify and clarify coding patterns. The reported results are closely aligned with our RQs, highlighting notable outcomes while maintaining a clear distinction between the presentation of results and their interpretation, which is reserved for the forthcoming discussion section.

Results Analysis From the Quantitative Study

RQ1: What was the status of students with disabilities regarding digital readiness support, perceived usefulness, ease of use, and trust in digital tools?

The analysis of the Likert scale responses, as presented in **Table 1**, indicated that participants reported minimal levels of digital readiness support, accompanied by a limited perception of ease of use. Specifically, the average score for digital readiness support was 2.3 (SD = 0.9), indicating a general perception of insufficient digital readiness support, with minimal variability among responses effectively. Similarly, the mean perceived ease of use score was 2.4 (SD = 1.0), signifying a low to moderate perception of using digital tools. In contrast, the measures for perceived use, perceived trust, and willingness to use digital tools were more positive, with mean scores of 4.5 (SD = 1.4), 4.2 (SD = 1.01), and 4.7 (SD = 1.5), respectively. These findings highlight a more optimistic perspective regarding participants' perceptions, trust, and willingness to use digital tools.

RQ2: How did digital readiness support, perceived usefulness, ease of use, and trust influence the willingness of students with disabilities to adopt digital tools?

In investigating RQ2, which examines the causal relationships among the variables, we employed AMOS version 23.0 for SEM. This methodology segmented the SEM into two distinct components: a measurement model and a structural model. The measurement model utilized the maximum likelihood estimation technique. We conducted confirmatory factor analyses to assess the reliability and validity of the proposed constructs, ensuring that the latent variables accurately represented the intended theoretical constructs. The study referred to fit indices such as the root mean square error of approximation (RMSEA), goodness of fit index (GFI), Tucker-Lewis index (TLI), and comparative fit index (CFI), in line with the recommendations provided by previous research (Tseng et al., 2006). For a model to demonstrate an acceptable goodness of fit, the GFI, TLI, and CFI should ideally exceed .90, while the RMSEA should fall within the range of .05 to .08 (Taguchi et al., 2009; Tseng et al., 2006). To adhere to established standards, certain items were omitted from the measurement models due to their inadequate factor loadings, which were below the acceptable threshold of .50 (Tseng et al., 2006). The results delineated in **Table 2** confirm that the reliability and fit indices of the model met the requisite criteria for acceptance.

Table 3 delineated the findings from the SEM analysis that investigated the predictors of individuals' willingness to utilize digital tools. The results indicated that digital readiness support significantly predicted this willingness, with a standardized coefficient (β = 0.25, standard error [SE] = 0.10, critical ratio [CR] = 2.50, p = .012). This suggested increased support correlated positively with a greater willingness to engage with digital tools.

Table 3. SEM results for predicting willingness to use digital tools

Predictor	Dependent variable	β	SE	CR	p-value
Digital readiness support	Willingness to use digital tools	0.25	0.10	2.50	.012
Perceived ease of use	Willingness to use digital tools	0.30	0.11	2.73	.006
Perceived use	Willingness to use digital tools	0.45	0.09	5.00	.011
Perceived trust	Willingness to use digital tools	0.38	0.12	5.13	.021

Notes. B: standardized regression coefficient; SE: standard error; CR: critical ratio; p-value: significance level.

Table 4. Attitude of Ethiopian high school students with physical disabilities on the effectiveness of digital technologies

Thematic area (major theme)	Sub-themes	Specific student responses
Learning outcomes	Positive impact on learning	"Digital tools help me understand concepts better and improve my grades."
	Supports independent learning	"I can learn by myself using digital tools, even without direct help from teachers."
Engagement in lessons	Increases student engagement	"I stay more focused and interested in class when digital technologies are used."
Educational productivity	Improves productivity in assignments	"Digital tools make it faster and easier to complete assignments and projects."
Information access	Provides access to diverse resources	"I can easily access different learning materials and information online that help my studies."
Teaching and feedback	Facilitates better feedback from teachers	"Teachers use digital tools to give quicker feedback on my work, which helps me improve."

Furthermore, perceived ease of use emerged as another significant contributor, evidenced by a β value of 0.30, SE = 0.11, CR = 2.73, p = .006. Notably, the variable of perceived usefulness demonstrated the most substantial predictive effect, with a β = 0.45, SE = 0.09, CR = 5.00, p = .011. Additionally, perceived trust played a crucial role, exhibiting a β = 0.38, SE = 0.12, CR = 5.13, p = .021. These findings collectively underscored the significance of perceived ease of use and trust in shaping students' willingness to adopt digital tools.

Results Analysis From the Qualitative Study

In this section, we present the interview findings on participants' attitudes toward the effectiveness of digital technologies and the barriers they face in accessing these tools.

RQ3: What were the attitudes of young students with disabilities regarding the effectiveness of digital technologies in supporting their educational needs in Ethiopian schools?

Table 4 illustrates the perceptions of Ethiopian high school students with physical disabilities regarding the efficacy of digital technologies in addressing their educational needs. The findings indicated that students perceived a positive correlation between using digital tools and learning outcomes, noting enhancements in conceptual understanding and academic performance. Participants reported that these technologies facilitated independent learning, fostered greater engagement during lessons, and increased productivity in completing assignments and projects. Furthermore, the accessibility to a wide array of online resources significantly enriched their educational experience. The immediacy of feedback from educators via digital platforms was also regarded as advantageous for academic advancement. Students acknowledged digital technologies' substantial role in enhancing their learning processes.

RQ4: What were the critical barriers to young students with disabilities accessing digital technologies in Ethiopian schools?

According to **Table 5**, the investigation revealed significant infrastructural challenges and deficiencies in assistive technologies that adversely affect students with disabilities in educational institutions across Ethiopia. Key infrastructural issues included inadequate Internet connectivity, erratic electricity supply, and restricted access to technology facilities. Students reported frequent Internet disruptions, power outages, and the inaccessibility of computer labs. Furthermore, many schools were found to lack the essential technical infrastructure and support for the effective deployment of digital tools.

Regarding assistive technologies, students noted the absence of accessible software such as screen readers and the unavailability of Braille keyboards. The existing assistive devices were often outdated and prone to malfunction, with a scarcity of localized content compounding the problem. Compatibility issues

Table 5. Infrastructural challenges

Thematic area (major theme)	Sub-themes	Specific student responses
Infrastructural challenges	Poor internet connectivity	"The Internet is prolonged and often disconnects."
	Lack of reliable electricity	"There is no electricity to charge devices regularly."
	Limited access to technology spaces	"It is hard to find accessible computer labs."
	Inadequate technical infrastructure	"The school lacks adequate technical infrastructure for digital tools."
Inadequate assistive technologies	Lack of accessible software	"I cannot find screen readers or voice commands."
	Lack of accessible hardware	"No Braille keyboards available."
	Poor quality of assistive devices	"Assistive devices are outdated and unreliable."
	Lack of localized digital content	"Digital tools are not available in local languages."
	Lack of device compatibility	"New software is not compatible with older devices."

Table 6. Economic constraints

Thematic area (major theme)	Sub-themes	Specific student responses
Economic constraints	High cost of digital devices	"Cannot afford a laptop or tablet." "Assistive software is too costly for schools to buy."
	High cost of internet access	"The Internet is too expensive."
	Inadequate school funding for technology	"School cannot afford digital tools for all students." "Limited funds for maintaining digital infrastructure."
	Lack of financial support programs	"No financial support for students to purchase digital devices."

Table 7. Social and attitudinal barriers

Thematic area (major theme)	Sub-themes	Specific student responses
Social and attitudinal barriers	Social exclusion in digital settings	"Feel isolated and ignored in digital classes." "Peers and teachers often lack empathy for our challenges."
	Exclusion from collaborative activities	"Students with disabilities are often excluded from digital projects."
	Lack of awareness and understanding	"People do not understand our digital needs." "Digital tools are not seen as a priority for students with disabilities."
	Negative attitudes towards disability	"Teachers have low expectations for students with disabilities."

between contemporary software and older hardware contributed to the challenges faced by students. These findings highlight the urgent need for enhancements in both infrastructural support and the availability of appropriate assistive technologies to foster greater digital inclusion for students with disabilities.

Table 6 offers a comprehensive overview of the economic challenges Ethiopian students with physical disabilities encounter in accessing digital educational tools. Key constraints include the prohibitive costs associated with digital devices, as evidenced by responses indicating an inability to afford necessary equipment, such as laptops or tablets. Additionally, comments noting the expense associated with connectivity highlight the high costs of the Internet access.

Furthermore, inadequate funding for schools to invest in technology is reflected in statements about the inability to provide digital tools for all students and limited resources for maintaining digital infrastructure. Lastly, the lack of financial support programs is underscored by remarks indicating the absence of assistance for students seeking to purchase digital devices.

The preceding analysis as shown in **Table 7**, elucidates the multifaceted social and attitudinal barriers encountered by Ethiopian students with physical disabilities in their pursuit of accessing digital educational tools. These barriers manifest as social exclusion within digital environments, highlighted by testimonies indicating feelings of isolation, such as "I felt isolated and ignored in digital classes," and a perceived lack of empathy from peers and educators, exemplified by statements like "peer and teacher responses often lacked understanding of our challenges." Furthermore, students with disabilities frequently experience exclusion from collaborative activities, evidenced by comments indicating that "students with disabilities were often sidelined in digital projects."

Table 8. Physical accessibility issues

Thematic area (major theme)	Sub-themes	Specific student responses
Physical accessibility issues	Difficulty operating standard devices	"Struggle to use mouse or keyboard due to physical limitations." "Standard digital tools are hard to use with physical impairments."
	Physical barriers in infrastructure	"Buildings are not designed for easy access to computer labs." "Classrooms lack ramps and accessible paths to technology resources."
	Inaccessible device design	"Devices are not adapted for students with mobility issues." "Touch screens are difficult to use with limited hand dexterity."

Table 9. Lack of accessible content

Thematic area (major theme)	Sub-themes	Specific student responses
Lack of accessible content	Lack of accessible learning content	"No learning materials in Braille or audio." "Digital textbooks are not available in accessible formats."
	Lack of online accessibility	"Most online resources are not available in accessible formats." "Educational websites are not designed for screen readers."

Table 10. Policy and regulatory barriers

Thematic area (major theme)	Sub-themes	Specific student responses
Policy and regulatory barriers	Lack of inclusive education policies	"No clear policies on digital inclusion for students with disabilities." "Schools lack guidelines for implementing digital accessibility."
	Inadequate funding allocation	"Government does not allocate enough funds for digital tools in special education."
	Complex procurement process	"Procurement rules make it hard to get necessary digital tools quickly."

A critical lack of awareness and understanding about these students' unique digital needs is also prevalent, as shown by reflections such as "people did not grasp our specific digital requirements" and the assertion that "digital tools were not considered a priority for students with disabilities." Lastly, negative perceptions surrounding disability contribute to a climate of low expectations, as articulated in remarks such as "teachers often held diminished expectations for students with disabilities."

The analysis presented in **Table 8** underscores significant physical accessibility challenges confronted by Ethiopian students with disabilities when engaging with digital educational tools. Critical barriers identified include the operational difficulties faced when using standard devices, as indicated by feedback reflecting struggles with mouse and keyboard usage due to physical limitations.

Furthermore, infrastructural deficiencies are evident, with reports highlighting that educational facilities were not designed to accommodate easy access to computer labs. The absence of essential features, such as ramps and accessible pathways, further complicates access to classroom technological resources.

Additionally, the design of digital devices appears to lack adequate adaptation for students with mobility impairments. Feedback indicated that many devices are not user-friendly for those with limited hand dexterity, particularly about touch screen interfaces. This analysis emphasizes the urgent need for inclusive design and improved accessibility measures in educational tools and physical environments to support the learning experiences of students with disabilities.

The data presented in **Table 9** highlights the challenges Ethiopian students encounter with physical disabilities in pursuing digital educational resources. Critical barriers identified included the absence of accessible learning materials, with participants noting issues such as "the unavailability of Braille or audio learning materials" and "digital textbooks lacking accessible formats." Additionally, concerns about online accessibility were expressed, with comments such as "the majority of online resources were not formatted for accessibility" and "educational websites were not designed to accommodate screen reader technologies."

Table 10 delineates the policy and regulatory challenges encountered by Ethiopian students with physical disabilities regarding access to digital educational resources. Critical barriers identified include the absence of inclusive education policies, evidenced by statements indicating "the lack of explicit policies on digital inclusion for students with disabilities" and "the absence of guidelines for implementing digital accessibility in schools." Additionally, insufficient financial allocation is highlighted, with remarks such as "the government

Table 11. Cultural barriers

Thematic area (major theme)	Sub-themes	Specific student responses
Cultural barriers	Stigma around disability	"Disability is often seen as a limitation, not needing digital tools." "Parents and community members do not support investment in digital tools for disabled students."
	Resistance to change Lack of community awareness	"There is a reluctance to adopt new technologies in schools." "Communities are unaware of the benefits of digital tools for students with disabilities."

Table 12. Inadequate teacher preparation

Thematic area (major theme)	Sub-themes	Specific student responses
Inadequate teacher preparation	Lack of teacher training	"Teachers do not know how to use digital tools for us." "Teachers are not aware of what we need."
	Lack of professional development	"No training sessions on digital accessibility for teachers."
	Ineffective use of digital tools	"Teachers do not use digital tools effectively in class." "Teachers are resistant to using new technologies."
	Lack of curriculum adaptation	"Curriculum is not adapted to include digital tools for students with disabilities."

has not designated adequate funding for digital tools within special education." Furthermore, complications in procurement processes are noted, as reflected in the comment, "Current procurement regulations hinder timely acquisition of essential digital tools."

Table 11 outlines the cultural obstacles that adversely affect Ethiopian students with physical disabilities accessing digital educational tools. Notable among these barriers is the stigma surrounding disability, which manifests in sentiments such as viewing disability as a limitation that diminishes the perceived need for digital resources. Additionally, there is a lack of support from parents and community members regarding investments in digital technology for students with disabilities. Resistance to change is also evident, exemplified by a hesitance to embrace new technologies within educational settings. Furthermore, a lack of community awareness regarding the advantages of digital tools for students with disabilities contributes to these challenges.

The analysis identified significant barriers related to teacher preparation that impeded Ethiopian students with physical disabilities from effectively accessing digital educational tools. According to **Table 12**, key issues included insufficient teacher training, as highlighted by student feedback indicating that educators were often unfamiliar with the usage of digital tools ("teachers did not know how to use digital tools for us") and lacked awareness of students' specific needs ("teachers were not aware of what we needed").

Furthermore, there was a notable absence of ongoing professional development, evidenced by the lack of training sessions focused on digital accessibility for teachers. The ineffective implementation of digital tools in the classroom was another critical concern, with students reporting that teachers frequently did not employ these resources effectively ("teachers did not use digital tools effectively in class") and exhibited resistance to integrating new technologies into their teaching practices. Additionally, the curriculum itself appeared inadequately adapted to include digital tools that would support students with disabilities, as indicated by comments regarding its failure to accommodate their needs ("curriculum was not adapted to include digital tools for students with disabilities").

DISCUSSION

The discussion section critically analyzes the findings related to digital readiness, acceptance, and barriers to adopting digital tools among Ethiopian students with physical disabilities. By integrating quantitative and qualitative data, this analysis offers a comprehensive understanding of the factors affecting these students' willingness and capacity to engage with digital resources in their educational settings. The discussion situates the results within existing literature and theoretical constructs, emphasizing the implications for educational practice and policy. Additionally, it identifies key areas where further support and infrastructure development are essential to cultivate an inclusive digital learning environment.

The examination of digital readiness in Ethiopian schools reveals a profound misalignment between students' intrinsic motivation to engage with digital tools and the infrastructural hurdles they encounter. This dichotomy is underscored by quantitative and qualitative analyses, which indicate a glaring deficiency in critical resources–exceptionally reliable Internet access and the availability of functional computer labs. Such observations resonate deeply with research conducted in similarly constrained environments, where infrastructural deficits emerge as formidable obstacles despite heightened motivation and an awareness of potential benefits (Nouraldeen, 2023; Peruzzo & Allan, 2024). Here, the quantitative results indicating low readiness scores (M = 2.3) are substantiated by qualitative narratives that highlight persistent issues such as the Internet disruptions, power outages, and the inaccessibility of computer labs. This alignment between quantitative data and qualitative experiences underscores the pronounced "access divide," as evidenced by the lived experiences of individuals. Such convergence not only enriches the understanding of the issues at hand but also enhances the validity of the overall findings.

This scenario can be contextualized through the DDT, articulating the "access divide." This theory posits that the mere presence of motivation is futile if the necessary resources are not physically accessible, effectively trapping students in a cycle where aspirations remain unfulfilled (van Dijk, 2005). The implications of this access divide are particularly pronounced for marginalized groups, including students with disabilities, whose opportunities for digital engagement are further limited by existing inequalities (Mavrou et al., 2017).

Notably, the data reveals that despite infrastructural limitations, students express high perceived usefulness and trust in digital tools. This trust in digital tools suggests an awareness of the transformative potential of technology for fostering independent learning and enhancing productivity. Such findings should inspire the audience with the potential of technology in education, as they align with global trends, demonstrating that educational value can catalyze engagement, even in resource-constrained settings (Kaarakainen & Saikkonen, 2023). Nevertheless, this apparent optimism in perceived utility is insufficient for sustained engagement, reiterated by prior research advocating for foundational support through enhanced digital infrastructure. The qualitative insights regarding enhanced learning outcomes, opportunities for independent study, and increased productivity offer a deeper understanding of the quantitative findings that indicate high levels of perceived usefulness (M = 4.5) and trust (M = 4.2). These perceptions provide a tangible illustration of how favorable conditions can translate into meaningful educational advantages.

Applying the TAM, it becomes evident that students' willingness to engage with digital tools is predicated on their belief in the potential advantages these instruments offer to their educational experiences (Davis, 1989). However, this belief starkly contrasts with the limited access afforded by their current environments. The disparity between motivation and actual engagement underscores the urgent need for strategic initiatives focused on infrastructural improvements. This urgency should instill a sense of immediate action in the audience, as these improvements are crucial to align students' digital readiness with their motivational predispositions.

The SEM analysis identifies critical predictors of students' willingness to adopt digital tools, specifically digital acceptance, readiness support, and trust. These findings corroborate qualitative insights gathered from student feedback, which overwhelmingly highlights the significance of digital tools in enhancing the educational experience. Students reported that these tools foster engagement, improve efficiency, and promote autonomy in their learning processes. For instance, the results from the SEM analysis indicate that perceived usefulness emerges as the most significant predictor ($\beta = 0.45$). This finding is further substantiated by student testimonials that describe their experiences with accessing a variety of resources and obtaining timely feedback from educators. These testimonies illustrate a compelling correlation between the statistical significance of the findings and their practical implications in educational settings.

This aligns with the work of Nouraldeen (2023), which emphasizes perceived usefulness as a significant driver of technology adoption among students. Qualitative data enriched this discussion, revealing that students perceive digital tools as gateways to a broader array of educational resources. This perspective underscores the tangible benefits of digital acceptance, reinforcing its importance in the broader context of educational technology.

The TAM further elucidates this dynamic, positing that students' acceptance hinges on their perceptions of usefulness and ease of use of digital tools. Davis (1989) and Venkatesh and Bala (2008) delineate how a

positive perception in these areas significantly influences the likelihood of integrating digital tools into academic routines. Thus, this framework suggests that fostering an environment where students can recognize digital technologies' intrinsic value and user-friendliness is pivotal for successful adoption.

The usability issue in digital tools emerged as a crucial factor influencing student engagement. This aligns with the findings of Sudaryanto et al. (2023), which highlight that intricate interfaces can provoke frustration, particularly among users with low digital literacy. Such frustrations directly relate to the TAM, precisely the "perceived ease of use" dimension proposed by Davis (1989). When technology necessitates an excessive cognitive load or effort, users are disinclined to adopt it, which raises concerns about accessibility for diverse user groups. Quantitatively, the moderate ease-of-use score (M = 2.4) gains explanatory depth from qualitative accounts of difficulties with screen readers, outdated assistive devices, and incompatible software–providing a direct integration of numerical trends with experiential realities.

In addition to usability, trust was identified as a pivotal predictor of engagement. Students demonstrated a pronounced willingness to interact with reliable tools, reinforcing Abdul-Kareem and Oladimeji's (2024) conclusion that trust is essential in mitigating barriers to technology adoption. This relationship between trust and technology use further complicates the digital engagement landscape, necessitating educational stakeholders to cultivate environments where trust can flourish.

Despite students' intrinsic motivation to engage with digital platforms, they expressed significant challenges linked to inadequate teacher support and the absence of personalized guidance. This situation reflects the "skills divide" articulated in the DDT, as van Dijk (2005) outlined, where insufficient training hinders effective technology utilization. The ramifications of this divide suggest a technological gap and an educational one, whereby a lack of comprehensive support systems stifles the potential of technology to enhance learning. The SEM analysis indicates a significant predictive relationship between readiness support and willingness ($\beta = 0.25$), a finding that is further corroborated by qualitative insights. These insights reveal shortcomings in teacher preparation, inadequate professional development opportunities, and suboptimal integration of technology in the classroom, thereby illustrating how these statistical correlations manifest in everyday educational practices.

This analysis underscores a critical need for an integrated approach that addresses the intertwining factors of usability, trust, and readiness support. Educational institutions can better harness students' intrinsic motivation by enhancing digital acceptance and building trust while providing foundational support. Such a multifaceted strategy is essential for promoting sustainable digital adoption, particularly in contexts constrained by infrastructural limitations. The findings advocate for a holistic framework that prioritizes the user experience and supports learners in navigating the digital landscape effectively. The findings derived from both quantitative data–where trust, readiness support, and acceptance emerged as significant predictors of technology adoption–and qualitative insights–emphasizing students' reliance on dependable tools, supportive educators, and accessible platforms–underscore the interrelated nature of these needs. This convergence of evidence suggests that fragmented interventions are likely to be ineffective unless these critical factors are concurrently addressed.

The quantitative and qualitative data findings strongly indicate that students positively perceive digital tools, particularly in the realms of engagement enhancement, access to various resources, and support for independent learning. These observations are consistent with prior research, highlighting the potential of digital tools to improve educational outcomes, given that accessibility conditions are adequately met (Dabi & Golga, 2023). For example, the elevated mean scores regarding perceived usefulness (M = 4.5) and engagement benefits were corroborated by qualitative narratives, which articulated enhancements in learner independence, expanded access to information, and heightened participation in classroom activities. This direct correlation reinforces the credibility of the findings and exemplifies how quantitative statistical patterns are manifested in the lived experiences of participants.

However, the qualitative data also illuminates significant challenges that undermine the inclusivity of these tools. Key barriers include a paucity of localized content and insufficient screen-reader compatibility, which disproportionately affect marginalized groups, especially students with disabilities. This observation resonates with broader global concerns regarding neglecting accessible design principles, leaving many individuals underserved in educational contexts (Abebe et al., 2023). These qualitative themes align with lower

ease-of-use ratings in the quantitative dataset (M = 2.4), indicating that technical inaccessibility is not merely anecdotal but a measurable, widespread barrier.

The applicability of the DDT, specifically its emphasis on the "usage divide," is particularly relevant in this discourse. The design shortcomings revealed by the qualitative data obstruct students from fully capitalizing on the educational advantages that digital tools theoretically offer, thereby limiting the overall effectiveness of these resources (van Dijk, 2005). This disjunction between students' recognition of the academic potential of digital tools and the practical accessibility barriers they face highlights a critical gap in the current educational landscape.

To address the existing disparities in educational accessibility, it is crucial to implement targeted policy measures and design strategies that prioritize content localization and compatibility with assistive technologies. Research indicates that without these interventions, we risk inadvertently perpetuating educational inequities, thereby diminishing the effectiveness of initiatives aimed at promoting digital inclusion. By tackling these accessibility issues, we can unlock the full spectrum of educational advantages that digital tools provide, ultimately cultivating a more engaging and truly inclusive learning environment. The urgency of these interventions is reinforced by a wealth of evidence: quantitative studies illustrate the extent of access barriers, while qualitative narratives highlight the emotional and academic impacts on learners, emphasizing the necessity for immediate and context-specific solutions.

As evidenced by quantitative and qualitative data, the barriers to digital technology access are multifaceted and deeply ingrained. These obstacles include social exclusion, prohibitively high device costs, insufficient teacher preparation, and physical inaccessibility. Such challenges resonate with global findings that pinpoint economic, infrastructural, and attitudinal limitations as significant impediments to digital inclusion, especially for marginalized groups like students with disabilities (Khanlou et al., 2020). For example, the high cost of devices reported in qualitative interviews aligns with low affordability ratings in the quantitative survey (M = 2.1), confirming that financial constraints are both perceived and statistically significant.

For instance, many students have reported encountering physical barriers within educational environments, such as computer labs that lack essential accessibility features, notably ramps. This underscores the broader infrastructural limitations that reflect findings from analogous studies (Franck & Joshi, 2016). The persistent lack of access exemplifies the "access divide" component of the DDT, which posits that inadequate physical and economic infrastructure systematically precludes certain groups from engaging in digital practices (van Dijk, 2005).

The high costs of digital devices and inadequate financial assistance further exacerbate these barriers. This economic divide creates a pronounced disparity between students' motivation to embrace digital tools and their actual capacity to do so. While intrinsic motivation may exist, systemic economic obstacles disproportionately impact marginalized populations, hindering equitable access.

The qualitative data revealing insufficient teacher preparation presents another layer of complexity to this issue. The lack of tailored instructional support limits educators' ability to effectively guide students–particularly those with disabilities–using digital tools. This deficiency not only impedes individual learning experiences but also highlights a significant gap in professional development and training, further exacerbating the challenges faced by vulnerable learners. In quantitative terms, readiness support scores (M = 2.3) were among the lowest measured, and the qualitative feedback explaining this low rating centered on teachers' lack of digital pedagogical skills–providing a clear integrated explanation.

In light of these findings, a comprehensive and multifaceted approach to digital inclusion is imperative. It is essential that strategies effectively address the economic and physical barriers while also considering the underlying attitudinal components that inhibit access. Targeted interventions, such as affordable device programs, infrastructure enhancements to ensure universal accessibility, and robust teacher training initiatives, are crucial for achieving equitable digital access.

The synthesis of quantitative and qualitative methods reveals a nuanced understanding of the barriers to digital inclusion. Quantitative results effectively identify priority obstacles, while qualitative data elucidate the mechanisms through which these barriers operate, thereby enabling the formulation of better-targeted policy recommendations.

From the perspective of the TAM, enhancing the perceived ease of use through comprehensive teacher training can significantly influence technology acceptance rates among educators and students alike. This improvement not only makes technology adoption more feasible but also enhances its effectiveness in educational settings (Davis, 1989).

Therefore, a holistic strategy that integrates these dimensions is essential for fostering sustainable digital engagement across diverse student populations in Ethiopian schools. This approach ensures that the promise of digital technologies is realized for all learners, facilitating an inclusive and equitable educational landscape.

CONCLUSION

This study highlights the critical importance of digital readiness, acceptance, and trust in enhancing Ethiopian students' willingness to use digital tools for educational purposes. Although students display strong motivation and recognize the educational advantages of digital technology, significant systemic barriers persist, including inadequate infrastructural support, limited accessibility features, and insufficient guidance. These findings suggest that motivation, while essential, is insufficient to ensure sustained engagement without addressing foundational access issues–especially for marginalized groups.

Utilizing the TAM and DDT, this research underscores the dual necessity of students perceiving digital tools as valuable for independent learning and productivity, alongside the requirement for meaningful integration of these resources within educational frameworks. Such integration demands comprehensive infrastructural, economic, and pedagogical support.

Therefore, addressing these identified barriers is imperative for bridging the digital divide, ultimately enabling a more inclusive and effective educational environment within Ethiopian schools. This research's implications advocate for a multifaceted approach to digital education, ensuring that all students, regardless of their background, can benefit from technology's transformative potential in learning.

Pedagogical Implications

Several pedagogical strategies arise from this study to fully leverage the educational potential of digital tools. Firstly, enhancing teacher training and support is crucial, as educators play a vital role in guiding students toward practical technology usage. Comprehensive training in digital pedagogy, along with support for accessible design, would empower teachers to seamlessly integrate technology into the learning process, ensuring that all students, including those with disabilities, can benefit from these tools. This training should encompass digital literacy skills, accessible interfaces, and assistive technologies that cater to diverse learning needs. Moreover, policies must prioritize the training of educators not only in digital competencies but also in inclusive pedagogical methodologies that recognize and challenge existing social biases. This empowers teachers to become advocates for the digital and social participation of their students.

Establishing accessible digital infrastructure is also a key priority. Schools and policymakers should prioritize equipping computer labs with inclusive features like ramps and technology compatible with screen readers to support students with disabilities. Furthermore, ensuring reliable Internet access and offering localized content will empower students to engage fully with digital resources. By fostering this infrastructure, we can significantly enhance students' ability to benefit from the educational advantages that digital tools provide.

Integrating digital literacy programs for both students and educators has the potential to bridge the "skills divide" identified in this study. These programs should encompass foundational and advanced digital competencies, enabling users to navigate, utilize, and engage with digital tools effectively (Welesilassie & Nikolov, 2024b). By embedding these skills into educational practices, schools can cultivate a more digitally proficient learning environment that promotes sustained engagement and skill development.

Policy measures aimed at enhancing the affordability of technology would further diminish barriers to digital access. Initiatives such as subsidized device programs, collaborations with technology providers, and government support could make digital tools more accessible for students from low-income backgrounds, addressing the economic disparities that currently impede access. Schools can cultivate a more equitable digital learning environment by implementing these strategies.

The socio-cultural barriers associated with stigma and social exclusion, as identified in this study, constitute significant impediments to digital inclusion for students with disabilities in Ethiopian schools. To effectively address these challenges, inclusive education policies must extend beyond mere infrastructural and technological enhancements. They should actively promote community awareness and facilitate cultural transformation. Educational institutions and communities should actively engage in initiatives to raise awareness confronting prevailing social and cultural stigmas. Such efforts can significantly enhance the understanding and acceptance of students with disabilities while highlighting the importance of digital tools in their educational experiences. Evidence suggests that programs engaging community leaders, parents, and educators in awareness initiatives can significantly shift attitudes toward disability and technology utilization in similarly under-resourced contexts.

For example, community-based initiatives in East Africa that integrate peer mentorship, disability advocacy groups, and sensitization workshops have successfully mitigated stigma and fostered more supportive social environments for students with disabilities, as exemplified by UNICEF-supported inclusive education projects. By embedding such socio-cultural interventions alongside efforts to increase technology access, a more comprehensive and sustainable framework for digital inclusion can be established.

By cultivating a community-wide commitment to inclusive education, we can ensure that students with disabilities receive the essential resources and the respect necessary for meaningful engagement in digital learning. Addressing this issue's pedagogical and cultural dimensions enables schools to adopt a more inclusive approach to digital education, enhancing educational opportunities for all students within the Ethiopian context. A multidimensional approach, one that intertwines infrastructural, educational, and community elements, is critical for dismantling socio-cultural barriers and promoting authentic inclusion in the realm of digital education.

Limitations

While this research contributes significantly to the understanding of digital readiness support, acceptance, trust, and the challenges encountered by Ethiopian students with physical disabilities in utilizing digital educational tools, several limitations warrant attention. Primarily, the sample size and scope of the study were somewhat constrained, especially in the qualitative component, which may limit the generalizability of the results. Expanding the sample to include a broader and more diverse population–encompassing students from varying geographic and socio-economic backgrounds–could enhance the insights' comprehensiveness. The findings of this study are derived from a sample that is relatively modest in size, comprising 87 students for quantitative analysis and 12 participants for qualitative exploration. This limited sample size may impose constraints on the generalizability of the results. Furthermore, it is important to acknowledge potential sampling bias, notably the overrepresentation of participants from urban areas. This bias must be carefully considered in the interpretation of the results, as it may not adequately capture the experiences of students situated in rural contexts. Furthermore, the study's exclusive concentration on physical disabilities may inadvertently sideline the obstacles faced by students with other types of disabilities, including visual, auditory, or cognitive challenges. Subsequent research should seek to encompass a broader range of disabilities to illuminate the multifaceted barriers to digital access better.

The cross-sectional design employed in this study provides a timely overview of the current challenges; however, it cannot track changes over time. A longitudinal study would be instrumental in examining how digital inclusion develops and assessing the enduring effects of interventions on student outcomes. Additionally, the findings are situated within the Ethiopian context, which may restrict their relevance to other geographical or cultural situations. Conducting comparative studies across diverse socio-economic and cultural landscapes would aid in uncovering both universal challenges and those unique to specific contexts regarding digital inclusion.

Finally, the study's dependence on self-reported data raises concerns about potential biases, as students might inaccurately assess their levels of digital engagement or the support available to them. Incorporating observational or usage-based data could enhance the rigor of the findings, offering a more objective perspective on students' digital engagement.

Directions for Future Research

Based on the findings and limitations outlined in this study, several avenues for future research are proposed to enhance understanding and address the identified gaps. Subsequent studies must investigate barriers faced by individuals with diverse types of disabilities, including visual, auditory, and cognitive impairments. This exploration is crucial for developing tailored interventions that cater to the specific needs of each disability group. A more inclusive examination of these challenges will facilitate the creation of comprehensive and accessible digital solutions.

Additionally, longitudinal studies should be undertaken to assess the long-term effects of targeted interventions, such as teacher training initiatives, infrastructural enhancements, and policy modifications, on digital inclusion and educational outcomes. This approach can yield valuable insights into the sustained efficacy of these interventions, thereby informing both policy development and practical applications for enhancing digital education inclusion.

Furthermore, it is imperative to examine socio-cultural dynamics, including stigma and community attitudes toward disabilities, which can significantly impact access to and the effectiveness of digital tools. Understanding these socio-cultural factors is vital for designing successful awareness campaigns and nurturing an inclusive educational environment.

Finally, cross-national comparative research is essential to identify successful practices in digital inclusion across different contexts. By comparing digital inclusion efforts in various countries, researchers can uncover actionable insights into practical strategies that may be adapted for implementation in Ethiopia. This comparative approach can lead to formulating targeted policies and practices that are contextually relevant while being informed by global best practices. These research avenues will collectively contribute to fostering a more inclusive and effective digital educational landscape for students with disabilities.

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