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RESEARCH PAPER

Analyzing the Teaching of Mathematics to Students with Blindness in Ethiopia in Reference to the Existing Policies and Programmatic Frameworks Context

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Abstract

Mathematics is widely recognized as a foundational subject that develops critical thinking and problem-solving skills, which are essential for academic, personal, and professional development. Despite mathematics' immense global significance, blind students in Ethiopia have experienced discriminatory practices in learning the subject. The study aimed to investigate the reasons behind the inaccessibility of mathematics to blind students, taking into account Ethiopia's educational policies and relevant programmatic frameworks. A qualitative design, with phenomenological elements and case studies, was employed. The study involved a total of fifteen key informants. Nine education experts, a disability advocate and six professionals with blindness were selected through purposive and snowball sampling techniques, respectively. Semi-structured face-to-face interviews were used to generate the data, which were then subjected to thematic analysis. The results demonstrate that although Ethiopian policies support inclusive teaching approaches, challenges pertinent to teacher training programs and the under-utilization of assistive technology have led to the exclusion of blind students from mathematics classes. These difficulties were made worse by historical customs and the expulsion of foreign missionaries after the 1974 revolution. The study emphasizes how this exclusion affects blind people's self-confidence, professional opportunities, and access to higher education study choices. Among the suggestions are integrating assistive technologies to support inclusive mathematics, enhancing the role of organizations of people with disabilities, establishing individualized education plans, and mainstreaming disability-inclusive pedagogy in pre- and in-service teacher training programs. The study underscores the importance of adopting the social and rights-based models of disability to address attitudinal barriers and ensure equitable access to mathematics for students with blindness in Ethiopia.

Keywords: Blindness, Mathematics, Inclusive Education, Assistive-Technology, Social and Right-Based Model of Disability

Introduction

Mathematics has become essential for participation in daily life, employment, and national development in today's knowledge-driven and digitally interconnected world. Studies indicate that classifying direction, quantity, shape, and logical attributes is at the core of mathematics, allowing students to develop critical problem-solving and reasoning skills. This is especially true when it comes to the application of mathematical knowledge and skills (Dick *et al*., 2025; Zhang, 2016). Like many other nations, Ethiopia understands the importance of mathematics in creating a workforce that is competitive and attaining sustainable development. As a result, mathematics is required in elementary and secondary school. However, systemic, pedagogical, and attitudinal barriers continue to severely limit the access of blind students to

mathematics education (Milki, 2025; MoE, 2016).

Research shows that students with blindness and visual impairments encounter challenges in terms of factors such as inaccessible learning resources, lack of specially trained teachers, and insufficient application of assistive technology (Driscoll and Watson, 2014; Zhang, 2016). Studies across multiple countries have found that, although innovations such as tactile devices, Braille textbooks, and digital assistive technology have helped improve access, there are still inequities in students' participation in mathematics as a result of weak teacher education and systemic support.

In African and Sub-Saharan regions, educating students with blindness and visual impairment (BVI) involves many continuing challenges. These issues are made worse by negative attitudes, lack of resources, and poor infrastructure. Educational leaders in several African countries are uncertain about the ability of students with blindness to learn and succeed in mathematics (UNESCO, 2018). Although low-cost and affordable tools like Braille slates and styluses are common, they do not effectively support broad mathematics instruction. This is particularly true for complex concepts that need tactile diagrams, mathematical symbols, and hands-on learning (Mwakyeja, 2013; Ncube, 2020). Research in South Africa, Zambia, and Senegal reveals that the lack of tailored teaching materials, such as tactile rulers, abacuses, and raised mathematical graphics, along with inadequate teacher training in inclusive methods, greatly interferes with successful mathematics learning for students with BVI (Chataika *et al*., 2012; Foko, 2020; Maphosa and Ndhlovu, 2019).

These educational challenges are closely connected to larger socio-economic issues for people with blindness. Inadequate access to worthwhile mathematics education restricts opportunities for further education, professional training, and contribution in science, technology, engineering, and mathematics (STEM) fields. These areas are key pathways to economic empowerment in today's economies (UNESCO, 2018). As a result, many people with disabilities in Africa face higher unemployment, underemployment, and reliance on informal or subsistence-level jobs (Leibbrandt and Mlatsheni, 2015). This economic marginalization often traps people in cycles of poverty, limits access to healthcare, and reduces social mobility, which deepens dissimilarity. In Sub-Saharan Africa, where poverty rates are some of the highest in the world, the exclusion of students with blindness and visual impairment from fair mathematics education not only deteriorates individual potential but also hinders national human capital development and novelty (Chimhenga, 2016; World Bank, 2022). The combination of these educational and socio-economic barriers shows the pressing need for policies that include accessible teaching methods, assistive technologies, and focused teacher training. These changes are indispensable to break the cycle of exclusion and marginalization of people with blindness in the region.

Historically, Ethiopia achieved early successes in mathematics education for persons with blindness. During the first decade of Emperor Haile Selassie's restoration, the United Presbyterian Missionaries of North America set up residential schools for the blind, introduced Braille, and taught mathematics from grades 1 to 12 using tactile instruments. Nevertheless, progress was slowed down by the military regime after 1974. This led to the expulsion of missionaries and the ongoing exclusion of persons with blindness from mathematics. It also restricted their ability to participate meaningfully in society, access career opportunities, and enroll in higher education institutions (Sissay, 2022).

While Ethiopia backtracked in upholding the educational and other rights of people with disabilities, including those who are blind, the international community was advancing. Scholars, disability rights advocates, and UN agencies began to promote a new idea: Disability isn't a personal issue; it's a problem within the society. Inspired by the social model of disability, thinkers like Oliver (2013) argued that the main barriers for people with disabilities come from inaccessible systems, biased policies, and old attitudes. The question

changed from "How can people with disabilities adjust?" to "Why won't society change?"

To meet the specific needs of learners with disabilities, including those with blindness, Ethiopia has made imperative development in supporting inclusive education. The Ethiopian government has made advances through policy changes like the 1994 Constitution, the Education and Training Policy (1994 and 2018), the Special Needs/Inclusive Education Strategy (2006, 2012, & 2022), and the Inclusive Education Master Plan (2016). However, the execution of these policies varies. Article 41(3) of the Constitution guarantees equal access to public services. Additionally, Ethiopia's ratification of the UN Convention on the Rights of Persons with Disabilities (CRPD) (2006) confirms the country's legal commitment to inclusive education. However, the experiences of students with blindness, particularly in STEM subjects like mathematics, show significant exclusion. The Master Plan for Special Needs/Inclusive Education (2016–2025) offers promises for adapting the curriculum, using flexible teaching methods, and incorporating assistive tools like Braille, tactile models, and audio-based learning. Nevertheless, these commitments have not become common in practice.

Studies prove that teachers play a key role in unlocking every child's potential, especially for students with disabilities. They don't just deliver lessons; they adjust their methods and make sure no learner is left behind. Effective teaching, especially for students with blindness, requires adapting the curriculum, using appropriate teaching methods, and applying assistive technologies. Recognizing this, Ethiopia's 10-Year Master Plan focused on teacher training, giving educator skills like curriculum adjustment and inclusive teaching strategies because a policy is only as good as the teachers who implement it (MoE, 2016).

Nevertheless, studies in Ethiopia show that teachers often don't have enough knowledge of Braille and suitable teaching strategies (Golga and Kana, 2024 Yohannes, 2007). For example, the study according to (Gasa and Negash, 2022) reported that students having no access to Braille-based mathematics resources or teacher support, which impacts their learning outcomes. Dawit and Fituma (2023) highlighted that many educators had hesitation about whether students with blindness can learn math through Braille, which led to their exclusion from STEM subjects.

Existing Ethiopian studies on Braille and mathematics education provide valuable insights but leave numerous gaps. While these studies have explored broader Braille literacy, the lived experiences of students with blindness, and barriers in mainstream schools (Dawit, and Fituma 2023; Gasa and Negash, 2022; Golga and Kana, 2024), none have focused explicitly on mathematics teaching, the importance of teacher training in Braille mathematics, or the availability and use of Braille-specific mathematical resources. Other studies broadly address inclusion challenges but sidestep the specific crisis in mathematics accessibility (Asmerom and Fituma, 2024; Mulat and Silesh, 2020). Even Yohannes' (2007) work on mathematics pedagogy gaps never clarified whether students with blindness were part of the study. There is also inadequate research assessing how well policies are implemented to facilitate mathematics education for blind students.

The present study was meant to confront these oversights. This study made its center on the factors contributed to the inaccessibility of mathematics to students with blindness while it has been supported by the country's education policy and other relevant programmatic documents. In the courses of data collection and analysis, more focus was given to the inclusive education Master Plan which was ought to be implemented from 2016 to 2025 and the lived experiences of professionals with blindness. This study wasn't just for academic purpose; it's about dismantling systemic bias and ensuring the next generations of Ethiopians with blindness aren't denied opportunities their peers take for granted. Furthermore, the study contributes to the literature by examining the systemic and institutional factors that influence persons with blindness mathematics education, situating the Ethiopian experience within

broader global and African contexts. Understanding these dynamics is crucial to developing strategies that ensure equitable learning opportunities for blind students, enhancing their problem-solving skills, and supporting their full participation in society.

Based on these veracities, the study aspired to answer the following basic questions:

1. What, if any, written policies or practices have historically limited the access of mathematics education to students with blind?
2. What institutional initiatives currently exist to facilitate mathematics learning for students with blindness in Ethiopia?
3. How do government authorities in the education sector perceive the capacity of blind students to learn mathematics?
4. What lessons can be drawn from past experiences and success stories of blind learners in mathematics?
5. What strategies or interventions are needed to transform existing exclusionary practices and ensure equitable access to mathematics education for blind students?

Materials and Methods

Research Design

This study employed a qualitative case study design with phenomenological elements, which is particularly suitable for exploring the lived experiences, institutional practices, and policy implementation related to teaching mathematics to blind students in Ethiopia (Creswell and Poth, 2018; Yin, 2018). Case studies enable an in-depth examination of contemporary phenomena within their real-life contexts, particularly where boundaries between the phenomenon and context are not clearly defined. Phenomenological elements were incorporated to capture the personal experiences of blind professionals, providing insights into the successes and challenges they encountered in learning mathematics. The qualitative approach was chosen over quantitative or mixed-method designs since the study seeks to explore complex social processes, attitudes, and practices, which cannot be effectively quantified. The design aligns directly with the research questions, which focus on policy implementation, institutional endeavors, teacher perceptions, historical experiences, and strategies to improve mathematics education for blind students.

Study Setting

The study was conducted in multiple administrative regions in Ethiopia, including the Addis Ababa city administration, Oromia, the Southern Nations, Nationalities, and People's Regional States. These regions were selected for the fact that they were relatively more peaceful than the other regional States in Ethiopia during the data collection period. Besides, most of the residential schools for the blind were situated in these settings.

Study Participants

The informants of the study were experts from Special Needs and Inclusive Education and Teachers and School leaders' development working in the Federal Ministry of Education, Addis Ababa City Administration, Oromia, the South Nation, Nationalities, and Peoples Regional States Education Bureaus. The Special Needs and Inclusive education experts are responsible to formulate Special Needs and Inclusive Education programs and strategies to facilitate the inclusion of all school age children in educational settings while the expertise in the teachers and school leaders 'were responsible for teacher training in pre- and in-service modalities and teachers' capacity building. Disability advocates from the Ethiopian National Association of the Blind (ENAB) and professionals with blindness were another set of the study participants.

Sample Size and Sampling Methods

A total of fifteen participants were included in the study. They comprised special needs and inclusive education experts and teacher and school leaders development experts working at the Federal Ministry of Education and Regional

or City Education Bureaus, Disability movement advocates, selected from the Ethiopian National Association for the Blind (ENAB), were included for their expertise and historical knowledge of the suitable strategies for students with blindness as well as the roles they have for promoting the right to an inclusive educational approach for persons with blindness.

Additionally, professionals with blindness who experienced success and challenges in learning mathematics education and currently serve in professional roles were included to provide insights into their lived experiences. Purposive sampling was used to select participants from the Ministry of Education, city and regional education bureaus, and ENAB, ensuring information-rich cases relevant to the study objectives (Palinkas *et al*., 2015). Snowball sampling was employed to recruit blind professionals, as they represent a hard-to-reach population; initial participants referred others with relevant experiences. The combination of these methods strengthens the link between policy-level insights and experiential knowledge, enhancing the study's comprehensiveness.

Sample Size and Profile

The participants from education institutions and advocacy organizations (Table 1) included experts from the Ministry of Education, Addis Ababa, Oromia, South Nations Nationalities and Peoples' Regional States Education Bureaus, and an advocacy officer from ENAB. Their roles encompassed special needs education and teacher development expertise with qualifications ranging from BA to MA and professional experience spanning eight to thirty years.

Table 1. Profiles of Education Experts and Advocates who shaped this study

Institution	Role	Gender	Age	Education	Years of Experience
Ministry of Education	Special Needs Expert	Male	48	MA	19
	Teacher Development Expert	Male	46	MA	8
Addis Ababa Education Bureau	Special Needs Expert	Male	34	MA	16
	Teacher Development Expert	Male	47	MA	21
Oromia Education Bureau	Special Needs Expert	Male	52	MA	31
	Teacher Development Expert	Male	47	MA	29
SNNP Region Education Bureau	Special Needs Expert	Male	53	MA	33
	Teacher Development Expert	Male	51	MA	30
Ethiopian Nat'l Assoc. of the Blind	Advocacy Officer	Male	58	BA	37

The following thematic summary of interviews with education experts and advocates (Table 2) indicated the gaps between policy intentions and actual implementation, perceived teachers misconception that mathematics is only for those without blindness, how lack of appropriate training affected educational services to students with blindness, and the inability to utilize the available resources due to factors attached to knowledge, skills, attitudes and stereotypes.

Table 2. Thematic Summary of Interview Insights from Education Experts and Advocates

Theme	Sample Participant Quote	Institution / Role
Policy–Practice Gap	"We write inclusive policies, but teachers never get the braille and tactile tools to implement them."	Ministry of Education – Special Needs Expert
	"Without braille textbooks, policies are just poetry."	SNNP Education Bureau – Special Needs Expert
Teacher Misconceptions About Blindness	"Most math teachers still believe blindness = inability to calculate. Training = None, Support = None."	Ministry of Education – Teacher Development Expert
	"Teachers fear inclusive math because they were never taught how."	Oromia Education Bureau – Teacher Development Expert
Lack of Training and Professional Support	"Training? None. Follow-up support? None."	Addis Ababa Education Bureau – Teacher Development Expert
	"We've never trained teachers in methods to teach math to students with blindness."	SNNP Education Bureau – Teacher Development Expert
Resource Shortages	"The city has resources, but students are forgotten."	Addis Ababa Education Bureau – Special Needs Expert
	"I've fought for tactile math tools since the 1990s. Progress is glacial."	Oromia Education Bureau – Special Needs Expert
Advocacy and Personal Experience	"I scored top in math class. Now they tell blind kids it's impossible to learn mathematics. Why?"	Ethiopian National Association of the Blind – Advocacy Officer

The study also included six pioneering Ethiopian professionals with blindness (Table 3) whose lived experiences span multiple decades of educational and advocacy work. These participants, aged between 53 and 79 years, held either bachelors or master's degrees and had between 30 and 48 years of professional experience, totaling 243 combined years of service. Their careers encompassed roles in inclusive education advocacy, teaching, lecturing, and advising within governmental, non-governmental, and academic institutions. Having personally experienced both inclusion and exclusion from mathematics education at various stages of their schooling, they offered powerful first-hand accounts of how systemic barriers, teacher attitudes, and instructional practices shaped their academic and professional trajectories.

Table 3. Profiles of Professionals with Blindness

Institution	Role	Age	Gender	Education	Years Working
Together for Inclusion	Officer	78	Male	BA	48
Yemisirach Center	Advisor	72	Male	BA	43
(Former) Primary School	Retired Teacher	79	Male	BA	54
(Former) Primary School	Retired Teacher	66	Male	BA	36
National Association of the Blind	Inclusion Expert	57	Male	BA	32
College of Teacher Education	Lecturer	53	Male	MA	30

Age as evidence

Participants' age (Table 3) ranged from53 to 79. Key informants aged 78 and 79 were those who had the opportunity to learn mathematics as a compulsory subject during the imperial government (before 1974) by the missionaries from North America. The key informant, aged 72, has never experienced mathematics learning. Key informants aged 53-66 did not have uniform experiences. A key informant with age 53 has begun learning mathematics on abacus but meanwhile, was forced to drop the subject by mathematics teacher of the non-boarding public school. The other two (57 and 66) had mathematics learning experiences up to grade 6 in a boarding school for the blind but were forced to drop the subject by the mathematics teacher of grade 7 when they went to the nearby government school. This has proven that the exclusion is not new; it's a generational systemic failure (from 1974 to date).

The following thematic analysis (Table 4) organizes participants' lived experiences into five major themes reflecting systemic and pedagogical challenges: policy-practice gaps, inaccessibility of mathematics, impact on socio-economic opportunities, teacher preparedness, and the need for assistive technologies. These themes highlight both the structural barriers and the personal consequences faced by students with blindness in accessing mathematics education.

Table 4. Themes and Illustrative Quotes from Professionals with Blindness

Theme	Illustrative Quote
Policy-Practice Gap	"Policies say inclusion is a right, but in mathematics classrooms, students with blindness are still invisible."
Inaccessibility of Mathematics	"Without accessible materials, mathematics becomes a closed door to students with blindness future."
Impact on Socio-Economic Opportunities	"If persons with blindness can't learn mathematics, they are locked out of many professions, career opportunities, access to higher education their interest field of study at the higher education institutions; and even basic financial management."
Teacher Preparedness	"Most teachers have good intentions but lack the skills and tools to teach mathematics to blind students."
Need for Assistive Technologies	"Even a simple talking calculator could change our learning experience, but such tools are rare and teachers' possess no ability to operate the device because they have no knowledge and skills to do so"

Data Collection tool

Face-to-face semi-structured interviews were used for data collection, as this method allows the researchers to explore issues in depth while

maintaining alignment with research objectives (Creswell and Poth, 2018). Interviews with education experts focused on policy implementation, institutional practices, and teacher preparation, whereas interviews with blind professionals explored their personal experiences in learning and using mathematics, including successes and challenges encountered. Interviews were conducted at locations convenient for participants and lasted between sixty and ninety minutes. All interviews were audio-recorded with participant consent and stored securely. Participants were assured of anonymity, confidentiality, and the right to withdraw from the study at any time. The researchers served as human readers during interviews with participants with blindness to ensure comprehension and accurate data capture.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Review Board (IRB) at the department level, Addis Ababa University, College of Education and Behavioral Studies, Departments of Special Needs and Inclusive Education under approval code SNIE 143/GP/12, dated 24/08/2021. Participants provided informed consent, and confidentiality and anonymity were maintained throughout the research process. Ethical safeguards were particularly important given the inclusion of high-profile officials and professionals with blindness.

Data Analysis

Thematic analysis, following Braun & Clarke's (2006) guidelines, was employed to analyze the data. Data analysis began with familiarization through repeated reading of transcripts, followed by coding key ideas and recurring patterns. Codes were then grouped into preliminary themes, which were reviewed and refined for consistency and relevance. The final themes were defined, named, and interpreted in relation to the research questions and study objectives. Themes were organized to correspond with research questions, including institutional practices, policy implementation gaps, teacher perceptions, and lived experiences of professionals with blindness.

Trustworthiness

Credibility was enhanced through member checking, allowing participants to verify the accuracy of interview transcripts. Triangulation was achieved by comparing interview data with policy documents and historical records. Dependability and conformability were ensured through a detailed audit trail, while transferability was supported by providing rich contextual descriptions (Guba and Lincoln, 1985).

Research Themes

The study identified four overarching themes. The first theme focused on the existing practices addressing blind students' mathematical needs according to relevant policy frameworks, including institutional undertakings promoting blind students' rights. The second theme explored education experts' understanding of teaching mathematics to blind students in the Ethiopian context. The third theme traced historical arguments and prohibitions that contributed to the exclusion of blind students from mathematics. The fourth theme addressed practical strategies for changing unlawful or traditional practices to improve access and inclusion in mathematics education.

Definition of Terms

Blindness refers to the total loss of sight, educationally identified as students using Braille as their primary reading and writing method.

Policy refers to any legal or strategic document developed or endorsed to address the educational needs of blind students.

Results

Existing Practices in Addressing the Special Educational Needs of Blind Students in Mathematics

Informants from the Federal Ministry of Education and regional/city education bureaus were asked to share their views on the major goals of primary education and the minimum learning competencies expected from students. They unanimously approved that reading, writing, computation, and the ability to utilize these skills in daily life are the minimum competencies required. Mathematics and English were recognized as compulsory subjects due to their essential roles in students' academic and professional futures. Despite this recognition, the informants highlighted a contradiction in current practice: blind students are frequently excluded from learning mathematics, which negatively affects their ability to achieve the expected learning outcomes at the completion of primary education.

When questioned about the existence of legal statements prohibiting blind students from learning mathematics, experts confirmed that no such documents exist. Instead, they emphasized that a lack of awareness and understanding among senior education leaders about the capacities of blind students, coupled with insufficient preparation of teachers to teach mathematics to this population, has led to the de facto exclusion of blind students from the subject. A special needs education expert from the Ministry of Education explained that repeated searches in official archives yielded no policy or law denying blind students the right to learn mathematics. Furthermore, the experts reported that no specific capacity-building programs had been provided to teachers in pre-service or in-service training to address the teaching of mathematics to blind students, despite the strategic objectives outlined in the federal Master Plan for inclusive education.

The study also explored the role of Inclusive Education Resource Centers (IERCs), which were established nationwide to support inclusive education. Respondents indicated that these centers are currently not supporting mathematics instruction for blind students because teachers lack training in the use of assistive devices and adaptive technologies available at these centers.

Institutional Efforts to Promote the Rights of Blind Students in Mathematics

Organizations of Persons with Disabilities (OPDs), including the Ethiopian National Association of the Blind (ENAB), have a mandate to promote the rights of their members, including access to education. However, interviews revealed that ENAB has not actively ensured that blind students have access to mathematics education. Similarly, SNE experts in the Ministry of Education and regional education bureaus acknowledged that while blind students are capable of learning mathematics and that mathematics is critical for academic and career advancement, institutional measures, including their respective bureaus, to support these students remain weak.

One expert noted that in the 1950s, blind students learned mathematics in schools established by missionaries, and this practice continued until the early 1970s. Following the fall of the imperial government in 1974, blind students' access to mathematics was largely confined to special schools up to grade six. Those integrated into regular schools were systematically excluded from learning mathematics, and the reasons for this exclusion were not formally investigated or addressed by educational authorities. All experts agreed that the current exclusionary practice contravenes both the United Nations Convention on the Rights of Persons with Disabilities (CRPD) and established pedagogical principles.

Education Experts' Understanding of Mathematics Instruction for Blind Students

General education experts in teachers' development programs reported that mathematics is perceived as a particularly challenging subject for blind students due to its reliance on visual instructional media. This perception influenced curriculum design, as adaptive teaching techniques were not incorporated into teacher education programs. Consequently, mathematics teachers in

inclusive classrooms are largely unprepared to address the needs of blind students.

Historical and Social Factors Influencing Exclusion

Experts, ENAB representatives, and blind professionals were asked to explain the historical factors behind the exclusion of blind students from mathematics education. Participants identified entrenched negative attitudes among decision-makers as informal yet influential barriers. One blind professional recalled learning mathematics only up to grade six in a residential school and then being forced to leave the school system that could support advanced mathematics learning. Upon entering a regular school, teachers discouraged further study in mathematics, claiming it was too difficult for blind students. Other informants noted that after the military government took power, foreign missionaries who had provided expertise and training in teaching mathematics to blind students were expelled, and their knowledge was not transferred to local teachers. This gap in teacher preparation and institutional knowledge significantly contributed to ongoing exclusion.

The consequences of this exclusion were evident in participants' lived experiences. Blind professionals who had not received mathematics education reported a lack of confidence in handling numerical tasks, feelings of helplessness, and restricted career choices, particularly being confined to social science streams. Conversely, those who had successfully learned mathematics from primary through secondary levels reported greater confidence in addressing numerical problems in professional and daily life, highlighting the critical role of access to mathematics education in self-efficacy and career advancement.

Practical Actions for Redressing Exclusion

Participants suggested several strategies to improve mathematics education for blind students. They emphasized the need to enhance teacher training programs to include adaptive and accommodative instructional methods, and to mainstream disability issues within pre-service and in-service teacher education curricula. OPDs, particularly ENAB, should educate members about their rights to learn mathematics and actively advocate against discriminatory practices. Implementing Individual Education Plans, assistive technologies, and inclusive adaptive ICT were recommended as essential methodologies for supporting blind students. Finally, participants proposed organizing pilot programs in selected inclusive schools to demonstrate effective practices for teaching mathematics to blind students, providing a model that could be scaled nationwide.

Discussion

The findings of this study disclose a noteworthy gap between policy intentions and actual practice in teaching mathematics to blind students in Ethiopia. Despite having strong legal frameworks, such as the Ethiopian Constitution (1994), the UN Convention on the Rights of Persons with Disabilities (CRPD, 2006), and the Federal Ministry of Education's Master Plan for Special Needs Education (MoE, 2016), blind students still experience exclusion from mathematics instruction. This situation matches global evidence, showing that having inclusive policies alone does not ensure educational access for students with disabilities. Effective implementation needs structural, pedagogical, and attitudinal support (Al-Azawei *et al*., 2016; Driscoll and Watson, 2014).

From the perspective of inclusive mathematics education, the study highlights that blind students can learn mathematics when they receive adaptive teaching methods, Braille materials, tactile tools, and assistive technologies. These findings align with research from both developed and developing areas, including sub-Saharan Africa, which indicates that learners with visual impairments can achieve similar mathematical results when adequately supported (Ali, 2019; Moyi, 2018). However, in Ethiopia, deep-rooted misconceptions about mathematics' visual nature and the lack of teacher training in adaptive teaching methods have resulted in

systemic exclusion. This reflects a trend that diverges from global best practices, where access and inclusion are increasingly seen as rights instead of privileges.

The historical review shows how institutional and social disruptions contribute to exclusion. In the mid-20th century, missionary schools effectively used Braille for math instruction up to secondary levels (Sissay, 2022). However, after the 1974 political shift and the expulsion of foreign educators, Ethiopian blind students faced a significant drop in access to mathematics education. This history shows that exclusion is not caused by students' abilities but by structural and attitudinal barriers within the education system. This idea is a key part of the social model of disability. According to this model, disability mainly comes from environmental and societal obstacles, not individual impairments (Oliver, 2013). In Ethiopia, the study indicates that high-level educational leaders, teachers, and institutions have maintained these attitudinal barriers by believing that math is unsuitable for blind students, which limits their access to the subject.

The findings also support the rights-based approach to disability. They emphasize that blind students should have equal access to educational activities, including mathematics, as a basic human right (CRPD, 2006). Excluding blind students from mathematics classes, regardless of their proven abilities, violates their fundamental rights and undermines the goals of inclusive education. Blind professionals interviewed in this study reported long-term effects of this exclusion, such as decreased confidence, fewer career options, and difficulties in higher education study choices. This aligns with global research showing that denying access to core subjects reduces educational and socio-economic opportunities (Driscoll and Watson, 2014; Zhang, 2016).

A key contribution of this study is the definition of the attitudinal barrier as a main factor in the exclusion of blind students from math education. While there are structural and policy frameworks, attitudinal barriers, such as negative views of blind students' abilities, teachers' lack of knowledge about adaptive methods, and institutional reluctance, serve as the main reason for exclusion. This supports social and rights-based models, which assert that educational inequities are socially created and need targeted interventions to change. Therefore, the study advances theory by showing how policy, teaching methods, and attitudes interact to shape access to mathematics education for blind students in Ethiopia.

The study findings align with research from Africa that emphasizes the importance of teacher preparedness and attitudes in making inclusive education work (Moyi, 2018; Sissay, 2022). However, these findings differ from what Ethiopian policies suggest. The policies imply that having inclusive education frameworks is enough to guarantee access. The findings of this study demonstrate that merely having legal recognition is not enough. Without changes in attitudes and practical steps like adaptive curricula, assistive technologies, and teacher training, blind students continue to be left out of essential subjects like mathematics.

The study highlights several actions for policy and practice. First, teacher training programs should include inclusive mathematics teaching methods, focusing on adaptive techniques, assistive technology, and individualized education plans. Second, the Ethiopian National Association of the Blind (ENAB) and other disability organizations should be supported in advocating for the rights of blind students, raising awareness, and tackling discrimination. Third, education authorities should oversee policy execution and create supportive structures, such as Inclusive Education Resource Centers, to promote fair mathematics learning. Finally, pilot programs that successfully teach mathematics to blind students can act as examples for expanding these practices across the country.

Conclusion

This study shows that, even with strong legal and policy support for inclusive education in Ethiopia, blind students still face systemic

exclusion from mathematics instruction. The findings point out that the main barriers are attitudinal, structural, and pedagogical, not based on the students' abilities. This is backed by the lived experiences of professionals with blindness who successfully navigated mathematics education from primary through secondary grades. Misunderstandings about the adaptability of the visual aspect of mathematics, inadequate teacher training, a lack of adaptive materials, and historical disruptions have limited blind students' access to the subject. The experiences of education professionals and blind individuals highlight that exclusion has real socio-economic effects, such as lower educational achievement, fewer career opportunities, and decreased confidence in numerically associated activities.

The study contributes to our understanding by stressing the importance of attitudinal barriers in determining access to mathematics. It adds to social and rights-based models of disability that place inequities in social structures instead of individual impairments. Similarly, the findings are consistent with regional and global research about the importance of teacher training, adaptive and tailored teaching methods, and inclusive practices. The findings also reveal a gap between what Ethiopian policies aspires and what actually happens in practice.

On a practical level, the study emphasizes the urgent need for thorough teacher training in inclusive mathematics teaching, access to Braille and tactile learning tools, empowering advocacy groups like ENAB, and creating supportive monitoring and resource systems. Pilot programs that show successful instruction for blind students could serve as models for wider implementation across the country. In general, the study corroborate that achieving inclusive mathematics education in Ethiopia necessitates targeted efforts to implement policy, adapt teaching methods, and attitudes, in order for students with blindness fully exercise their educational and socio-economic rights.

Recommendations

Teacher Education and Capacity Building: Both pre-service and in-service training programs should include inclusive mathematics teaching methods for students with blindness. They should focus on Braille instruction, adaptive teaching tools, and personalized support.

Policy Implementation and Monitoring: Educational authorities must put inclusive policies into action. They need to ensure compliance at both the classroom and institutional levels, while also establishing ongoing monitoring and evaluation systems.

Provision of Resources: Schools should have accessible mathematics materials, tactile tools, assistive technologies, and inclusive learning environments to effectively support blind students.

Attitudinal Change and Advocacy: Awareness campaigns should target misconceptions about the abilities of blind students in mathematics. Organizations of Persons with Disabilities, especially ENAB, should be strengthened to actively advocate for inclusive practices.

Pilot Programs and Research Integration: Demonstration projects that implement inclusive mathematics education should be tested in selected schools. These projects can showcase best practices and guide changes in national policy.

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Conflict of Interest

Authors disclose that there is No Conflict of Interest

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Authors contributions

Tsegaye Gerba Milki was responsible for reviewing the existing literature and developing the introduction section of the study. He also designed the research methodology, prepared appropriate data collection tools and mechanisms, and conducted the data analysis. Furthermore, he played a leading role in compiling and writing up the overall research report. *Belay Hagos Hailu* served as the main advisor of the research, reviewing the structure and framework of the study and providing insightful feedback on the final write-up, which greatly enhanced the quality of the research. *Abebe Yehualawork Malle* acted as the co-advisor of the study and served as the proofreader for the entire document, ensuring the accuracy, coherence, and clarity of the final research report.

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