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Pedagogical Responsiveness of Mathematics Instruction at Inclusive Secondary Schools: A Particularistic Case Study

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Abstract: This qualitative particularistic case study explores the perspectives and experiences of learners with visual and hearing impairments regarding the teaching of mathematics. Extreme-case sampling was employed to select four learners (three hearing impaired and one visually impaired) from the only two inclusive secondary schools in the northern part of Namibia. The study qualitative study utilised open-ended questionnaires and interviews. Verbatim quotes from the research participants were used as inferences to identify descriptors within the first-generation Cultural Historical Activity Theory, which served as a theoretical and analytical tool. The findings revealed that the activity system of learners with visual and hearing impairments exhibited tensions that negatively affected their performance in mathematics. Learners experienced marginal responsive pedagogy in mathematics classrooms due to teachers' lack of knowledge and pedagogical skills for delivering meaningful mathematical instruction. While learners without disabilities struggled with comprehension and effective communication skills, learners with visual and hearing impairments faced a lack of equipment to support the conceptualisation and visualisation of mathematical subject content. The author emphasises the critical importance of addressing communication barriers and adapting teaching practices to support the learning and inclusion of visually and hearing-impaired learners in mathematics, with an emphasis on mathematical language that promotes a better understanding of mathematical concepts. Teacher training should also incorporate responsive pedagogy to enhance outcomes and foster a more inclusive learning environment that promotes academic success and positive social experiences for all learners. Recommendations at a policy level, including advocating for a decolonised curriculum were made.

Keywords: Inclusive education, social equality, mathematics teaching, visual impairment, hearing impairment.

1. Introduction

Awareness of how mathematics instruction adjusts to meet the needs of various learners is becoming essential as inclusive education gains momentum. Globally, children with disabilities are more likely than their peers to be out of the school system or to leave school before completing primary or secondary education (Handicap International - Humanity & Inclusion, 2022; United Nations Educational, Scientific and Cultural Organization (UNESCO), 2009). Reports indicate that persons with disabilities living in developed countries experience inferior educational systems, and they are more likely to be poor and marginalised than those without disabilities (Barnes & Sheldon, 2010; Goodley, 2017). The World Report on Disability cites several countries in Africa with limited educational opportunities for children with disabilities. Furthermore, some schools employ teacher assistants who are deaf, have no teaching background or qualifications, and some have not completed their education (United Nations Children's Fund (UNICEF), 2015). Consequently, some interpreters for secondary school deaf learners have low levels of education, below secondary school level. Thus, these teachers and assistants lack knowledge of the subject content. Similarly, Maguvhe (2015) observed a trend of insufficient skills among teachers to instruct learners with visual impairments. This lack of skilled instruction could explain the poor academic performance of learners with hearing and visual impairments, as only a few meet university admission

requirements. Therefore, the education and cognitive development of learners with hearing and visual impairments require greater effort, commitment, motivation, and appropriate pedagogical approaches (Spinczyk et al., 2019). Alarmingly, the author of this paper has been a teacher trainer for more than five years but has not had a student in the teaching methodology module with either visual or hearing impairment who aspires to become a secondary school mathematics teacher. It is unlikely that students with such characteristics of interest would enrol at the national university and if registered for mathematics teaching at the secondary level, would default to joining the author's class. Considering that mathematics is a compulsory subject in Namibian schools, some school managers in certain areas do not permit learners with special needs, including those with visual impairments, to take mathematics as a subject (Ampweya, 2022; Mungunda, 2023). This raises the question: Why are these learners not allowed to take subjects like mathematics? Are teachers' pedagogical approaches not sufficiently responsive to accommodate these learners?

Article 26 of the Universal Declaration of Human Rights highlights that education is a fundamental human right (United Nations (UN), 2023). Education systems are key to national growth and development (Government of the Republic of Namibia, 2004). Education reduces colonial poverty and serves as a passport to enter the labour force. Consequently, governments have been striving to strengthen the quality of education and training systems by improving efficiency and eliminating inequalities within the education sector (Government of the Republic of Namibia, 2004; National Development Plan (NDP5), 2017). Namibia is also a signatory to national and international legal frameworks that aim to ensure that all children have the right to education, regardless of their race, gender, nationality, or disability, among other factors. Hence, the introduction and launch of the Sector Policy on Inclusive Education (SPIE) in 2013 (Ministry of Education, 2013). This policy aims to promote inclusivity, equity, quality, and access to education for all children, including those with disabilities. As such, the policy provides for the appointment of support staff, such as interpreters and teacher assistants or facilitators, when needed, to contribute to the pedagogical and broader educational development of learners. Furthermore, the notion of inclusive education is encapsulated by SDG Goal 4, which advocates for "ensuring inclusive and equitable quality education... opportunities for all" (UNESCO, 2017, p.6). This goal implies that teachers, as drivers of learning in the classroom, should ensure that, beyond access to schooling, all learners receive meaningful and effective education by employing pedagogical approaches that support their cognitive growth.

Therefore, a responsive pedagogical approach to mathematical teaching is crucial to ensure that all learners can use mathematical knowledge in their personal and professional lives. Consequently, this paper presents the views of learners with visual and hearing impairments at inclusive schools regarding their experiences in mathematics classrooms in relation to pedagogical responsiveness. The problem statement is presented first, followed by the research question. The author then presents and discusses the theoretical framework of first-generation Cultural Historical Activity Theory (CHAT) (Engeström, 2001) within which this study is situated. Additionally, literature on pedagogical responsiveness is presented to share a variety of perspectives through which understandings of pedagogy research can be explored and developed. The methodology and findings are discussed before concluding the study.

1.1 Problem statement

The pedagogical responsiveness of mathematics in inclusive education schools and classrooms has not been thoroughly researched. For example, in her study on pedagogical inclusion, Sheyapo (2017) employed a humanistic approach to learning, exploring lecturers' perspectives on the inclusion of students with visual impairments in higher education institutions. Interestingly, while there is a significant amount of scholarly research on the challenges faced by learners with special needs in Namibia (Bruwer & February, 2019), particularly in mathematics (Ampweya, 2022; Mungunda, 2023) at inclusive secondary schools, research in mathematics education in Namibia has excluded

pedagogical approaches concerning learners with visual and hearing impairments (Kapenda, 2015; Kasanda et al., 2005). Consequently, no study has been conducted on the phenomenon of pedagogical responsiveness in mathematics instruction at inclusive secondary schools. Generally, data on inclusive education in African countries is insufficient (Alborz et al., 2013; Trani & Bakhshi, 2008). Thus, this study aims to fill the gap in knowledge and contribute to the existing empirical data on the responsiveness of pedagogical approaches applied to teaching mathematics to learners with visual and hearing impairments in inclusive secondary schools. Therefore, the study focuses on recording learners' experiences of mathematics instruction with reference to responsive pedagogy. The study is guided by the research question below:

- *How do learners with visual and hearing impairments experience Mathematics instruction at inclusive secondary schools?*

2. Theoretical framework

The study is informed by the first-generation Cultural Historical Activity Theory (CHAT) (Engeström, 2001). This first-generation CHAT was conceptualised by Vygotsky as a triangular model based on the concept of mediation (Engeström & Miettinen, 1999; Flavin, 2017; Vygotsky, 1978). An activity system is described as 'a collective, artifact-mediated and object-oriented' entity, which is taken as the prime unit of analysis (Engeström, 2001, p. 136; Hakkarainen, 1999) (Figure 1). Subjects use artifacts as 'conductors of human influence' to shape cognitive development (Vygotsky, 1978, p. 55). Mediating artifacts encompass practices, including pedagogical practices, that mediate thinking and feeling, flows of communication, and all actions and interactions (Daniels & Tse, 2020; Nicholson, 2022) in teaching and learning environments. The object element represents the 'problem space', which in educational practices refers to the learner(s) and their learning and development (Engeström & Sannino, 2021, p. 8). Importantly, the terminology employed within Activity Theory should not be interpreted as positioning learners as 'mere objects of [educators'] actions' (Freire, 2017, p. 67). Rather, it calls for a consideration of each individual learner's unique perspectives regarding pedagogical practices (Nicholson, 2023). The Activity Theory triangle can be interpreted differently depending on the specific case under investigation (Engeström, 1999). In this study, the activity system is applied to mathematics instruction for learners with visual and hearing impairments. The act of teaching (mediating artifact) is a pedagogy, a means through which mathematics teachers (subject) intend for learners with visual and hearing impairments (object) to engage with mathematics learning content. The activity system is characterised by contradictions, which serve as sources of change and expansive growth (Engeström, 2001). These contradictions, referred to as 'structured tensions' within the activity system, should be studied to embrace the possibilities of change (Engeström, 2015).

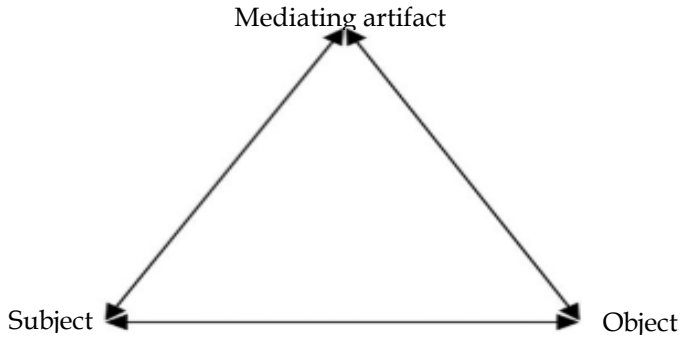

***Figure 1**: First-generation Activity Theory model (Engeström, 2001, p.134)*

Notably, "human activity is not only individual production" and cannot be reduced to a triangle as depicted in Figure 1 (Engeström, 2015, p. 114). Engeström (2001, p. 34) contended that the first-

generation CHAT presents a 'revolutionary' way of understanding human actions, which is the focus of this study. In this context, pedagogical responsiveness considers how learners with disabilities (objects) are taught by teachers (subjects) while factoring in the mediation process (teaching), which consequently affects their cognitive development. The pedagogical responsiveness of instruction is discussed next.

3. Literature Review: Pedagogical Responsiveness

In an increasingly diverse and differentiated educational environment, attaining equitable learning outcomes requires a shift towards instruction that is responsive to diverse learners in inclusive schools. The concept of pedagogy has been widely researched and conceptualised. Dalmau and Guðjónsdóttir (2017) noted that the term pedagogy describes the many and complicated difficulties confronting the teaching profession. Meanwhile, Curtin and Hall (2018, p. 367) recognised that "researching pedagogy is tremendously challenging". Some scholars have investigated inclusive pedagogy, which presupposes that all learners have equal and equitable access to education and that educational institutions establish their learning environments to accommodate all learners (Dalmau & Guðjónsdóttir, 2017). Moreover, they noted that teaching methods, instructional programmes, and curricula, as well as moral education and discourse about teaching and learning, are key elements of inclusive education, consistent with the framing of this study. However, Leach and Moon (2008) asserted that pedagogy is "more than the accumulation of techniques and strategies, more than arranging a classroom, formulating questions, and developing explanations. It is informed by a view of mind, of learning and learners, and the kinds of knowledge and outcomes that are valued" (p. 6).

Curtin and Hall (2018) adopted a sociocultural perspective to research the challenges and extend theoretical and methodological frameworks for understanding what it means to teach and learn. They concluded that pedagogical research is nuanced, complex, multilayered, and inclusive. They further argued that pedagogy focuses on the relationships between values, identities, interactions, and understandings embedded in rich and varied pedagogical contexts, texts, and settings.

Moreover, pedagogy has been heavily discussed in Nicholson (2022) in the development of a framework referred to as pedagogy-as-praxis, as part of a doctoral study exploring the transition from Early Childhood Education to Compulsory School Education in two schools in England. Based on Cultural Historical Activity Theory (CHAT), Nicholson (2023) argued that the performance of teaching is positioned as a tool, while the remaining elements of the activity system—subject, object, rules, community, and division of labour—serve as a means of understanding pedagogical discourse. Collectively, these elements provide insights into the discourse that shapes how the performance of teaching is developed, structured, and enacted. For Nicholson (2023), pedagogy transcends mere action; it encompasses both the performances of teaching and the discourse surrounding what teachers and learners do. Although this study is situated within first-generation CHAT rather than second-generation CHAT as in Nicholson's (2023) study, it forms a basis for exploring the performance of teaching (tools), teachers (subjects), and learners (objects) to understand the pedagogical discourse in mathematics classrooms at inclusive schools.

Additionally, Smith et al. (2016) guide this study by describing the roles of teachers and learners within a learning environment that embraces a responsive pedagogy. They contextualise responsive pedagogy within social cognitive theory (Bandura, 1977) through the concept of self-efficacy. They concluded that responsive pedagogy involves a recursive dialogue between the learner's internal feedback and external input supplied by significant others, such as teachers and classmates, during the three stages of self-regulation: forethought, monitoring, and reflection. In a responsive pedagogy, the teacher's primary goal is to help learners believe in their competence and capacity to perform tasks and confront obstacles, thereby developing learners' self-efficacy in a given domain and enhancing their overall self-concept. Furthermore, they hypothesised that responsive pedagogy positively influences learners' academic performance. Similarly, Walton and Osman (2022), in their

chapter on pedagogical responsiveness in complex contexts, argue that pedagogical responsiveness is characterised by inclusivity and a focus on learners, knowledge work, dialogue and relationality, a community orientation, and a commitment to social justice and equity. This responsiveness is enabled by collaboration and relational agency, epistemic engagement, contextual sensitivity, technology, institutional capacity, and Ubuntu.

In general, learners with special needs are placed in mainstream schools. Ramberg (2024) stresses that the arrangement of placing these learners in mainstream schools results in fully segregated settings for some, indicating a gap between inclusive education as a societal goal and its practical implementation. This gap may be attributed to overcrowded classrooms and the lack of time that teachers often experience (Nilsen, 2020). Additionally, Kohanová (2011), who conducted a study in Slovakia, described teaching mathematics to inclusive secondary school learners as ineffective. Slovak teachers are not qualified in this area and often rely on a trial-and-error method to teach their visually impaired learners among sighted peers. Affected learners often lack textbooks and appropriate learning materials, possessing only limited braille notation for mathematics. Furthermore, Kohanová (2011) noted that while learners with visual impairments do not necessarily struggle to demonstrate basic mathematical competencies, they face challenges in dealing with braille notations for all the new symbols needed to create their own mathematical language as their mathematical knowledge expands. This situation is exacerbated by the fact that there are not enough competent individuals available to comprehensively develop the teaching and learning materials. In addition, Manchishi (2015) stresses that more than one mode of presentation is needed, comprising manipulative, verbal, pictorial, and symbolic modes. In support of this view, these could include manual, oral, and simultaneous communication methods, where sign language is produced in the same order as spoken words and at the same time. Furthermore, Manchishi (2015) stated that learners should be encouraged to translate between sign language, English, and the specific language of mathematics to make connections between all the modes presented. This process requires teachers to have a firm grasp of sign language to positively impact learners' mathematical thinking and to meet the requirements for creating a holistic learning environment. Moreover, Luckner et al. (2016) argued that determining an appropriate environment for each learner who is hearing and visually impaired may be difficult, as their placement is not synonymous with the appropriate services and professional needs. Thus, to ensure their needs are met, they should be monitored using assessments that compare learners' rates and levels of performance to expected benchmarks, ensuring timely responses and establishing appropriate interventions when learners are progressing academically.

In summary, the responsive pedagogy of any instruction, including mathematics, goes beyond merely including individuals with special needs in the mainstream classroom. It encompasses teachers' adaptation of pedagogical strategies for the inclusion of diverse learners, the promotion of collaboration, the provision of opportunities with instructional materials, and the prioritisation of social justice and equity. Learners are also required to adjust their learning strategies to incorporate multiple modes of pedagogical support. However, there is a research gap in the literature between the theoretical understanding of inclusive pedagogy and its implementation in classrooms. As Curtin and Hall (2018) proposed, research should thoroughly engage with the teaching process itself; therefore, this study aims to conduct extensive research on pedagogical practices in an inclusive mathematics teaching and learning environment based on learners' insights. The goal of the study is to document participants' experiences and recommendations through the lens of first-generation CHAT.

4. Methodology

This qualitative particularistic case study is conducted within a critical paradigm, exploring a complex social phenomenon, emphasising inequality and advocating for social change (DeCarlo, 2018). A particularistic case study is descriptive and concentrates on a specific case or event (Teet,

2018), such as classroom interactions in an inclusive teaching environment. Through exploring the phenomenon of learners' perspectives and experiences on the pedagogical responsiveness of mathematics instruction, this case study investigated them within their real-world context since the boundaries between phenomenon and context are not evident (Yin, 2001).

4.1 Population and participants

The only two secondary phase schools, School A and School B were purposively selected from a population of all 22 secondary schools in the Oshana region, Namibia (Education Management Information System (EMIS), 2021), on the basis that they cater to secondary phase learners with visual and hearing impairments. School A caters for visually impaired learners, and School B caters for hearing impaired learners. Extreme-case sampling was used to select learners from the sampled schools. The total population sample was used as the population of learners with visual and hearing impairments is too small. Therefore, all four learners – that is, three hearing impaired from School A and one visually impaired from School B – were all research participants in this study. Further, one male learner with visual impairment and two male and one female learner with hearing impairment participated in the study.

4.2 Instruments and data analysis

The data was collected using an open-ended questionnaire and an unstructured interview based on the objectives of the study. A sign language interpreter was engaged to convey the research guidelines and the purpose of the study to the hearing-impaired learners. The hearing-impaired learners completed the questionnaire, while only the visually impaired learners were interviewed. The questions answered by the learners were the same. A case study can reveal linkages and variables that were previously unknown, leading to a rethinking of the phenomena being investigated (Merriam, 1988). Therefore, based on the third-generation CHAT as an analytical frame, the data were analysed using thematic analysis to determine the perspectives and experiences of learners with visual and hearing impairments during the teaching of Mathematics.

4.3 Ethical considerations

Before commencing data collection, the researcher obtained ethical clearance from a university in Namibia to proceed with the study. Permission was then sought from the Executive Director of Education, the Director of the Oshana education region, and two school principals to conduct the research. Participants were assured of anonymity and confidentiality, as well as the right to withdraw from the study for any reason. To maintain confidentiality, participants' names were not disclosed. Instead, open coding was employed, referring to participants by numbers, such as L01 for Learner 1, and so on. This approach helped to protect their identities. Learners with visual impairments are coded as L01, while those with hearing impairments are coded from L02 to L04. This coding method was communicated to the participants to encourage them to express their views freely.

5. Findings and Discussion

In this section, the paper delves into the experiences and perspectives of learners with visual and hearing impairments regarding the teaching of Mathematics. The study's findings offer insights into the activity system of these learners. After thematic analysis, the data is presented based on the identified sub-themes, which are informed by the research question and operationalised within this study to illuminate its focus. The sub-themes were developed through critical engagement with the reviewed literature and participants' responses. These sub-themes are: teachers' responsiveness and pedagogical practices (Nicholson, 2022, 2023), and the classroom environment during mathematics instruction (Curtin & Hall, 2018; Smith et al., 2016; Walton & Osman, 2022).

The first sub-theme, "Teachers' responsiveness and pedagogical practices," encapsulates how mathematics teachers adapt their instructional methods and interactions to meet the needs of learners with visual and hearing impairments, ensuring effective participation and understanding of mathematical concepts. The second sub-theme, articulated by one participant, states, "*Sometimes teachers teach even when there is no sign language interpreter,"* which highlights the learning environment that facilitates or hinders the experiences of these learners. This sub-theme also underscores the importance of mediating tools, as depicted in the Cultural-Historical Activity Theory (CHAT). It further accentuates the need for learners to feel accepted, valued, and integrated within the mathematics classroom and how these feelings impact their engagement and learning outcomes.

As previously stated, the study aims to investigate the pedagogical responsiveness of mathematics instruction in classrooms where the act of teaching (mediating artefact) used by mathematics teachers (subject) may contradict or promote the learning experiences of visually and hearing-impaired learners (object) in engaging with mathematics content. The sub-themes are presented and discussed first. Secondly, any tensions described in this study as opportunities for improvement within the activity system are presented to embrace possibilities for change (Engeström, 2015). All perspectives expressed are based on learners' responses.

5.1 Teacher's responsiveness and pedagogical practices

The learners with hearing impairments were asked to share their experiences during mathematics instruction in an open-ended questionnaire. Their experiences relate to pedagogical knowledge and skills, resulting in ineffective teaching and learning. In the context of this study, appointing an interpreter is a requirement as stipulated by the Sector Policy on Inclusive Education (Ministry of Education, 2013); however, mathematics teachers did not adhere to this policy requirement. It appears that teachers do not engage interpreters, as indicated by L02, as follows:

> *Sometimes, teachers teach even when there is no sign language interpreter, and this hinders our understanding (L02, School A)*

Further, while teachers concentrate on the subject, they do not apply appropriate teaching methods to cater for learners with special needs, as expressed:

> *Teachers speak while facing or writing on the chalkboard; some deaf learners can lip read but, in this case, it becomes difficult for them (L04, School A)*

Thus, learners attributed their failure of assessments to a lack of mathematical subject content. This is noted by L03:

> *At the end of the day, we failed tests because we didn't understand what was presented (L03, School A)*

The findings regarding the absence of a sign language interpreter during lessons severely hinder the mathematical understanding of learners with hearing impairments. Although the Sector Policy on Inclusive Education (Ministry of Education, 2013) provides for interpreters at respective schools, it is possible that the schools have not appointed one or that the interpreter is absent on certain days. Furthermore, teachers may be pressed for time to complete the subject curriculum while managing large classrooms, which negates the need for inclusivity (Nilsen, 2020). Additionally, teaching in the absence of an interpreter may render their presence during mathematics lessons insignificant due to a lack of knowledge of the subject content. Similarly, Maguvhe (2015) observed a trend of insufficient skills to teach learners with visual impairments. This could explain the poor academic performance of learners with hearing and visual impairments, as only a few meet university admission requirements. Therefore, the education and cognitive development of learners with hearing and visual impairments require more effort, commitment, motivation, and appropriate pedagogical approaches (Spinczyk et al., 2019).

The findings highlight a lack of knowledge and skills among teachers to teach mathematics effectively in inclusive classrooms. They also demonstrate a lack of necessary accommodations, which directly affects learners' comprehension and leads to poor test performance. Pedagogical responsiveness necessitates the adaptation of teaching methods to accommodate all learners. The failure to ensure that no teaching occurs in the absence of a sign language interpreter demonstrates a lack of responsiveness, meaning these learners will not be accommodated in the teaching and learning process. To foster an inclusive learning environment, it is essential to minimise communication barriers through the consistent presence of qualified interpreters. The concern about teachers explaining mathematical content while writing on the chalkboard illustrates another unresponsive pedagogy. This issue highlights the need for pedagogical practices that are mindful of the diverse ways in which learners access and process mathematical information. Pedagogically responsive mathematical instruction would involve ensuring that teachers maintain visual contact with learners and utilise teaching aids that can be easily followed by all learners.

Learners also lamented that they are not provided with assistive devices to enhance learning, as noted by L01 in an interview:

> *During the teacher presentations, I was left out because I needed to be provided with assistive equipment so that I would be able to follow the mathematics explanations easily like others (L01, School B).*

The experiences highlight the importance of incorporating teaching and learning resources to ensure that learners can effectively follow mathematical explanations. The learner feels excluded during mathematics instruction due to a lack of necessary tools, indicating a need for mathematics teachers to implement adaptive technologies and inclusive teaching methods to support the full participation of visually impaired learners in the learning process. Consequently, based on learners' experiences, a responsive pedagogy should operate in a conducive environment, comprising appropriate and supportive teaching and learning resources, as well as equity.

5.2 Classroom environment during mathematics instruction

This section reports on learners' experiences during classroom instruction, highlighting interactions between them, their peers, and teachers in pedagogical contexts. The responses are based on questions that required learners to explain the challenges they face when learning mathematics in an inclusive teaching and learning environment, as well as their sense of inclusion and support during mathematics instruction. The identity of the selected learners emerged as a key issue; they perceived themselves as different compared to the majority of their peers, as expressed by two of the learners (L03 and L04):

> *We are mostly disturbed by hearing learners* (L03, School A).

In addition, learners expressed that they were mostly unable to participate in classroom discussions due to their limited ability to communicate with their counterparts. L04 expressed:

> *Hearing learners do not know how to properly communicate through sign language thus we cannot mostly participate in classroom discussions and are on many times left out (L04, School A).*

Seemingly, learners exert extra effort in learning mathematics, as expressed by L01.

> *On the topic of drawing graphs, I work very hard to draw the lines or plot the points in their position (L01, School B).*

Learners' perspectives highlight an unconducive learning environment characterised by disruptive mini-discussions and limited engagement and inclusion. Learners view themselves as having a different identity from the rest of the class. This could be attributed to the fact that they are a minority in mainstream schools and do not conform to the expectations of the social majority regarding appearance (Dreyer, 2015), a possible influencer of human identity (Vygotsky, 1978). This finding is

similar to that of Ramberg (2024), which suggests that this segregation creates a lack of opportunities for learners with disabilities to fully thrive academically. Furthermore, the inability to engage in collaborative activities and epistemic engagement depicts contextual insensitivity, social inequality, and a lack of ubuntu, as postulated by Walton and Osman (2022).

In addition, the study found that visually impaired learners exert extra effort to perform tasks requiring visual precision, such as drawing graphs, due to their impairment. This outcome demonstrates that learners with disabilities need multimodal approaches to understand and present their mathematical concepts in their mathematical language. Similarly, Manchishi (2015) found that teachers are not familiar with the mathematical language of learners with visual and hearing impairments, leading to failure in the subject. These findings could be interpreted to mean that effective pedagogical responsiveness requires teachers to acquire special pedagogical skills, particularly in learning and understanding the specific mathematical language needed to teach learners with visual and hearing impairments.

Tensions found during mathematics instruction negatively affect pedagogical responsiveness and, subsequently, the operations of the Activity system. The following descriptors were identified:

a. **Tensions between Subject (Mathematics Teachers) and object (Learners with Visual and Hearing impairment)**

Teachers sometimes teach without sign language interpreters, hindering understanding and contributing to poor test performance for learners with visual and hearing impairments. Additionally, teachers often face away or write on the chalkboard while speaking, making lip reading difficult for affected learners.

b. **Tensions between Mediating artefacts (Instructional Adaptations and Assistive Technologies) and objects (Learners with Visual and Hearing impairment)**

Insufficient use or availability of interpreters, along with a lack of adaptive teaching methods, hinders effective communication and understanding. This negatively impacts the sense of inclusion and learning outcomes for visually and hearing-impaired learners.

c. **Tensions between Object (Visual and Hearing-Impaired Learners) and mediating artefacts**

Without adequate tools and adapted teaching methods, learners may experience exclusion and struggle to follow explanations, which affects their sense of belonging and academic performance.

The inter-relationships of descriptors earlier identified are depicted in Figure 2 below.

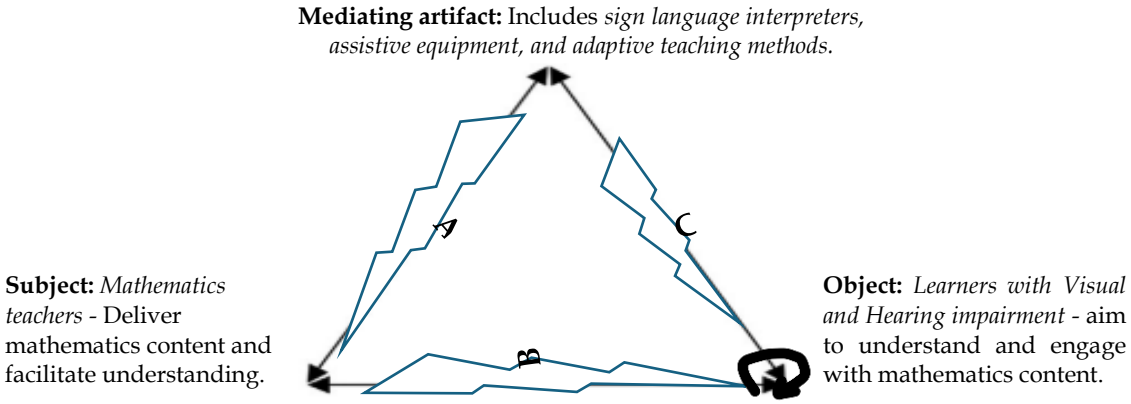

Figure 2: *Activity system for learners with visual and hearing impairment in Mathematics*

Figure 2 depicts descriptors of tensions in the Activity system. As explained earlier, the Activity system is disrupted by how teachers interact and the insufficient provision of equipment and support for learners with visual and hearing impairments. The findings of this study show that learners with visual and hearing impairments (object) were affected significantly, as highlighted in Figure 2 (as depicted by a circular arrow around the object), negatively impacting their mathematical performance. In the same vein, Engeström (2015) stresses the importance of continuously learning from tensions, as they provide possibilities for change with a focus on expansive growth and responsive pedagogy.

6. Conclusion and Recommendations

In conclusion, the pedagogical approaches employed during mathematics instruction at inclusive schools are unresponsive. Tensions in the activity system arose due to teachers' lack of pedagogical skills and insufficient use of interpreters to support the affected learners, as well as the essential skills needed by learners to conceptualise and visualise the mathematical content.

The study recommends ensuring the consistent availability of qualified sign language interpreters during mathematics instruction and implementing adaptive technologies and teaching methods that cater to diverse learning needs, such as maintaining visual contact and using visual aids effectively. The author also suggests training teachers and peers in basic sign language to facilitate better communication and interaction among all learners at the school. Teachers need to be trained in mathematical language that promotes a better understanding of mathematical concepts for learners with visual and hearing impairments. Based on the findings of the study, the critical importance of addressing communication barriers and adapting teaching practices to support the learning and inclusion of visually and hearing-impaired learners in mathematics is emphasised. By focusing on responsive pedagogy, educators can enhance outcomes and foster a more inclusive learning environment that promotes academic success and positive social experiences for all learners.

Notably, the study had limitations. First, it was a small-scale study involving only four participants. Although the study was conducted in the most ideal circumstances—with learners at the only secondary schools in the northern part of the country that cater for learners with visual and hearing impairments—further research in other parts of the country could provide a comprehensive understanding of the pedagogical responsiveness of teachers during mathematics instruction. Despite these limitations, this study offers hope for what a larger-scale study with a longer time frame might yield. While this study provides a basis for understanding the activity system of learners with visual and hearing impairments, further investigation should be conducted to extend the activity system to include rules, community, and division of labour. Additionally, further research is necessary, as individuals influence and are influenced by the cultural-historical contexts in which they live and work (Engeström, 2015). Moreover, the study should be conducted to provide numerical evidence that responsive pedagogy has a positive influence on learners' academic performance and to the extent it promotes social justice.

7. Declarations

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Data availability: In accordance with ethical standards and the stipulations set forth in the consent agreement with participants, the data must be maintained as confidential. Nevertheless, individuals seeking further information may contact the corresponding author.

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