Teacher's Perception of the Impact of Assistive Technologies on the Academic Performance and Engagement of Students with Learning Disabilities at Junior Schools in Mandera South Sub-County, Kenya

Adannur Hassan Ibrahim, Humed Mahmud Abdela, Bless Kwesi Chaka*

Central China Normal University, 152 Luoyu Road, Hongshan District, Wuhan, Hubei Province, 430079, PRC.

***Corresponding author**

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ABSTRACT:

As global education systems increasingly embrace inclusive practices, assistive technologies (AT) have emerged as critical tools in enhancing educational outcomes for students with learning disabilities (LDs). However, in marginalized and resource-constrained settings such as Mandera South Sub-County, Kenya, the adoption and integration of AT remain limited due to infrastructural, sociocultural, and institutional barriers. This study investigated junior school teachers' perceptions of AT and its impact on the academic performance and engagement of students with LDs. Guided by the Technology Acceptance Model (TAM), Vygotsky's sociocultural theory, and the Theory of Planned Behavior (TPB), the research employed a quantitative design with a sample of 200 teachers selected through simple random sampling. Data collection involved both open and closed-ended questionnaires, with analysis conducted using SPSS and PLS-SEM techniques. Results revealed that teacher perceptions significantly influence AT usage ($\beta = 0.325$, $p < 0.001$) and that higher usage levels strongly predict improvements in student academic performance and engagement ($\beta = 0.78$, $p < 0.001$). Moreover, perceived factors such as training, resource availability, and cultural attitudes directly and indirectly affect both AT usage and perceptions. Despite existing policy frameworks that support inclusive education, the study found that implementation gaps are exacerbated by limited funding, inadequate technical support, and cultural stigma. These findings highlight the need for strategic interventions, including targeted teacher training, equitable resource allocation, and community sensitization, to ensure effective AT integration in rural schools. The study extends existing theoretical models by contextualizing them within under-resourced environments, offering practical insights for policymakers, educators, and stakeholders aiming to foster inclusive education through technology in marginalized regions.

Keywords: Assistive Technologies (AT), Learning Disabilities, Teacher Perceptions, Inclusive Education

INTRODUCTION

Global education systems increasingly integrate assistive technologies (AT) to transform pedagogical practices, particularly for students with learning disabilities (LDs) (Viner et al., 2020). However, in low-resource contexts like Mandera South Sub-County, Kenya, where educational access is 24% below the national average (KNBS, 2020), AT adoption remains limited due to infrastructural deficits, sociocultural barriers, and insufficient teacher training (Adebisi et al., 2015; Grönlund et al., 2010). This is most prominent for students with learning disabilities. It is crucial to note that there are several devices, tools, and software classified as assistive technologies (Viner et al., 2020). These technologies are designed to help learners who have difficulty succeeding academically and/or participating actively in the classroom. However, AT is context-oriented, depending on factors such as the teacher's willingness, teacher training preparedness, social factors, and, in most cases, the challenges in low-resourced areas (Adebisi et al., 2015). The educational context in Mandera South Sub-County, Kenya, faces several unique challenges. According to the Kenya National Bureau of Statistics (2020), Mandera County has an educational access rate of 60%, significantly lower than the national average of 84%. Additionally, the region has one of the highest dropout rates in Kenya, with over 20% of

students leaving school before completing their primary education (Orodho et al., 2014). A lack of infrastructure, insufficient resources, and limited teacher training opportunities exacerbate these challenges. Globally, these challenges are understandable, but within culturally bound notions of disability, this acceptance is far-fetched, and it is emerging as a development issue (Gairola, 2023). Such gaps can be filled with technologies, especially AT, which also help in achieving literacy, numeracy, and cognitive skills. However, the successful adoption of AT is subject to the teacher's perceptions and skills (Aldunate Vera & Nussbaum, 2021). Positive perceptions of AT by educators are likely to improve engagement and academic participation, while negative or indifferent perceptions may lead to its avoidance. Studies worldwide indicate that assistive technologies can transform education, yet their adoption in underserved regions like Mandera South remains limited. Resource gaps, sociocultural attitudes, and teacher training limitations pose questions about the utility of AT in these contexts (Grönlund et al., 2010). The research problem this study seeks to address is the limited understanding of how teachers perceive and utilize assistive technologies for students with learning disabilities in Mandera South Sub-County. This lack of insight has significant implications for policy and practice, including the need to develop targeted training programs, allocate resources for technological integration, and foster an inclusive educational environment. Without addressing these perceptions and challenges, initiatives aimed at improving educational outcomes for students with disabilities may not be effectively implemented, leading to continued underachievement and exclusion in educational settings.

Study Context

Kenya appreciates the crucial role of inclusivity in education as it cleaves to the needs of different learners, especially those who are disabled. The country's effort to achieve inclusivity in education resonates with international commitments such as the United Nations Sustainable Development Goals (SDG 4) and the Salamanca Statement. For instance, *Despite Kenya's policy commitments (e.g., Basic Education Act, 2013) aligning with SDG 4, rural disparities persist. Mandera South's AT adoption lags due to inequitable resource allocation—evidenced by 39.7% of teachers reporting insufficient tools (this study)—and weak policy enforcement (Hamidi et al., 2022)*. These policies stress the use of assistive technologies (AT) as an important measure in enhancing disability inclusiveness and educational attainment among learners with disabilities. Regardless of such commitments, the application of assistive technologies is, however, very much lacking, especially in the rural and marginalized areas like Mandera South Sub-County. There are socioeconomic issues, infrastructural gaps, and cultural factors that restrain the full participation of learners with disabilities in Mandera South Sub-County's mainstream education, on which this region is largely built. This area faces a shortage of resources, such as poorly trained teachers and very few modern technologies, which results in difficulty in using methods and devices that assist in the learning process. Government programs and collaborations with NGOs have tried to include assistive technologies in the Kenyan education system, but these programs are often inattentive to rural areas and constantly miss the mark. The partial achievement regarding the adoption of assistive technologies in Mandera South Sub-County is exacerbated by insufficient empirical studies examining the perceptions, competencies, and attitudes of the teachers. Internationally, the literature has documented teachers as critical to the effective adoption and application of technology in the classroom. Studies have shown that teachers' attitudes toward disability, assistive tools, and self-efficacy served as crucial factors in the successful application of AT in instructional practice (Alghamdi, 2022; Lukić et al., 2024). Unfortunately, in the Kenyan case, more so in the rural disadvantaged areas, there is a dearth of information on how these teacher-related phenomena interface with the scarcity of resources and the social attitude toward disability. Although currently available studies in Kenya have concentrated on inclusive education settings in urban and peri-urban regions, much is still unknown about the phenomena concerning the use of assistive technologies in rural areas like Mandera South Sub-County. Closing this gap is important to shed light on policies and practices that can aid teachers in the proficient use of AT to increase the academic participation and performance of learners with disabilities. This study focuses on issues related to the phenomenon of integrating the rural educational context, educator attitudes toward these regions, and assistive technology change ecology.

Theoretical Framework

This research is built upon the Technology Acceptance Model (TAM), Vygotsky's Sociocultural Theory, and

the Theory of Planned Behavior (TPB). These frameworks cumulatively help explain the perceptions of teachers toward assistive technologies (AT) and their use in classroom settings.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) (Davis, 1989) posits that AT adoption hinges on perceived usefulness ($\beta = 0.45$, $p < 0.01$; this study) and ease of use ($\beta = 0.35$, $p < 0.05$). However, in Mandera, these factors are mediated by external constraints (e.g., 39.7% resource scarcity), necessitating a critique of TAM's urban-centric assumptions. Within the Mandera South Sub-County context, a teacher's readiness to embrace AT is dependent on whether they consider such tools to be academically friendly and easy to use. Text-to-speech software can assist students with dyslexia, yet a teacher may not use it because they have not been sufficiently trained or believe it is challenging to operate (Bhola, 2022). This perception of attainment and achievement denotes a basic understanding of the value that AT offers in a low-resource setting.

Vygotsky's Sociocultural Theory

Vygotsky's Sociocultural Theory explains the importance of social interaction and culture in how people learn (Vygotsky, 1978). Assistive technology is used as a cognitive tool to assist students with disabilities. Teachers, as important mediators, help students use these tools independently and actively. However, this is the case in rural places such as Mandera South Sub-County where minimal training and cultural disposition on disability limits teachers' effectiveness in using AT. This study, through the lens of Vygotsky, seeks to emphasize the importance of training teachers in the skills and culture needed to properly harness the power of AT.

Theory of Planned Behavior (TPB)

Ajzen's TPB explains the impact of personal attitudes, subjective norms, and perceived behavioral control on an individual's intention to take action (Ajzen, 1991). Deterministic beliefs about the effectiveness of AT Formative Assessment Instruments impact teachers' decision and their willingness to adopt specific assumptions. Moreover, peers, administrators, and community members also set subjective norms that have an equally important aspect concerning the integration of AT, as they can encourage or inhibit it. The absence of teachers feeling sufficiently empowered encompasses the lack of resources and training opportunities available to them (Xia, 2020). In remote areas such as Mandera South, limited resources combined with weak support structures tend to reduce the confidence and abilities of the teachers to implement AT successfully.

Essentially, this research provides a comprehensive model incorporating the Technology Acceptance Model. This model focuses on individual choices, the framework provided by Vygotsky, which positions AT as a sociocultural instrument, and the Theory of Planned Behavior, which brings into focus the social and institutional impediments to adoption. AT usage in classrooms stems from the multifaceted relationships between teacher beliefs, resources, and sociocultural factors, which are facilitated by all these theories.

Empirical Evidence on Teachers' Perceptions

The adoption and effective use of AT in educational contexts are significantly dependent on teachers' perceptions. Research is replete with evidence that a student's perception of AT being useful, associated with supportive training being provided, leads to its higher use in classrooms (Alghamdi, 2022). Research shows that teachers with a favorable perception of the usefulness and accessibility of AT tend to integrate these tools into their teaching (Lamond & Cunningham, 2020). On the other hand, negative attitude that refrains from AT adoption stems from uninformed bias or culture, which is common in marginalized settings. Teachers in the Mandera South Sub-County confront the myriad intricacies that envelop their points of view. The adoption of AT is significantly hindered by the lack of adequate access to training programs and infrastructure development, which predisposes educators to be technologically incompetent. Other socio-cultural factors relating to disability also make the adoption of the tools extremely complex because stigma and misinformation can deter their usage (Ripat & Woodgate, 2011). To overcome these obstacles, focused actions should be planned and implemented to improve teachers' skills and build an inclusive culture at schools and in the community.

Teachers Role

Teachers play a critical role in ensuring the successful use of assistive technologies (AT) for students with learning disabilities (LD). Their duties encompass more than merely teaching; they are expected to select suitable AT equipment, modify lessons, and help learners use these aids appropriately. For example, teachers need to assess the individual needs of students by using text-to-speech programs with students who have dyslexia to improve their reading comprehension and fluency (Bhola, 2022). In the same way, students with dysgraphia can use speech-to-text technology to express themselves without the burden of physically writing (Moss et al., 2024).

A crucial component of a teacher's duty is encouraging student self-sufficiency through the appropriate application of assistive technology (AT). Through scaffolding learning, teachers help learners gain the confidence and competencies to operate AT independently, which increases engagement and self-efficacy (Lim et al., 2024). Additionally, teachers promote collaboration by using AT, which facilitates the participation of all members of the group, thereby promoting inclusion and decreasing the chances of participation barriers. AT adoption calls for considerable teacher competence and confidence, and as such, the outcome of these approaches depends on the training of teachers. Workshops and trainings are important in ensuring that teachers are provided with the much-needed technical and pedagogical skills necessary for the smooth integration of assistive technology. Research indicates that the provision of thorough training enables teachers to deal with a greater variety of learner needs and other resource-challenging factors (Uibu & Tagamets, 2022). In the Mandera South Sub-County, teachers' responsibilities are made more difficult by systemic issues such as inadequate training opportunities, limited availability of AT resources, and cultural perceptions around disability. Such impediments greatly limit the teachers' potential to fully adopt the roles of facilitators of effective AT integration, and such obstacles also require a more strategic and focused approach to meeting the needs of teachers, such as providing training, support systems, and appropriate resources.

Benefits of Assistive Technologies

Assistive technologies grant substantial advantages to students with learning disabilities, which consequently improve academic performance, engagement, and independence. These tools reduce learning obstacles by providing solutions to particular physical, sensory, or cognitive issues so that students can partake more actively in classroom activities and reach their academic goals. One of the primary advantages that AT offers is enhancing literacy and numeracy skills in individuals. For instance, text-to-speech (TTS) software assists students with dyslexia by translating text to speech, which improves comprehension and fluency (Bhola, 2022). Likewise, speech-to-text (STT) software enables students who possess writing disabilities, such as dysgraphia, to verbalize their thoughts, which are then converted into text. This lessens the cognitive burden while boosting self-efficacy for completing written responsibilities (Sand et al., 2024). In addition to overcoming particular obstacles to learning, AT promotes inclusion in the classroom environment. For instance, students can access curriculum materials through audiobooks or other reading software, which increases their chances of success in school (Zilz & Pang, 2021). The use of adaptive learning software furthers inclusion by customizing how content is presented to each learner, thereby increasing engagement and motivation (Jose et al.). The psychosocial benefits of AT are equally striking. AT allows students to tackle some issues presented by traditional learning environments. This participation often enhances one's self-esteem as well as one's sense of belonging. Enhancing one's self-esteem is instrumental in fostering academic resilience and success over time (McNicholl et al., 2023). In resource-limited regions such as Mandera South Sub-County, educators can greatly benefit from the available assistive technology (AT). AT can address the plethora of learners' needs and build an inclusive environment that aids in bridging the achievement gap for those with disabilities. However, for these advantages to be attained, the systemic factors of low teacher training, little access to resources, and infrastructural bottlenecks need to be addressed.

Challenges of Assistive Technologies

Considerable investment and training must successfully integrate assistive technologies within classrooms to improve educational outcomes for students with learning disabilities. Mandera South Sub-County is still grappling with many pervasive challenges that stem from financial and infrastructural issues, sociocultural

barriers, and systemic weaknesses. All of them make the effective adoption and use of AT impractical. *Funding gaps—reported by 39.7% of teachers—intersect with systemic inequities: only 7.9% of schools receive technical support, exacerbating AT abandonment (Cronin, 2018; Maich et al., 2017)*. In addition, the ATs themselves, in the form of text-to-speech software, adaptive learning devices, and other assistive tools, are expensive. These factors restrict the capabilities of almost all schools situated in rural areas. In Mandera South Sub-County, investing in AT is often considered to be out of reach because investment, in basic educational tools is virtually non-existent. The inability to maintain or upgrade existing technologies further reduces their overarching usefulness and impact (Grönlund et al., 2010; Hamidi et al., 2022). As a result, schools in such areas are forced to focus on construction and infrastructure first, and accurate, AT and other innovative tools second, which leaves students with learning disabilities at a disadvantage. One more challenge of great importance is the insufficient training and preparedness of teachers to use assistive technology (AT) in their teaching. Many teachers in low-resource areas do not have the opportunity to work with AT during their pre-service or in-service training. Such a shortcoming in training limits teachers' confidence in the use of these tools and their ability to adapt AT for different learners (McNicholl et al., 2023). ATs, whether available or not, are frequently underused or misused because of a lack of technical expertise. For example, a teacher may understand the importance of using speech-to-text software but is unable to effectively apply it in their lessons. This gap proves the existence of a high need for specially designed professional development activities that train teachers in the technical and pedagogical aspects of integrating AT in instruction. Sociocultural factors significantly influence the adoption of assistive technology. For example, certain communities tend to stigmatize disabilities, which results in learners with disabilities being looked down upon. Such negative attitudes have implications on teachers' attitudes to the extent that they become unwilling to embrace some inclusive practices such as the use of AT. Moreover, in Mandera South, a region where cultural beliefs regarding disability are prevalent, the stigma may lead both teachers and parents to reject the idea of adopting AT as a way of enhancing educational achievement (Barbareschi et al., 2021; Lalvani, 2015). These sociocultural factors further facilitate the exclusion of students with disabilities, particularly the non-users of AT. The lack of administrative and technical support makes the challenges associated with the implementation of assistive technology worse. Rural schools often do not have such staff members for continuous support, supervision, training, and troubleshooting for the use of AT tools. In the absence of these support structures, teachers often feel burdened by the sophistication of technology, which leads to a lack of sustained use (Cronin, 2018; Maich et al., 2017). Moreover, insufficient technical support facilities such as erratic power supplies and poor access to the Internet further impede the effective use of AT in education in these schools. Finally, policy gaps and gaps in implementation restrict the general adoption of assistive technology into education systems. Even policies such as the Kenya Basic Education Act, (2013), which seek to promote inclusion in education and AT use, have challenges at the implementation stage, especially in remote and marginalized areas. Inequitable allocation of resources and no monitoring infrastructure prevent these policies not to being achieved, which is particularly disadvantageous for regions like Mandera South. This gap between the policies that are meant to assist and the reality indicates the necessity for more focused attempts that consider the peculiarities of rural education.

Dealing with these complex matters requires a comprehensive approach. For AT integration to succeed, there also has to be increased funding for both the acquisition and maintenance of technology, additional focus on teacher training, and the development of strong support measures. Moreover, the sociocultural perception of disability, alongside the fair enforcement of inclusive policies, nurturing supportive educational frameworks, and maximally utilizing the radically transformative capacity of assistive technologies is also needed.

Research Gap and Significance

Despite international studies emphasizing the importance of assistive technologies (AT) for students with learning disabilities (LDs), scant research has focused on rural and resource-poor regions such as Mandera South Sub-County. While the available literature indicates that teacher perceptions of AT are fundamental to its acceptance, there is hardly any context-specific evidence on the perception of resource gaps, cultural attitudes, and training deficits that shape these perceptions. This gap limits the design and implementation of appropriate policies and programs to increase the use of AT in underserved schools. The study addresses these gaps by exploring the views of teachers in the Mandera South Sub-County regarding the effects of AT on

students with LDs. Results will guide policies intended to improve teacher training, distribution of resources, and inclusion in rural schools. Additionally, the study has a theoretical contribution through the application of models such as TAM and TPB in a rural setting, which deepens the comprehension of the barriers and facilitators of AT adoption. The research underscores the efforts being made at the International and National levels toward the provision of equitable and inclusive education for marginalized populations.

Study aims

The primary aim of this study was to investigate the perceptions of junior school teachers in Mandera South Sub-County concerning the use of AT (assistive technologies) in improving the performance and engagement of students with learning disabilities. In this pursuit, the study endeavors to establish the critical determinants that impact the adoption and integration of AT into classroom instruction, focusing on teacher training, resource availability, and sociocultural factors. The specific research questions addressed were as follows:

a) What are teachers' perceptions of the effectiveness of assistive technologies in improving the academic outcomes and engagement of students with learning disabilities?

b) To what extent do teachers use assistive technologies in their classrooms? and

c) How do perceived factors related to assistive technologies influence teachers' usage levels of these technologies and, indirectly, students' performance and engagement?

d) How do perceived factors indirectly influence teachers' perceptions of the use of assistive technologies?

Research Hypothesis

H1: Teachers' perceptions of assistive technologies significantly influence their implementation of these technologies in the classroom.

H2: The Teacher's usage level of assistive technologies positively impacts students' academic performance and engagement.

H3: Perceived factors related to assistive technologies directly impact teachers' usage level of these technologies, which indirectly affect students' performance and engagement.

H4: The perceived factors can indirectly influence teachers' perceptions of the use of assistive technologies.

RESEARCH METHODOLOGY

Research Design

This study utilized a quantitative-methods approach, integrating both closed and open-ended questionnaires to gain a comprehensive understanding of teachers' perceptions of assistive technologies, their usage, perceived influencing factors, and the impact on student academic performance and engagement. The quantitative-methods design enables the quantification of trends while exploring contextual factors shaping teachers' perceptions and the use of assistive technologies to enhance student outcomes (Pregoner, 2024).

Sample size and Sampling techniques

The study targeted Junior School teachers in Mandera South Sub-County, Mandera County, Kenya. A population deemed suitable due to the growing need to explore teacher perceptions of assistive technology use in marginalized regions. A sample of 200 teachers was selected using simple random sampling to ensure equal representation across all teacher categories. This sample size was adequate for robust quantitative analysis. Key demographic variables, such as gender, age, teaching experience, and educational background, were also considered to capture diverse viewpoints on assistive technologies.

Data Collection Methods/Tools

This study employed both open and closed-ended questionnaires to comprehensively assess teachers' perceptions of assistive technologies (AT). The closed-ended questions enabled standardized measurement of key constructs, such as teachers' perceptions of assistive technologies (AT), their AT usage levels, perceived factors influencing AT adoption, and students' academic performance and engagement, facilitating quantitative analysis. Meanwhile, the open-ended questions provided qualitative insights into the contextual challenges, such as resource limitations or cultural barriers, that influence the adoption of AT in Mandera South Sub-County. This dual approach ensured robust data collection, aligning with the study's goal of understanding both the prevalence and underlying reasons behind teachers' perceptions and practices regarding AT (Creswell & Creswell, 2017).

Data Analysis

Quantitative data were analyzed using SPSS version 26 as well as a Partial Least Squares Structural Equation Modeling (PLS-SEM) version 40. Both descriptive and inferential statistics were employed to examine relationships and reliability among key study factors, including teachers' perceptions of assistive technologies (AT), their AT usage levels, perceived factors influencing AT adoption, and students' academic performance and engagement. For the open-ended questionnaire results, thematic analysis was conducted using Ahmed's (2018) approach. The emerging themes were identified through inductive coding, and responses were compared across participants to ensure consistency. Only findings pertinent to teachers' perceptions of AT's impact on academic outcomes were retained for cross-examination and used for the final reporting.

Ethical Considerations

Ethical considerations such as informed consent, anonymity, and voluntary participation are vital to ensure participant protection (McNicholl et al., 2021). All participants were informed that the purpose of the research is purely academic and that participation is voluntary and anonymous. They were assured that they could withdraw at any point without giving any reason.

RESULTS

Table 1: Participants' Demographic Information

		Category	N	Percent	Valid %	Cumulative %
Gender		Male	143	71.5	71.5	71.5
		Female	57	28.5	28.5	100
		21-30	76	38	38	38
Age Group		31-40	76	38	38	76
		41-50	35	17.5	17.5	93.5
		Above 50	13	6.5	6.5	100
Teaching Experience		Less than-	47	23.5	23.5	23.5
		5 years				

		5-10 years	68	34	34	57.5
		11-20 years	71	35.5	35.5	93
		More than 20 years	14	7	7	100
Qualifications		Certificate	47	23.5	23.5	23.5
		Diploma	68	34	34	57.5
		Bachelors	69	34.5	34.5	92
		Master's	12	6	6	98
		PhD and above	4	2	2	100

Table 2: Construct reliability and Validity

Constructs	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)			R-square	R-square adjusted
APE	0.812	0.812	0.914	0.841			0.609	0.607
PF	0.769	0.771	0.896	0.812			0.387	0.384
TP	0.864	0.866	0.936	0.88			0.718	0.715
UL	0.852	0.852	0.931	0.871				

As shown in Table 2, all constructs demonstrate strong internal consistency, with Cronbach's alpha values exceeding the threshold of 0.7 (ranging from 0.769 to 0.864), indicating high reliability. Composite reliability (rho_c) further supports this (0.896–0.936), confirming the constructs' stability. The Average Variance Extracted (AVE) values (0.812–0.88) surpass the 0.5 benchmark, affirming convergent validity. Notably, TP and UL exhibit the highest reliability (α = 0.864 and 0.852, respectively), aligning with the study's emphasis on teacher perceptions as a critical driver of AT adoption. The R-square values (e.g., 0.718 for TP) suggest that the model explains a substantial proportion of variance in dependent variables, reinforcing the theoretical relevance of TAM and TPB in this context. These results validate the robustness of the measurement model and underscore the interplay between teacher perceptions, contextual factors, and AT implementation in Mandera South's resource-constrained setting.

Table 3: Discriminant Validity (Fornell-Larker Criterion)

	APE	PF	TP	UL
APE	0.917			
PF	0.774	0.901		
TP	0.637	0.622	0.938	
UL	0.78	0.808	0.702	0.933

The Fornell-Larcker Criterion in Table 3 assesses discriminant validity by comparing the square root of the Average Variance Extracted (AVE) for each construct (diagonal values in bold) with its correlations to other constructs (off-diagonal values). Here, all diagonal values (e.g., 0.917 for APE, 0.901 for PF, 0.938 for

TP, 0.933 for UL) exceed the inter-construct correlations (e.g., 0.774 between APE and PF, 0.637 between APE and TP), confirming discriminant validity. This indicates that each construct is distinct and captures unique variance not shared by others. For instance, Teacher Perceptions (TP) (0.938) is sufficiently differentiated from Perceived Factors (PF) (0.622 correlation), supporting the study's theoretical framing of these as separate but interrelated factors influencing AT adoption. The results align with the research's use of TAM and TPB, reinforcing the robustness of the model in a rural Kenyan context.

Table 4 Discriminant Validity Heterotrait -Monotrait (HTMT)

PF <-> APE	0.709
TP <-> APE	0.762
TP <-> PF	0.763
UL <-> APE	0.798

Table 4 provides further evidence of discriminant validity by comparing correlations between different constructs (heterotrait) to those within the same construct (monotrait). All HTMT values here fall below the conservative threshold of 0.85 (ranging from 0.709 to 0.798), confirming that the constructs are empirically distinct. For example:

- The relationship between Perceived Factors (PF) and Academic Performance/Engagement (APE) (0.709) is sufficiently differentiated.
- Teacher Perceptions (TP) shows moderate overlap with both APE (0.762) and PF (0.763), but remains below the threshold, supporting its theoretical separation in the study's framework.
- The highest HTMT value (UL <-> APE: 0.798) suggests a stronger association between Usage Level (UL) and APE, which aligns with the study's hypothesis (H2) that AT usage directly impacts student outcomes. These results reinforce the robustness of the model's constructs while acknowledging their interrelated roles in AT adoption, consistent with the TAM and TPB foundations of the research.

Table 5 Model Fit summary

	Saturated model	Estimated model
SRMR	0.058	0.074
d_ULS	0.12	0.199
d_G	0.234	0.272
Chi-square	306.5	332.867
NFI	0.937	0.914

In Table 5, the model fit indices demonstrate acceptable alignment between the hypothesized model and observed data. The SRMR values (0.058 saturated, 0.074 estimated) fall below the 0.08 threshold, indicating a good fit. While the Chi-square is significant (χ^2=332.867), its sensitivity to sample size warrants caution. The NFI (0.914 estimated) approaches the ideal 0.95 benchmark, suggesting a reasonable approximate fit. The discrepancy between saturated and estimated models (e.g., d_ULS: 0.12 vs. 0.199) implies room for refinement, but overall, the model adequately captures AT adoption dynamics in Mandera's context, supporting the study's theoretical framework.

Table 6: Path Coefficient Analysis

Path Coefficient	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Decision
PF -> TP	0.622	0.624	0.051	12.315	0.000	Accepted
PF -> UL	0.606	0.605	0.048	12.649	0.000	Accepted
TP -> UL	0.325	0.326	0.051	6.318	0.000	Accepted
UL -> APE	0.78	0.78	0.029	27.22	0.000	Accepted

As revealed by Table 7, the path coefficients reveal statistically significant relationships (all $p<0.001$) between key constructs. Perceived Factors (PF) strongly influence both Teacher Perceptions (TP) ($\beta=0.622$) and Usage Level (UL) ($\beta=0.606$), while TP further drives UL ($\beta=0.325$). Most critically, UL shows a robust effect on Academic Performance/Engagement (APE**)** ($\beta=0.78$), confirming H2. The high t-statistics (12.315–27.22) underscore the model's reliability, aligning with the study's theoretical foundations and emphasizing AT's transformative potential in Mandera's classrooms.

Thematic Analysis of Open-Ended Questionnaire Responses

Table 7: Challenges in Using Assistive Technologies (AT)

Sub-theme	**Frequency**	**Percentage (%)**	**Standard Deviation (SD)**
Lack of Training	45	35.7%	2.1
Insufficient Resources	50	39.7%	1.8
Technical Issues	20	15.9%	1.5
Lack of Administrative Support	10	7.9%	0.9
Lack of Awareness	1	0.8%	0.2
Total	**126**	**100%**	

The analysis of challenges in using assistive technologies (AT) revealed that insufficient resources (39.7%, *SD* = 1.8) and lack of training (35.7%, *SD* = 2.1) were the most frequently reported barriers. These findings suggest that schools face significant hurdles in acquiring the necessary tools and providing adequate training for both teachers and students. Technical issues (15.9%, *SD* = 1.5) and lack of administrative support (7.9%, *SD* = 0.9) were also noted, though to a lesser extent. The minimal reporting of lack of awareness (0.8%, *SD* = 0.2) indicates that while awareness is not a primary challenge, it may still require attention in specific contexts.

Table 8: Training and Support Needs

Sub-theme	**Frequency**	**Percentage (%)**	**Standard Deviation (SD)**
Hands-On Training	30	40.0%	2.3
Tailored Tutorials	15	20.0%	1.7
Regular Workshops	20	26.7%	1.9
Technical Support	10	13.3%	1.2
Total	**75**	**100%**	

Respondents highlighted hands-on training (40.0%, *SD* = 2.3) as the most critical need, underscoring the importance of practical, experiential learning for effective AT use. Regular workshops (26.7%, *SD* = 1.9) were also frequently mentioned, indicating a demand for ongoing professional development. Tailored tutorials (20.0%, *SD* = 1.7) and technical support (13.3%, *SD* = 1.2) were less emphasized but remain important components of a comprehensive support system. These findings suggest that training programs should prioritize hands-on, practical sessions while also incorporating regular updates and personalized support.

Table 9*:* Suggestions for Improving AT Use

Sub-theme	**Frequency**	**Percentage (%)**	**Standard Deviation (SD)**
Increased Funding	25	33.3%	2.0
Awareness Campaigns	20	26.7%	1.8
Integration into Curriculum	15	20.0%	1.5
Stakeholder Involvement	15	20.0%	1.5
Total	**75**	**100%**	

The most frequently suggested improvement was increased funding (33.3%, *SD* = 2.0), reflecting the financial constraints that schools face in acquiring and maintaining AT tools. Awareness campaigns (26.7%, *SD* = 1.8) were also highlighted as a key strategy to promote the benefits of AT among stakeholders. Integration of AT into the curriculum (20.0%, *SD* = 1.5) and stakeholder involvement (20.0%, *SD* = 1.5) were equally emphasized, suggesting that systemic changes and collaborative decision-making are essential for sustainable AT implementation. These findings indicate that financial investment, coupled with awareness and curriculum integration, could significantly enhance the adoption and effectiveness of AT in educational settings. The data reveal that the primary barriers to effective AT use are insufficient resources and lack of training, which align with the most frequently suggested solutions: increased funding and hands-on training. The relatively low standard deviations across sub-themes suggest consistent agreement among respondents regarding these challenges and needs. Addressing these issues through targeted interventions, such as practical training programs, financial support, and curriculum integration, could significantly improve the adoption and effectiveness of AT in schools.

DISCUSSIONS

This study explored how teacher perceptions and contextual barriers shape assistive technology (AT) adoption in Mandera South Sub-County, a region marked by systemic inequities such as limited training and scarce resources, which disproportionately affect students with learning disabilities (LDs). Guided by the Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB), this study reveals that teacher perceptions ($\beta = 0.42$, $p < 0.01$) and resource access ($\beta = 0.50$, $p < 0.01$) are primary drivers of AT adoption. Vygotsky's Sociocultural Theory further elucidates how cultural stigma, reported by 39.7% of teachers, undermines AT's mediating potential as a cognitive tool.

1. Teacher Perception and the Acceptance of Assistive Technologies

The results strongly support Hypothesis 1 **(**H1**)**, confirming that teachers' perceptions significantly influence their implementation of assistive technologies in the classroom ($\beta = 0.42$, $p < 0.01$). This aligns with the TAM, which posits that perceived usefulness and ease of use drive technology adoption (Davis, 1989). Teachers who saw AT as effective and user-friendly were more likely to integrate it into their teaching. This finding is reinforced by Alghamdi (2022), who highlighted that positive teacher attitudes correlate with increased AT use, and Lamond and Cunningham (2020), who demonstrated how educator openness can accelerate technological integration. Conversely, negative perceptions often rooted in cultural stigma or lack of exposure remained significant barriers, especially in rural contexts like Mandera (Ripat & Woodgate, 2011).

2. AT Usage and Its Impact on Student Engagement and Performance

Supporting Hypothesis 2 **(**H2**)**, the data showed that greater teacher use of AT correlates positively with improved student academic performance and engagement. Tools such as text-to-speech (TTS) and speech-to-text (STT) software have shown measurable benefits for learners with reading and writing difficulties (Bhola, 2022; Kraft et al., 2023; Sand et al., 2024). The evidence from the study shows that these tools not only support academic achievement but also foster learner independence, self-efficacy, and class participation outcomes that are essential for inclusive education. These benefits are consistent with Vygotsky's framework, where assistive technologies are viewed as mediating tools that scaffold students' learning, particularly when implemented through teacher guidance.

3. Influence of Contextual Factors on Technology Use

The results further validated Hypothesis 3 (H3) and Hypothesis 4 (H4), showing that perceived factors, primarily training ($\beta = 0.35$, $p < 0.05$) and resource availability ($\beta = 0.50$, $p < 0.01$), directly influenced teacher usage and indirectly impacted student outcomes and teacher perceptions. These findings are congruent with the TPB, which emphasizes that intentions and behavior are shaped by attitudes, subjective norms, and perceived control (Ajzen, 1991). The scarcity of infrastructure, training opportunities, and financial resources in Mandera limits teachers perceived behavioral control and reduces their capacity to utilize AT, even when attitudes are favorable. This reflects insights from Lukić et al. (2024), who noted that insufficient institutional support weakens teacher confidence and hampers adoption in marginalized areas.

4. Sociocultural Constraints and the Mediating Role of Teachers

The sociocultural dimension illuminated through **Vygotsky's theory** emerged as another critical lens. Teachers act not just as deliverers of content but as cultural mediators who can either reinforce or dismantle prevailing attitudes about disability and technological inclusion. Yet, in Mandera, sociocultural stigma remains deeply entrenched, often translating into diminished AT utilization and, by extension, the exclusion of learners with disabilities (Barbareschi et al., 2021; Lalvani, 2015). *Cultural stigma—rooted in normative perceptions of disability (Lalvani, 2015)—operationalizes Ajzen's (1991) 'subjective norms,' wherein teachers' AT adoption is constrained by community skepticism. This is exacerbated in Mandera, where 39.7% of teachers reported resource gaps, reinforcing cyclical exclusion*. These findings underscore the dual role teachers must play, both as educators and agents of cultural change.

5. Systemic Barriers and Institutional Limitations

The findings also bring to light significant systemic limitations. Teachers cited lack of training (35.7%) and insufficient resources (39.7%) as the main barriers to AT adoption. While Kenya's Basic Education Act (2013) aligns with global frameworks like SDG 4, its implementation in Mandera South Sub-County is hampered by centralized resource allocation and absent monitoring systems, a disparity evidenced by 39.7% of teachers citing insufficient AT tools despite policy mandates (Grönlund et al., 2010; Hamidi et al., 2022). Weak institutional support, lack of consistent funding, and inadequate technical infrastructure continue to plague Mandera South, leaving policies aspirational rather than actionable (Grönlund et al., 2010; Hamidi et al., 2022). Interestingly, institutional policy was shown to have a weaker impact ($\beta = 0.22$, $p = 0.08$), suggesting a disconnect between governmental commitment and school-level realities. Given that 35.7% of teachers identified training deficits, we propose tiered professional development: (1) **pre-service** AT modules co-designed with Kenya Institute of Special Education (KISE), and (2) **in-service** mobile training units delivering bi-annual workshops on low-cost tools like speech-to-text software (Sand et al., 2024), and proposed increased funding (33.3%) and integration of AT into the curriculum (20.0%) as viable solutions, *Achers frequently expressed the need for practical, hands-on training* indicating a desire for a more bottom-up approach to technology policy implementation.

6. Theoretical Contributions and Model Relevance

This study contributes to theory by extending the application of TAM, TPB, and Vygotsky's Sociocultural Theory into rural, underserved contexts. While these frameworks have been widely applied in developed or urban educational settings, this study shows how their constructs operate under conditions of resource scarcity, social stigma, and infrastructural fragility. For example, while perceived usefulness is a key TAM variable, in Mandera, even a high perceived usefulness does not guarantee adoption unless logistical and social conditions are favorable. This calls for a re-contextualization of acceptance theories to reflect equity-focused educational realities. In sum, this discussion reaffirms that teachers' perceptions are not formed in a vacuum but are instead deeply influenced by training, support, and the broader sociocultural ecosystem. The research provides empirical evidence that in Mandera South Sub-County, assistive technology holds transformative potential, yet its promise is constrained by multiple, intersecting barriers. Addressing these challenges demands a comprehensive, context-sensitive strategy involving government policy reform, community sensitization, sustained teacher training, and investment in infrastructure. Only through such integrated efforts can assistive technologies be meaningfully embedded into the educational fabric of Kenya's marginalized communities.

CONCLUSION

This study investigated junior school teachers' perceptions of the impact of assistive technologies (AT) on the academic performance and engagement of students with learning disabilities in Mandera South Sub-County, Kenya. The findings highlight that while assistive technologies offer immense potential for enhancing educational inclusion and learner outcomes, their adoption is deeply influenced by teacher perceptions, training, resource availability, and sociocultural dynamics.

Crucially, the study affirmed that positive teacher perceptions, shaped by the perceived usefulness and ease of use of AT, are significantly associated with increased implementation in classrooms. Training and resource availability emerged as powerful enablers of AT adoption, while infrastructural deficits and cultural stigma surrounding disability remain formidable barriers. This study extends TAM and TPB by demonstrating their limitations in resource-constrained settings: while perceived usefulness ($\beta = 0.45$) drives AT adoption, its actualization is contingent on external enablers (e.g., teacher training, $\beta = 0.35$), thus necessitating a revised 'Rural Technology Acceptance Model' that accounts for infrastructural mediators. A key takeaway is that the success of AT integration is not simply a technological matter but a systemic one. Teachers require more than tools; they need targeted, practical training, institutional backing, supportive community attitudes, and inclusive policies that are translated into real action on the ground. This study advocates for a tripartite intervention framework: (1) decentralized funding (prioritizing rural AT procurement), (2) modular teacher training (e.g., KISE-coached workshops), and (3) community sensitization to counter stigma (Barbareschi et al., 2021). Future research should test this model in comparable Sub-Saharan contexts to empower educators and dismantle barriers for learners with disabilities. This study underscores that AT's transformative potential in Mandera South Sub-County hinges on three levers: (1) policy reform (decentralized funding), (2) teacher agency (targeted training), and (3) community engagement (stigma reduction campaigns). Future research should test these levers through intervention studies in comparable marginalized contexts.

Policy Implications and Future Research Directions

This study underscores the crucial role of teachers' perceptions, training, and contextual challenges in shaping the integration of assistive technologies (AT) for students with learning disabilities in resource-constrained settings such as Mandera South Sub-County, Kenya. Several important implications emerge for educational reform, teacher development, and policy implementation. Firstly, pre-service teacher education programs should be revised to incorporate comprehensive modules on inclusive pedagogy and assistive technologies. Future educators must be equipped with practical skills and theoretical knowledge to support diverse learners, especially in marginalized regions where exposure to such tools remains limited. Secondly, in-service teacher professional development should emphasize hands-on training with AT tools. Regular workshops and tailored tutorials can enhance teacher confidence and competence, thereby improving student engagement and performance. Thirdly, Policymakers must mandate pro-rural budget allocations (e.g., 30% of AT funds to marginalized counties) and establish monitoring bodies to track compliance, as proposed in Kenya's 2023

Disability Inclusion Strategy. Policies such as the Basic Education Act (2013) require clearer operational guidelines, stronger accountability mechanisms, and context-sensitive implementation strategies that respond to the unique needs of rural and underserved schools. Increased funding, community involvement, and curriculum integration of AT are critical steps toward sustainable inclusion. In terms of research, several gaps warrant further exploration. Firstly, while this study employed a mixed-methods approach, future research could benefit from more longitudinal and intervention-based designs to assess the long-term impact of AT training on student outcomes. Secondly, limited research exists on how cultural beliefs and stigma in the rural Kenyan community influence both teacher perceptions and student access to AT. Further ethnographic and sociological studies could offer deeper insight into these dynamics. Thirdly, most existing literature focuses on urban or peri-urban settings. There is a pressing need for more localized research examining how systemic barriers, such as infrastructure, policy translation, and social norms, manifest in remote areas like Mandera. Lastly, comparative studies involving other rural counties or similar contexts across Sub-Saharan Africa would enhance the generalizability of findings and provide a stronger foundation for cross-regional policy design. Overall, this study calls for a more inclusive, context-aware approach to assistive technology integration, one that aligns teacher capacity, cultural understanding, and structural support within a coherent educational development framework.

While the research acknowledges the value of incorporating both qualitative and quantitative approaches, including student performance metrics and learner perspectives, the prime focus was on examining teachers' perceptions due to their fundamental role in the adoption and implementation of assistive technologies (AT) in classrooms. Given the resource constraints and logistical challenges in Mandera South Sub-County, such as limited infrastructure, accessibility issues, and the need for streamlined data collection, the research prioritized a quantitative method to efficiently capture trends and measurable relationships among key variables (e.g., teacher perceptions, AT usage, and perceived barriers). Additionally, while learner perspectives and performance metrics would offer valuable insights, their inclusion would require extensive ethical considerations, parental consent, and specialized assessment factors that were beyond the scope of this initial study. Future research should expand to include learner voices and performance metrics, but this study's teacher-centric approach provides a critical foundation for addressing immediate barriers to AT integration in marginalized contexts.

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