Challenges Faced by Learners with Visual Impairment in Mathematics: Proposal for a 'Blind Mathematics' Curriculum

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Abstract

This study examines the typical challenges that learners with visual impairment encounter as they engage in the various activities in mathematics learning in secondary schools. The study adopts a constructivist epistemology, using a multiple-case study design to generate rich descriptions of the interface, experiences, opinions, internal states, feelings and emotions of learners with visual impairment in mathematics. A convenience sample of 11 learners with visual impairment, 11 parents and 3 school managers was chosen for this study. Data collection methods included in-depth interviews, participant observation and non-participant observation. The study found that the challenges which learners with visual impairment faced were deeply rooted in the definitions of disability, that focused either on the medical or social perspectives as defined in extant literature. The study recommended the need to perceive visual impairment and other disabilities as aspects of human diversity and not as deficits, the need to recognise the existence of two groups of learners (with disabilities and without disabilities), who require different learning approaches and methodologies, the need to provide adequate teaching and learning resources and the need to equip the teaching personnel with adequate skills and competencies. In an attempt at overcoming negative stereotypes and improving performance in mathematics for learners with visual impairment in secondary schools, the study proposes 'Blind Mathematics' as an appropriate Mathematics Curriculum for such learners.

Key words: 'Blind Mathematics,' appropriate curriculum, Visual Impairment(VI), social model, learning challenges.

1. Introduction

Learners with disabilities, more especially those with Visual Impairment (VI) have faced serious challenges in learning mathematics (Aljundi & Altakhayneh, 2020; Brawand & Johnson,2016; Adababneh & Hassan, 2012). A survey in most of the educational institutions which enroll learners with visual impairment(VI) has indicated that such learners have often been neglected or left to fend for themselves during mathematics lessons. This neglect is largely attributed to the fact that much of the teaching approaches and the available learning resources such as textbooks are best suited for learners without VI. Jackson & Neel (2006) have also alluded that learners with

disabilities are accorded very little opportunities to learn mathematics because of the methodologies and curricula which put more emphasis on procedural rather than conceptual instruction. If this trend continues without taking appropriate measures, it means that learners with physical challenges could continue to face discrimination in education. VI is a form of physical disability which poses serious impediments to mathematics learners. Many of the concepts in mathematics are not easily accessible to the children with blindness or visual impairment because they are presented graphically which requires visual display (Maguvhe, 2015). Hence, this article is an attempt to develop a perspective in mathematics (Blind Mathematics) which is designed to improve performance in mathematics for LVI.

1.2 Background to the study

Mathematics is a critical subject and basic knowledge and understanding of it is useful in everyday life transactions which include buying, selling, ratio, rate, time, distance, volume, mass and counting. Improved competencies in STEM (which includes mathematics) increase the chances of better employment, income generation and work productivity (Jeary, 2017). In Zimbabwe, for instance, a pass with a Grade C at GCE 'O' level is a requirement for entry into all STEM related programmes. The problem is that the majority of Learners with Visual Impairment (LVI) are always excluded from these STEM related programmes because of their physical challenge, that makes it difficult for them to access the available teaching and learning resources. This means that individuals with VI cannot aspire to be engineers, medical doctors, nurses, surveyors, bankers, chartered accountants or statisticians. People with blindness will not be able to participate in development programmes hence they will remain at the marginalised and at the tail-end of the society. In many cases people with VI are found to be beggars and inhabiting the streets.

The authors of this article have always been perplexed at discovering the doubts which most people have about people with VI engaging in mathematics programmes. For example, an official at the disability rehabilitation centre at the University of Zimbabwe reiterated that it was not possible for people with blindness to do mathematics. An official in the human relations department in the Zimbabwe Ministry of Education who was employed to serve public service employees with disabilities did not know how individuals with VI could be handled. Meanwhile, performance in mathematics among LVI has been found to be very poor. This observation is based on the researcher's experience as a mathematics teacher for LVI. Reports on national examinations do not provide details of specific results for these learners. Statistical data which provides adequate information about the numbers of individuals who are affected is not available and moreover ZIMSEC does not provide records of such candidates who do not appear on their registration lists (ZIMSEC, 2019). Therefore, it is difficult to ascertain the actual figures but observed evidence from schools with LVI shows that the majority of them never register for mathematics and even those who register for mathematics examinations always perform badly (Dorothy Dunken Braille Library Meeting for Visually Impaired Learners (DDBLMFVI, 2020).

Based on information gathered from one secondary school which enrolls LVI had a total of 40 examination candidates in 2016. Out of this number a total of 22 candidates had VI. Of the 22 candidates only 8 candidates registered for mathematics and 4 passed with a Grade 'C' or better (DDBLMFVI, 2020). In the light of these observations there is need to conduct a study in order to understand the challenges which LVI face in mathematics learning and to suggest a blind mathematics curriculum as a solution to this problem.

1.3 Purpose of the study

The purpose of this study is to probe and stimulate interest among education stakeholders such as learners, parents and education managers about the challenges faced by LVI in mathematics learning. The study thus intends to come up with a proposal for a 'Blind Mathematics' curriculum that will enable such learners to become more productive.

1.4 Objectives of the study

The objectives of this study are:

To investigate the challenges which LVI face in mathematics learning at secondary school level.

To examine appropriate strategies that can be employed to improve performance in mathematics learning for LVI.

To propose an appropriate mathematics curriculum for secondary school LVI.

1.6 Justification of the study

First, this study will contribute to knowledge by shedding light on the specific challenges which LVI face in mathematics learning in Zimbabwe. Second, the study will unravel the various teaching strategies and approaches that are useful to improve performance in mathematics learning for LVI. Third, this study will provide insight about the mathematics curricula that is best for LVI.

1.7 Review of related literature

VI is a form of physical disability. There are two perspectives of understanding definitions of disability which are the medical model and the social model (Siebers, 2008). For Siebers (2008), the medical model defines disability as the individual problem which must be fixed for the individual to function normally. The individual with the disability such as VI is perceived as one with the problem. This implies that unless this deficit is fixed the affected individual cannot function independently, what then follows is dehumanisation and exclusion from the mainstream (Powell & Brantlinger, 2008). Thus, a learner with visual impairment cannot fully participate in mathematics learning in the class because he/she is regarded by his/her peers or mathematics teacher as one who is not fit to learn the subject. Vision allows access to information that helps to build a conceptual understanding of basic mathematical concepts (Brawand & Johnson, 2016).

On the other hand, the social model defines disability as a product of social order which requires significant changes in relation to society's perception of disability (Siebers, 2008). Individuals may differ in terms of their cognitive or physical capabilities and disability is determined to a larger extent by society's response to these differences (Woods, Turner, Civil & Eli, 2016). In many ways society's response is characterised by social exclusion, stigma, discrimination and dehumanization which affects the individuals with the disabilities to a larger extent. According to Tan (2014) several studies on rhetoric for equity in mathematics education research are rarely included for marginalised students. Social systems are therefore a critical aspect of disability studies because they can create or exacerbate the extent of disability of an affected individual (Tan, 2014). Disability is widely regarded as contextual hence the significance of sociocultural interaction (Lambert, 2015).

This perspective of understanding disability is fundamental. The school as an organisation is a social system whose members are learners, teachers, support staff and the local communities. Hence, the social and political aspects of understanding the individual's position in the classroom, school or community with particular reference to mathematics learning is fundamental. Issues of social justice are critical in a school organisation, to challenge existing stereotypes which exacerbate exclusion of learners with disabilities such as VI (Powell & Brantlinger, 2008). Such initiatives include the need to reconstruct the role of mathematics, equip marginalised learners to gain the fundamental basics of mathematics, craft models of learning and curricula which respond to the needs of the learners with disabilities and to create social awareness which perceives disability as an aspect of diversity which requires suitable environmental designs (Wood, Turner, Civil & Eli, 2016). Physical disability such as VI or hearing impairment affects learning to a larger extent because the senses of hearing or seeing are useful in learning (Wood, Turner, Civil & Eli, 2016).

Studies which focus on the causes of low mathematics performance have often left the challenges which LVI face. These learners have often not been able to participate in effective mathematics learning in large numbers because of several challenges such as lack of access, technologies and attitudinal barriers. The challenges which they face are also related to the models of teaching and learning of mathematics. These challenges include the ability to master number, geometric shapes, graphs, size, distance, direction and computations such as addition, subtraction, multiplication and division, including speedy performance in these computations (Aljundi & Altakhayneh, 2020). Brawand and Johnson (2016) allege that the challenges which they face in mathematics include problem solving, getting access to relevant information, presenting the various steps and calculating the answer because mathematics is highly visual in nature. Beal and Rosenblum (2015) have found that LVI lack proficiency in key algebra-readiness skills such as division, fractions, decimals and unit conversion.

Maguvhe (2015) asserts that LVI regard mathematics as a difficult subject because of difficult and abstract concepts which depend largely on visual instruction, yet there are many concepts which cannot be explored by

touch only. The absence of accessible media is a significant barrier for them to pursue mathematics. Aljundi and Altakhayneh, (2020) have alleged that LVIs' perfection of mathematical skills requires longer time and harder effort. Consequently, this presents significant challenges to train teachers who can handle LVI. This implies that vision loss causes significant challenges such as increased dependence in mathematics learning, isolation from regular mathematics learning and increased time of completion of assigned tasks. Other challenges include inadequate staff support for teachers of LVI, insufficient time for instruction during mathematics lessons, inadequate content knowledge in mathematics among many others. Other challenges such as lack of quality mathematics assessment and intervention for students in lower grades and the difficulties of handling learners with multiple needs were alluded to by Louie, Brodesky, Brett, Yang and Tan (2008).

Several methods have been put forward to assist LVI to learn mathematics. The operations of addition and subtraction are frequently taught using the abacus (Amato, Hong & Rosenblum, 2013). Higher order skills such as multiplication and computing in fractions can be taught using technologies such as talking calculators and developing skills in mental mathematics (Brawand & Johnson, 2016). Braille mathematics allows LVI to gain access to mathematical work and to provide solutions to mathematical computations (Rosenblum & Smith, 2012). Tactile materials include graphic illustrations which are intended to be read by touch rather than vision (Braille Authority of North America, 2012). Concrete materials are physical objects which are used as teaching tools to provide a hands-on experience to LVI (Brawand & Johnson, 2016). Concrete materials provide LVI with concrete experience of their environment and to learn skills and concepts such as addition and subtraction, integers, time, measurements, place value, geometric shapes and textures (Saracho, 2012).

Other practices which focus on improving mathematics learning for LVI include the use of a central mathematics led teacher to provide direct support, providing structured and flexible collaboration of staff to support them, adopting an inclusive philosophy which incorporates a variety of services and the environment, such as using math coaches to support them before, during and after school. Teachers should also be provided with published mathematics programmes and how to implement them, using an inclusion model for classroom placement of learners, and knowledge on how to analyse state assessment results and to share them with all members of the maths department, benchmark testing and development and retention of quality staff (Louie et al. 2008).

1.8 Theoretical framework

This study is informed by a constructionist epistemology (Crotty, 1998). Constructionist epistemology holds that there is no objective truth to be discovered but that we discover and interpret meanings of various phenomena through our engagement with different life situations (Crotty, 1998). Emphasis is on symbolic interactionism which focusses on social interaction as the means to gain understanding (Anderson, 2006). The significance of this approach in understanding human behaviour is the emphasis which it places on people's interpretation of

meanings, words and symbols (Patton, 2002). In symbolic interactionism more emphasis is on narratives, feelings, emotions, internal states, opinions and observation of participants in their natural environments. This will enable the researchers to gain knowledge about the challenges which LVI face together with ideas relating to the proposal of a 'blind mathematics' curriculum.

Blumer (1969)'s ideas were instrumental in the development of symbolic interactionism and he further alluded that there are three ways of understanding this perspective. The first is that the actions which people perform are primarily based on the meanings which they attach to things. The second is that the meanings of things arise from the process of social interaction which people have and the third is that the meanings which things have are not always static but they are subject to, and modified by the interpretive processes. Based on the constructionist theory we can understand that the actions which humans perform are based on their beliefs. In this study we gain a deeper understanding of such actions as dehumanisation, isolation, exclusion, etc., together with how these actions may be linked to the medical or social model of understanding disability. Hence we appreciate the significance and gain ideas of proposing a 'blind maths' curriculum as an effective way of inculcating the social perspective of understanding disability. In view of this theoretical framework the qualitative methodology was chosen to collect and analyse data.

2 Materials and Methods

2.1 Research paradigm and design

The qualitative methodology was employed to probe participants in order to gain in-depth understanding of the problem. The qualitative methodology is informed by interpretivism, which emanates from phenomenological philosophy, which emphasizes inductive processes where generation of hypotheses and theories takes place during the research process (Merriam, 2009). Rigorous qualitative methods allow investigators to generate hypotheses, gain in-depth understanding of the problem and develop innovation and dissemination strategies (Choo, Garro, Ranney, Misel, & Guthrie, 2015).

The multiple case study design was used, which focusses on the examination of a specific phenomenon (Merriam, 2009). Such a phenomenon can be an individual, group, event or programme into which the researcher is interested in gaining knowledge through interpretation of the case being studied (Anderson, 2006). A case typically forms a unit of analysis, hence it must be specific, unique and relating to a bounded context (Stake, 2000). So, the multiple-case study focusses on a cross-case analysis of several cases by examining and comparing if factors which are found to be important in another case could apply to other cases (Babbie, 2001). In this study an individual case is defined as a learner with VI who is attending a secondary school in Zimbabwe. A better understanding of each case is expected to lead to a deeper understanding of a larger group of cases which must ultimately lead to induction and generalizability. Through the multiple-case study the aim is to identify common themes, while also noting significant differences through the examination of each case, in order to provide thick and rich descriptions of the experiences of LVI in mathematics learning in secondary schools. The findings would be useful to gain in-

depth understanding of the subject, generate hypothesis and to make specific intervention strategies. Interviews and observation methods were used as data collection strategies.

2.2 Population, samples and sampling techniques

The target population was composed of all learners with visual impairment who were attending secondary schools in Harare, Zimbabwe. The study used purposive sampling to select a sample of 5 secondary schools, 11 LVI, 3 school managers and 11 parents. The 11 LVI were sampled because they always attended holiday mathematics lessons at a local centre which rehabilitates persons with VI, so it was easy to have access to them. Since they were brought by their parents it was also easy and convenient to arrange for interviews with their parents. The 5 secondary schools were sampled because these are the only schools that have enrolled LVI.

2.3 Data collection methods

In this study, the observation method was used to gather data in order to gain knowledge about how events unfolded and the natural interactions between the participants. This observation was nonreactive because we did not demonstrate reaction to what was happening. We used nonreactive observation (1), to observe LVI during mathematics lessons, (2) to observe LVI during their free time, and (3) to observe school managers and how they related to LVI. We also became participant observers in which we actively participated together with the learners. This was during the mathematics lessons which were conducted every school holiday. Our observation was largely unstructured but we incorporated structured content to provide a checklist to guide our study.

Our checklist included how learners interacted, how teachers responded to learners, responsiveness of school managers to LVI, how learners submitted required written exercises, how the work was marked, feedback initiatives and teacher and learner attitude during mathematics lessons. The observation method was a useful way to gain information because we generated information in its natural context.

The study also used qualitative interviews with open ended questions to gather data. We conducted both single-person and multiple-person interviews. Single-person interviews were organised for participants who required some degree of privacy. Multiple-person interviews were arranged for participants who had similar perspectives and those who felt comfortable to participate as a group.

School managers responded to five questions. Three members of the school management teams which comprised two head teachers and one deputy were interviewed. Eleven parents of the LVI were also interviewed and they gave their own perspective on the subject.

2.4 Data analysis procedure

The findings from the above data collection strategies were then summarised as below. A critical procedure involved making comparisons of the responses to make tentative connections between components of similar

conceptualisations. The associations were based on contexts, situations, ways of thinking, perspectives, processes, activities, events and strategies. Content analysis and dialogic analysis were used to discover the emerging themes.

3. Results

Lesson Observation

In our observation activities we noted the following:

1. LVI did not practice mathematics because they did not have adequate materials like braille textbooks, braille machines, audio recorders, etc.
2. LVI did not receive adequate instruction from mathematics teachers that would enable them to maneuver in practising mathematics during their study time.
3. During lessons LVI were in most cases neglected while they sat at the back of the classrooms with their braille machines. Mathematics teachers would demonstrate a few examples on their writing boards and use such expressions as 'you see' which would embarrass LVI because they could not see.
4. Learners without VI could not assist because in most cases they said they were busy with their own work.
5. LVI were not compelled or forced to submit their work. Where the work was submitted, it was not marked or it was not marked in time and there was no feedback.
6. The majority of the mathematics teachers did not have knowledge in braille mathematics. Some few teachers who knew how to use braille were not mathematics teachers. They could only help to transcribe the work.
7. The majority of the LVI did not attend mathematics lessons even at primary school level because they were made to believe that they would never excel in mathematics. This was largely attributed to the difficulties that they would encounter due to their physical incapacity.
8. School managers appeared not to have much concern for the plight of the LVI. School managers did not have adequate resources and skilled manpower to handle LVI.
9. The majority of the LVI did not register for national mathematics examinations only less than 10% of the learners could register for the national examinations in mathematics.

Interviews with learners

The responses which the learner-participants gave in the interviews were classified into five categories of themes of which a summary of these responses is provided.

(1). Views about relationships with family members with specific reference to family support in mathematics education: The participants gave narratives of their views about their relationships with their family members with specific reference to family support in mathematics education. Three of the respondents were happy with the support which they got from their families which included adequate financial, moral, emotional and psychological support. Their families could afford to buy learning materials and pay fees for extra tutorials. Eight of the participants expressed that they had serious challenges with financial support. Their families could not afford to

buy learning materials and to pay for extra tutorials. In most cases the reading materials for LVI were provided by the school. The eight learners explained that their families could not even afford to provide funding for them to join braille libraries. All the learners explained that they did not receive home tuition in mathematics because their families did not know how to assist them. Two of the participants said what their family members could only do was to help with reading questions for home work but they could not afford to read or explain diagrams. Ten of the respondents said their families encouraged them to do mathematics while one of the respondents said his parents did not want him to do mathematics because he had blindness. Three of the participants said their home environments were conducive for studying while the other eight said their homes were not conducive for learning because of overcrowding and noise.

(2). Views about teacher-learner relationship with reference to models of teaching and learning: All the 11 respondents said mathematics teachers did not regularly attend lessons, mathematics teachers did not provide clear instructions during mathematics lessons, and mathematics teachers or their heads of departments did not provide braille materials for reading and writing. Only one of the respondents who was a student at an inclusive boarding school for the blind said the head of department (HOD) was very helpful because he had adequate knowledge in braille mathematics. Some students provided their own braille machines and they did not understand when the teachers were teaching. The models of teaching and learning were suitable for learners who did not have VI and one of the respondents expressed with grief and sorrow that she was offended when the mathematics teacher entered the classroom and began to teach using visual display methods such as writing on the board. LVI did not receive homework and they were not asked to submit their work for marking. The mathematics teachers did not care whether LVI did some work or not because the teachers did not know how to handle braille. Mathematics teachers discouraged LVI from doing mathematics because they had blindness, those who submitted their braille sheets for marking never received them back and those who were tasked to transcribe the braille materials never responded when they were asked. All the mathematics teachers who taught these learners did not understand the use of braille in mathematics and so they could not assist them and all the 11 respondents said they were not allowed to use their lap top computers. The use of laptops for LVI in schools had not yet been approved by the Ministry of Education so LVI were only able to use braille.

(3). Views of learners about learner-learner relationships and collaboration in mathematics learning: All the 11 learners said they could not help one another because they did not understand mathematics concepts. One of the respondents said she used to meet with four other LVI to discuss mathematics questions but they did not have textbooks to refer to. All the LVI did not have any written materials in braille which they could refer to and learners who did not have VI could not assist them because they did not have time since they also wanted to finish their own home work. Two of the learners said some of the learners without VI asked for payment in order to help them. Two of the learners said when their parents paid a visit some of the learners without VI always pretended to assist them as they anticipated some tokens of appreciation from the visitors.

(4). Learners' views about learner-school management relationships and management's support initiatives towards effective mathematics programmes in the school:

All the 11 learners said they never received any significant support either psychological, social, or material support from the school management. When they needed any support, they were always referred to their mathematics teachers. The school managers never had adequate time to consider the plight of the learners. One of the respondents said that some of the teachers and members of the school management team always discouraged them from doing mathematics even at primary school level. She said many LVI dropped mathematics at primary school level. Four of the LVI thought they were not an eligible group of interest to the school hence the school management enrolled them because they were compelled by the education policy of inclusive education to enroll learners with disabilities. Five of the respondents thought that they were being neglected because the school management did not have the technical skills and resources to assist LVI, hence they were considered to be a burden to the school organisation.

(5). Views of learners on learner-community relations and community factors which hinder or support mathematics learning:

Eight learners said their communities were not conducive for studying at home because of noise, conflicts and crime. Nine of the respondents said members of their communities discouraged them from doing mathematics. Ten of the respondents felt that they were excluded and marginalised by their communities. Two of the respondents said they did not want to use their walking aids in their communities because of stigma and discrimination.

Interviews with school managers

School managers responded to five questions in the interviews.

(1). They gave their views about roles with reference to their support for mathematics programmes in the school. They believed they were doing everything they could in order to promote effective learning for all learners including LVI. Their performance was limited by the unavailability of resources.

(2). They gave narratives about their relation with LVI and how they supported them. They believed they had a good relationship with LVI. Their support was limited because they did not have the skills and the capacity to assist them.

(3). They provided an account of the impact of mathematics policies on performance in mathematics education. They believed that the current mathematics policies were favorable because they provided a standard for all learners without discrimination. One of the respondents noted that there was need for a separate curriculum which focused on the specific needs of the LVI such as teaching methods, approaches and resources.

(4). They described their relationship with mathematics teachers and how it affects learning. The majority of the mathematics teachers were not specialised to teach LVI. There was very little they could do since there was a shortage of mathematics teachers in the country. It was much advisable for the parents to engage private tutors to assist their children especially during the school holidays.

(5). They gave an account of how they related to the parents of the LVI and the impact of this relationship on performance in mathematics learning. They believed that parents were doing their best to support their children, such as bringing them to school, taking them home, providing funding support, providing braille materials, etc.

Parents' views

(1). Parents gave their opinions about the programme of mathematics learning in the school. The parents said the mathematics programme was a useful one because it was a basic requirement for life skills and employment. Some of the parents were worried because they thought their children could not do mathematics due to their disability. They expressed that most of the LVI had long dropped mathematics when they were still at primary school level because they had been advised by teachers that their children who had VI were not able to do mathematics. It would be practically difficult and almost impossible for LVI to start doing mathematics at secondary school level when they were not grounded in the basics. Most mathematics teachers were not trained to teach LVI, so it was more advisable to engage private teachers during the holidays, but some parents did not have adequate funding to educate their children and they expected the Government to assist them. The Government was already facing stiff challenges in financing education, the shortage of mathematics teachers being also a serious problem for all learners.

(2). Parents provided an account of their relationship with the school management and mathematics teachers and how it affected mathematics learning. Their relationship with the school management and teachers was generally sound. They said most mathematics teachers neglected their children including those who were marginalised and excluded from most of the school activities.

4. Discussion

A total of seven themes were identified from the responses to the questions asked and observations made. These themes include (a) management distinctions, (b) motivation paradigms, (c) pedagogy prototypes, (d) social utility, (e) economic derision, (f) policy fundamentals and (g) perceptual fundamentals. Brief explanations of these are given below.

Management distinctions relate to what school managers must do to improve mathematics learning including education management at other levels. These functions include planning, supervising, collaboration, coordinating, team building, organising, mobilising, controlling, etc. As the respondents were giving their opinions they were pointing to these functions as critical in maximising productivity in mathematics education. For example, one of the learners said,

> *It is pathetic to imagine that LVI are widely being neglected and excluded from mathematics learning programmes in the schools*

These findings corroborate the views of Chand (2017) who found that management is a key process in an organisation because it focusses on what managers must do to achieve organisational efficiency.

Motivation paradigms encompass everything that can be done to encourage mathematics teachers and learners to be more productive. These include conditions of service, work climate, training, resources, motivation, etc. One of the participants said,

> *The salaries and conditions of service for teachers cannot sustain them when compared to the high cost of living*

With reference to these ideas, Chand, (2017) found that motivation is a mechanism which managers use to influence employees to act in a desired way.

Pedagogy prototypes relate to the models of teaching and learning. These encompass the skills, competencies, resources, personnel, etc. that are required to achieve maximum participation of LVI in mathematics education. For example, one of the participants said that school managers and teachers lacked the skills and competencies that are required to handle LVI. These views agree with scientific management theory which emphasizes the need to scientifically select and train employees for specific tasks and the strict observance of rules at the work place (Chand, 2017).

Social utility focusses on factors which are associated with the home/community which influence performance in mathematics learning such as psycho-social support, funding, home tuition, peer influence, beliefs and myths, family status, etc. In view of social utility theme, this study revealed that the family members of LVI play an important role in the learning process such as helping the learners to read printed material.

Economic derision as alluded to by Mugano, (2020) is related to the economic barriers which have caused shortages of resources, unemployment, poor services, poor standards of living, etc. One of the respondents echoed such sentiments by saying,

> *Schools which enroll LVI are failing to effectively satisfy the learning needs of their learners because of shortages of resources*

Policy fundamentals relate to the policy guidelines for mathematics learning and specific policies which relate to learners with disabilities such as inclusion as cited in (Ginsburg, 2016). For example, one of the participants alleged that LVI are always excluded in the designing of new curricula and policies for mathematics learning.

Perceptual fundamentals relate to beliefs and myths about mathematics learning with specific reference to learners with disabilities like VI. For instance, one of the respondents had this belief,

> *Society has developed a negative attitude towards LVI which assumes that such learners cannot do mathematics hence it is a waste of time and money to provide learning resources to LVI*

In this study it was found that school managers and their teams had very little or no contact with LVI. This research has proved that they consider this particular group of learners as a burden to their institutions. This might be as a result of lack of relevant requisite skills to handle LVI and lack of adequate financial and material resources. For instance, some secondary schools in Zimbabwe do not have the capacity to accommodate LVI. The school management's perspective or worldview about visually impaired learners is underpinned by the medical model of

defining disability (Ginsburg, 2016; Jeary, 2017) and this was also the case in this study. They view LVI as individuals with a defect which must be fixed in order for the individuals to function normally. Therefore, such individuals cannot be enrolled because they cannot perform.

This research showed that there is lack of motivation initiatives for both learners and their mathematics teachers. Motivation is a multi-dimensional process which must occur at different stages. As learners begin to socialise at home with their families, in their communities with their peers, and at primary school and secondary school levels with other learners, they are always excluded and marginalised and hence they are demotivated so that they grow with low esteem. It was also shown that the majority of mathematics teachers lack the professional qualifications to teach LVI and so they find it to be a burden to work with this group. The situation is exacerbated by lack of adequate mathematics teachers and overcrowded classes. This makes it difficult for mathematics teachers to provide personalised attention to LVI. Beyond this, mathematics teachers fail to perform their duties because of poor salaries and conditions of service, as also alluded to by (Mugano,2020).

This study showed that LVI were largely not catered for by the models of teaching and learning. Teacher training colleges and universities in Zimbabwe train teachers who are equipped to handle learners in general but it is not clear whether such training wholly focuses on learning disabilities or learners with physical disabilities. It would appear that training of teachers to teach learners with disabilities has somehow not been a priority.

Our societies have viewed individuals with VI as incomplete beings who cannot be independent. Our society believes that such individuals cannot fend for themselves and that may be why many people with blindness are beggars and destitute in the streets. Our communities may have significantly contributed to this catastrophe and to avert this disaster there is need to first acknowledge this mistake.

Government and private institutions which enroll LVI have not been able to provide adequate teaching and learning materials like special braille and audio books. Above all they have failed to provide specialised attention to the learners with VI because they do not have adequate financial resources to accommodate such learners and to hire qualified staff. The involvement of LVI in mathematics education has been a nightmare. Mathematics teachers who can teach mathematics using braille are very few and in great demand in Zimbabwe. There is need for such special knowledgeable and supportive mathematics teachers of LVI as has also been alluded to by Klingenberg, Holkesvik, and Augestad (2019). However, many of such teachers have left their jobs because of poor salaries and conditions of service. Economists such as Mugano (2020) hold similar sentiments.

Policies are significant guidelines which provide direction of how learning activities will be conducted. The policy of inclusion was effected without conducting adequate research to determine its feasibility. The current challenges which LVI face suggest that no meaningful feedback has been done to assess its applicability and to determine what needs to be done. In general mathematics policies have not been assessed in view of the current contexts hence their relevance is questionable. Some of the most important stakeholders like mathematics teachers and the LVI have been excluded from important policy formulation phases. Many LVI have dropped out of school and those who have remained have dropped mathematics. The actual numbers of LVI of school going age is not known

because they are geographically dispersed. Some organisations like Deaf Zimbabwe have always voiced their concerns about lack of statistical data for learners with physical disabilities like VI and hearing impairment. For the few LVI who are attending school, substantial resources are being spent on them by government, parents and the particular learning institutions. However, it needs to be established whether the expenditure of these resources is yielding any formidable results. As noted,before, specific pass-rates of LVI are not readily available with ZIMSEC. Information gathered from visually impaired learners from several secondary schools around Zimbabwe which enroll LVI showed that the national pass-rates in mathematics in every case did not exceed 8% by the year 2019. For example, 2 of the participants who attended the same school said that for the past 4 years they have been attending the school the mathematics pass rate never exceeded 5%.

5. Conclusion

This study has found that LVI are widely being neglected and excluded in meaningful mathematics learning in secondary schools in Harare, Zimbabwe. Secondary schools are not adequately equipped to accommodate LVI who require specialised learning resources and specialised teacher competencies. There is lack of political will on the part of educational planners to acknowledge the existence of diversity in relation to physical disability. LVI are considered by the society as people who are not well, who are incapacitated and who cannot participate fully in mathematics learning. The problems and the extent of disability that LVI face evolve more from societal perceptions of what disability is. So, the society' perception about who should do mathematics is a critical factor related to the future performance of LVI in mathematics. To address these and other challenges, recommendations towards a 'Blind Math' Curriculum are proposed.

6. Recommendations

The recommendations of this study are based on the thematic framework which has emerged from a thematic analysis of the narratives and their contexts. These themes form a theoretical foundation which is necessary for the formulation of prospective innovation and dissemination strategies. The challenges which LVI face are broad and complex and in order to solve them they need to be perceived from a multi-dimensional perspective. In this light the following recommendations are proffered:

For school managers

There is need to make a thorough research to investigate which skills and competencies school managers need to deal with inclusiveness in a secondary school. When teachers are promoted to become school heads, they do not undergo specific management training except for some workshops which they attend. Therefore, it is necessary to build the relevant requisite skills and competencies which are required to manage an inclusive secondary school. The training will equip them with the strategies of how to manage their employees. To guarantee efficient and effective learning of LVI school managers need to consider the following:

(1). School managers need to think about LVI, design meaningful plans and design specific objectives and relevant actions which relate to mathematics education. School managers should create organisational structures which bring together both human resources and non-human resources, such as technical skills and resources which are required by LVI. They should also command and give clear guidelines about what needs to be done, for example, the specific activities and actions which must be performed by mathematics teachers and LVI in mathematics programmes. Coordination is necessary to collaborate all the departments to work together for the common good of the learners. Controlling enables school managers to compare the actual performance of LVI with the expected performance and determining if there is need for improvement.

(2). School management teams and school development committees should mobilise financial support in order to create adequate funding for the school. This could include funding for teaching and learning resources for LVI and to hire relevant staff.

For mathematics teachers

(1). There is need to examine the various ways in which mathematics teachers are motivated to do their work. Motivation paradigms should be targeted towards ensuring that mathematics teachers who teach LVI remain at their jobs and participate fully in the teaching and learning process of LVI. Motivation could include provision of accommodation, transport, basic food necessities, opportunities for further education and training, provision of adequate teaching and learning resources, etc. School-work environments must encourage team work, participative management, appreciation of performance and mutual respect. Salaries and conditions of service should be revised in line with the prevailing economic conditions. Other conditions of service should ensure adequate health benefits, pension and retirement packages.

(2). There is need to train mathematics teachers to equip them with relevant skills to handle LVI. Training programmes which integrate LVI must be availed in all teacher education programmes at all levels of training.

For policy makers and planners

(1). Critical policy formulation phases should be inclusive to ensure that all important stakeholders are involved in the process. Specific policies must be designed to represent the marginalised groups such as the LVI. This could include issues of social justice which relate to equitable access to mathematics education and provision of adequate teaching and learning resources. Policy instruments must bear both the legal aspect and the social aspect so that those who are directly involved in the teaching and learning process are answerable for their actions. Policies must be relevant to the prevailing contexts and they need to be revised periodically to determine if there is need for adjustment.

(2). There is need for educational planners to seriously consider the existence of two groups of learners, those with disabilities and those without disabilities. All learners should receive equal treatment in relation to

educational provision. Issues about who should and who should not do mathematics must be left to individuals to make personal decisions.

(3). Research should be conducted in order to determine different ways to respond to the ever-changing environment and perceptual shifts. This will address the challenges which LVI face.

For the 'Blind Math' Curriculum

Math Content to be taught and Math Activities appropriate for the LVI: There is need to craft a mathematics curriculum which suits the needs of the LVI. This does not imply that such a curriculum should differ from the ordinary curriculum for learners without VI. The quality and the content must remain the same in order to meet the expected standards. A separate curriculum for the LVI should contain specific teaching methodologies and approaches which are relevant to an LVI. This could include duration of mathematics lessons and examinations. This study proposes that a normal maths lesson for LVI could be one hour while time for national mathematics examinations could be extended to three and a half hours. There is need to introduce special learning aids for topics such as graphs, circle geometry and transformation. These aids could include the use of equipment such as computers with JAWS programmes and braille machines that are connected to electronic machines which can translate braille print to ordinary print, or the use of human aids to provide personal assistance during lessons and examinations. In addition to the braille materials and braille machines LVI should be trained and allowed to use electronic calculators and computers with JAWS software programmes. This will create independence and reduce dependence on others to assist LVI during mathematics lessons and mathematics examinations.

A 'blind mathematics' curriculum must aim to develop basic knowledge, skills and techniques in mathematics without the use of the sense of sight. This entails the need to develop other senses such as the sense of touch, hearing, vivid imagination, etc., through the use of both concrete and abstract objects. These could include solids made of clay and wood and graphs engraved on braille paper. Specific focus must be to develop a maths curriculum that is compatible to VI. This should begin at the lowest levels of learning so that any decisions about who should do mathematics should be left to the learners themselves.

A proposed 'blind mathematics' curriculum's objective must focus on harnessing digital-based learning and technology. Klingenberg, Holkesvik and Augestad, (2019) have found that digital-based learning and technology are significant tools that increase the use of educational and assistive technology while also incorporating media rich environments. This encompasses interactive e-learning with audio and touch-based technology. This will include computers fashioned with sophisticated software, graphics calculators, packages with geometry software and algebra systems and web-based applications (Kleanthous and Meletiou-Mavrotheris, 2016). In this regard physical textbooks can be replaced by digital textbooks that can be transcribed to other mediums as synthetic speech, human voice audio, large print and braille.

Teaching and assessment strategies must be supported by qualified personnel. Hassan and Salleh, (2017) have alluded that teaching strategies and aids are significant components of the learning environment. Mixed-ability grouping strategies are most preferred because they promote inclusion which allow interaction of the learners.

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