OPPORTUNITY TO LEARN MATHEMATICS: THE CASE OF VISUALLY IMPAIRED SECONDARY SCHOOL STUDENTS IN ZIMBABWE

by

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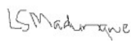
DECLARATION

I, Louise Stanley Madungwe, declare that the research report submitted in fulfilment of my Doctor's Degree in Curriculum Studies is my own work, and that it has never been produced before any other institution. All the sources that I have used or quoted have been indicated and acknowledged by means of complete references.



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ABSTRACT

The study examined the opportunities to learn Mathematics that are accorded to secondary school students with visual impairment in Zimbabwe. The study focused on form one and form two students who are completely without sight, but are learning in inclusive settings, together with their Mathematics teachers. The study examined how teachers interacted with the subject matter, how the teachers interacted with the visually impaired students and how these students interacted with partially sighted students in the teaching and learning process. The study adopted the case study approach under the qualitative inquiry. Data was collected using document analysis, lesson observations, personal interviews with teachers and focus group interviews with students who were purposive sampled. The study established that visually impaired students were not accorded adequate opportunities to learn mathematics at secondary level. The reasons for this deficit are (1) visually impaired students learnt the same curriculum as sighted students when they could not access some topics on the syllabus, (2) the teachers were professionally qualified but they lacked the necessary specialist training for teaching students without sight, (3) teachers used the same teaching methods as those used with sighted students, (4) a lot of time was spent on task though not much ground was covered, (5) the schools were not adequately resourced with appropriate teaching and learning materials for use by visually impaired students, culminating in lost opportunities to learn mathematics. The study recommends that appropriately qualified teachers be deployed to teach at schools for the visually impaired, that all secondary teachers learn the basic modules in Special Needs Education during training. The study also recommends for the government to assist the schools for the visually impaired students to import the much needed teaching and learning equipment. The study has provided some knowledge about the learning of mathematics by visually impaired students in Zimbabwe in the areas of lesson delivery, materials provision, and programme adjustments at secondary teacher training colleges and universities. It has also provided curriculum planners with an insight on the prevailing situation with regard to the teaching and learning of mathematics by visually impaired students. This knowledge could be used when formulating future mathematics curriculum and training policies to do with non-sighted students in Zimbabwe and other countries in Africa.

KEY WORDS

Visually impaired, opportunity to learn, Braille, secondary school students, mathematics, resource teacher, itinerant teacher, special needs education

DEDICATION

I dedicate this thesis to my late mother and my two children.

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First, I am grateful to the Lord Almighty for giving me the strength, courage, wisdom and determination to complete this project. With God, nothing is impossible.

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LIST OF ABBREVIATIONS

CSBE	California State Board of Education

ECD Early Childhood Development

GZU Great Zimbabwe University

HI Hearing impaired

ICEVI International Council for Education of People with Visual Impairment

IDEA Individuals with Disabilities Act

MoPSE Ministry of Primary and Secondary Education

NCLB No Child Left Behind

NCTM National Council of teachers of Mathematics

NGO Non-Governmental Organisation

OTL Opportunity to Learn

PED Provincial Education Director

UN United Nations

US United States

USAID United States Aid

VI Visually Impaired or Visual Impairment

ZAVH Zimbabwe Association for the Visually Handicapped

ZIMSEC Zimbabwe School Examinations Council

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CHAPTER ONE

THE PROBLEM AND ITS SETTING

1.1 INTRODUCTION

In Zimbabwe, a common site at street corners is a child leading a singing blind beggar who sings in order to attract sympathy from the public. The majority of people may not be aware that these members of society with visual impairment (VI) are normal people, capable of leading an independent life. Some people are under the impression that the visually impaired (VI) members of society need assistance to move around, bath or even dress up. Very few are aware that the VI can manage on their own, especially when in familiar environments. In addition most VI people have had some educational experience that enables them to count money and read Braille.

The current researcher has marked Ordinary level ('O' level) Mathematics examination scripts for the VI students for about ten years in Zimbabwe. The students with VI are taught together with, and write the same examinations as their sighted colleagues. They, however, meet a number of challenges and perform worse as compared to their sighted colleagues. Very few of them, so far only one, in the last ten years, has passed external examinations in Zimbabwe (Madungwe 2013). When their Mathematics examination papers are set, at the item writing stage, there is emphasis on minimising questions with diagrams and those that require the use of mathematical tables or calculators. The argument for such measures is that the students with VI may not comprehend when too many lines are involved, and they can not use calculators. Yet Jackson (2002) reports in '*The World of blind mathematicians*', of the celebrated blind mathematician and Newtonian, Michael Sanderson, who was a lecturer; Bernard Morin, the blind geometer; Emmanuel Giroux, a VI geometer; Lawrence Baggett, a lecturer in analysis, to mention just a few. This means that the view that visual impairment negatively affects Mathematics performance is contestable.

In Zimbabwe, however, few of the students with VI have gone through ‘O’ and ‘A’, level as reported by the Commission of Inquiry into Education and Training (CIET), commonly referred to as the Nziramasanga Commission of 1999 (p 216). Most of those who did ‘A’ level have gone through university or have had some form of training, mostly in the Arts subjects. To date, none of the VI has taken mathematics at ‘A’ level. This is according to the teachers at a special school for the blind, and confirmed in the statistics compiled at provincial level in Masvingo. The researcher is therefore interested in examining the opportunitie to learn mathematics that are accorded to students with visual impairment, which lead them to fail the subject at ‘O’ level. The researcher is also interested to find out whether failure could be attributed to the way they are taught, the attitudes of the teachers, attitudes of the students, or whether it is a question of non-availability of resources.

1.2 MOTIVATION

From the time that the researcher began her teaching career in the secondary sector, she has been in contact with some student with VI. These totally blind students came to the school where the researcher taught to study ‘A’ level Arts subjects. None came to study Mathematics. The researcher however was intrigued by the way they learnt their Arts subjects. The routine was that they would sit in a lesson listening to the teacher teaching and recording the proceedings on a tape recorder. The students would listen to the recorded lessons and write their own notes in Braille in their free time. If they needed to refer to some text, they would ask a friend to read printed material to them while they took notes in Braille, a seemingly long process. Only then would they be in a position to write assignments. At that time The Zimbabwe Council for the Blind was very active and provided learning materials for the students with VI in the form of a manual typewriter, a tape recorder and a Perkins Braille typewriter. Apparently these students did very well in the Arts subjects. The few students with VI who proceeded to university were provided with 'talking' computers that were fitted with speech devices which could read aloud, word for word or letter by letter, any text typed on the computer. At secondary school level there were not enough resources to cater for all the students. Students had to sit and listen to the teacher teaching, which meant they had to rely mostly on their memory. Petty (2009) remarks that even psychologists are still not sure how we remember and why we forget, but they believe that the process of remembering involves passing information from our short term memory to our long term memory. It therefore means the VI students have to develop good long term memory in order to remember what they are taught.

Later on when the researcher became a school inspector, she had the opportunity to observe a few lessons taught to VI students at a special school that was run by missionaries. That was when she became interested in the teaching and learning of Mathematics of students with VI. She realised that these students had to rely mostly on their memory during and after lessons since they did not have adequate reading material in Braille to refer to. The researcher then realised, as Chabongora (2013: 3) puts it, that

"Opportunities to learn (OTL) can help in the pursuit of good practice in the learning and teaching situation because it takes into consideration all stakeholders, from those who make decisions, those who implement *the* decisions, the learner and support materials, in order to provide the learners with VI meaningful opportunities to learn mathematics".

It means all stakeholders need to be involved in assisting the visually impaired students to realise their educational dreams.

In addition, one of the students the researcher had met previously became her friend and the researcher has always had the pleasure to observe how she manages in her home since she stays alone. It is interesting to observe how this lady engages in mathematical activities such as moving in the house, budgeting, calculating, estimating and measuring, without using calculating devices or measuring instruments. It is amazing how the proportions usually come out correct. She arranges her household items in a certain order which she does not want disturbed, otherwise she will not be able to locate the items when she wants to use them. She has developed a high degree of independence and a very sharp memory such that she can memorise most telephone numbers and addresses until she can save these on her phone.

What then is Mathematics for students with VI? Do these students need to learn Mathematics? Paling (1982: 2) sees Mathematics as "a way of finding answers to problems; a way in which we use information, use our knowledge of numbers, shapes and measures, use our ability to calculate, and most important, think for ourselves in seeing and using relationships." The Oxford English Dictionary (2012) defines Mathematics as the science of space, number, quantity and arrangement whose methods involve logical reasoning and usually the use of symbolic notation, and which include geometry, arithmetic, algebra and analysis. Through the use of abstractions and logical reasoning, mathematics developed from counting, calculation, measurement and the systematic study of shapes and motions of physical objects. So, it is apparent that practical mathematics has been a human activity from far back in history. Hence, as long as students with VI of necessity, have to survive, they need to deal with quantities, shapes and motions, just as their sighted counterparts do. In addition to being able to count physical objects, people with VI also need to be able to recognize how to count abstract quantities like time in days, months and years. Mathematics is, therefore, for everybody, regardless of their physical state.

Chabongora (2013) notes that not every learner is expected to reach a high level of proficiency in Mathematics, but it is important that they be given the opportunity to learn it. If learners acquire knowledge of Mathematics, they can use it in other areas where such knowledge is required. Many students in ordinary classrooms seem to have problems of perception of Mathematical symbols. Instances have been cited of sighted pupils who confuse 6 and 9, > and <, □and□, etc. It is even worse for students with VI who have to learn a new language, that is, Braille, and then another new set of Mathematical symbols, the Nemeth Code (Jackson 2002). The students with VI also have to contend with non-availability of Braille books, especially for Mathematics.

In this study the researcher observed the students with VI in the actual process of learning Mathematics so that she gets to know what they actually learn and how they learn it, as a way of examining the opportunities to learn mathematics. The researcher is generally aware that VI students have to commit most of what they learn to memory and have to recall it when it is required. In other words, they have to develop good long term memory. Students with VI may have turned blind at different stages in their lives. Some were born blind while others turned blind in later life. Socks (1995) talks of Hull, a blind man in his 40s, who, after only five years of blindness, reported that his own visual memories had become so uncertain that he was no longer sure which way around the number "3" went. He had to trace it in the air with his fingers. Thus, the numeral was retained as a tactile-motor concept, but no longer as a visual concept. Hull states that the blind 'live in time almost exclusively'. He notes that "this sense of being in a place is less pronounced […] Space is reduced to one's own body and the position of the body is known not by what objects have been passed, but by how long it has been in motion" (Socks 1995: 25). Position is thus measured by time. So the stage at which a person becomes blind could have a bearing on how he/she learns in later life.

The researcher also wanted to interact with the students with VI to find out what sort of mental pictures they have of different objects and concepts. Socks (1995) reports that another blind man, Diderot, maintained that the blind may, in their own way, construct a complete and sufficient world, have a complete 'blind identity' and have no sense of disability or inadequacy, and that the 'problem' of their blindness and desire to cure this, therefore, is ours and not theirs (Socks 1995: 139). This study gave the researcher an opportunity to examine the sort of opportunities to learn Mathematics that are given to VI students in view of these apparently additional efforts that they are expected to make.

The other factor that motivated the researcher to embark on the study was that she was challenged by a whole list of blind mathematicians reported by Jackson (2002). The researcher was intrigued by the works of blind mathematicians such as Bernard Morin, Nicholas Sanderson, Zachary Battles and Lawrence Baggett, all of whom turned blind at very early ages (six years and below). The others such as Lev Semenovich Pontryagin, Louis Antoine, Emmanuel Giroux, Norberto Salinas, Abraham Nemeth, to mention just a few, turned blind later in life. It is amazing that these men attained degrees in Mathematics, Physics or Computers Science and some even graduated with PhDs. Professor Nemeth was the one who developed the Nemeth code, the standard code for mathematical symbols that is in use up to this day. So, if these early people with VI could achieve so much in the field of Mathematics, what can stop our own Zimbabwean students with VI from taking up and understanding Mathematics? That was the challenge this study sought to unravel.

1.3 BACKGROUND OF THE STUDY

Teaching Mathematics to students who are blind or visually impaired is essential for the same reason that it is essential for sighted students. However, the California State Board of Education, (CSBE) (2006), notes that it can be especially challenging for blind students because many aspects and concepts of Mathematics are visual and spatial in nature. The CSBE (2006) reports that in 2002 when President Bush signed the No Child Left Behind (NCLB) legislation, the United States Department of Education made it clear that the Individuals With Disabilities Act (IDEA) would be re-authorised to incorporate NCLB's structure. The IDEA stated that " to the extent possible, children with disabilities are entitled to the same educational experiences as their non-disabled peers". Papperman, Heinze and Sticken (2000), in CSBE 2006), contend that a thorough grounding in Mathematics enhances educational and occupational opportunities for all people, whether sighted or visually impaired. In day-to-day routines, a practical understanding of Mathematics enables a person to function more successfully and independently.

In the United States of America, there are reports of efforts made by Susan Osterhaus of Texas School for the Blind in educating students with visual impairment. Osterhaus (2002) makes use of the multi-sensory approach, that is, “see, feel, eat math, listen to math, try to do it”. She makes use of technology tools such as talking calculators,tactile graphics and teaching tools or aids and her students can study mathematics up to tertiary levels.

In Slovakia, Kohanova (2006) describes how mathematics was made accessible to students with visual impairment through the Lambda editor.

In the same vein, the Zimbabwe government has put in place various legislation, in an effort to accommodate children with disabilities. Zimbabwe, as a member of the United Nations (UN), is party to all conventions and agreements, which include The Standard Rules (1993) on the Equalisation of Opportunities for Persons with Disabilities, which emphasises the need for a clearly stated policy on education and training for the disabled. We have the Zimbabwe Education Act (1987) which advocates for education for all. However the CIET (1999) noted that education for the disabled has been taken as a charity issue as evidenced by the lack of clarity on Special Education. There is the Disabled Person’s Act Chapter 17.01 of 1992, an Act that makes provision for the welfare and rehabilitation of disabled persons. The Act was promulgated later than the Secretary’s Circulars. The Secretary for Education issues out Policy Circulars through the Chief Education Officers, now called Directors. Such circulars include the Secretary’s Policy Circular No. P3 of 1990 which specified teacher-pupil ratios for special classes, and the Chief Education Officer’s Circular No. 3 of 1989, which spelt out the curriculum in special education. There was also the CIET (1999), whose terms of reference included identifying specific areas in education and training systems, which required reform on a short term, medium term or long term. The Commission identified special needs education as an area requiring reform. Recommendations of the Commission are being revisited after the drafting of the new Zimbabwe Constitution in 2013. In a way, these legislations have similar intentions to those of the NCLB policy.

Secondary school education in Zimbabwe is structured such that students do four years of compulsory schooling and write national external examinations at Ordinary level (‘O’ Level). Those students who want to go further with education can then proceed to write Advanced level (‘A’ level) after another two years. At ‘O’ level, Mathematics is one of the ‘compulsory’ subjects. A pass in ‘O’ level Mathematics has become mandatory since Mathematics has been made a pre-requisite in a number of professions. Both students with VI and the sighted ones are required to write their ‘O’ levels within four years.

A child with visual impairment uses multisensory experiences to develop and organise computations, solutions and spatial relationships that are expressed in Mathematics (CSBE 2006). The CSBE further explain that a student with VI cannot take in his/her surroundings at a glance, hence, touching is essential. For this reason, the child with VI will need additional time in order to have the opportunity for tactile explorations of shapes, objects or graphics. They go on to say that the extra time does not mean that the child is a slow learner. It simply means he/she needs a different (non-visual) method of learning. Mathematics, must of necessity, be presented in a tactile mode for those who cannot access print since children who are visually impaired deserve the same learning opportunities as their sighted counterparts. Multisensory experiences are needed to maximise the use of tactile information when learning and applying Mathematics concepts. For this reason, the CSBE drafted Braille Mathematics Standards which specify explicitly the content that students with VI need to acquire at each grade level from kindergarten to grade 12.

Unfortunately, in Zimbabwe, no such standards exist. What we have is the general Mathematics curriculum content standards that each child is expected to learn, defined by the syllabus but without due regard for any form of disability. No OTL standards have been set to guide their implementation for students with VI. No separate statistics have been compiled on the performance of students with VI in Mathematics at 'O' level. The researcher, as an 'O' level examiner for ten years has noted that virtually no student with VI has passed 'O' level Mathematics in Zimbabwe. These results seem to suggest that students with VI may lack adequate knowledge and skills to manipulate algebraic expressions and visualising geometrical concepts, which amount to lack of the opportunity to learn mathematics. However all this seems to be contradicted by the number of eminent VI Mathematicians already referred to earlier on.

Other problems encountered by students with VI could emanate from the transcription of their work from Braille to print, which the non-specialist teacher or the examiner may not be familiar with. In the schools under study, the teachers responsible for marking the children's assignments have no specialist training (Madungwe 2013). It was explained that some teachers go to the extent of asking other students with VI to read Braille for them. The accuracy of such transcriptions leave a lot to be desired. So, when a non-specialist teacher marks the work it may not be clear exactly what the student wrote originally. However for examinations, specialists are engaged to do the transcription.

The other problem that students with VI encounter is the inability to revise their work. The nature of the Perkins brailler is such that when the student wants to revise, he/she has to move the paper up so that he/she can touch the dots and then move it back. With a slate and stylus, it is even worse because the student has to remove the paper from the slate, turn it over to read what has been written, then return it into the slate. So when the student wants to continue it becomes difficult to tell exactly where he had left, which may result in either leaving a big gap between the lines or typing on top of what had been written before. This process of trying to revise may call for more time as compared to the ordinary writing where the sighted student just crosses out the unwanted work and writes afresh. This constitutes another case of lost opportunity to learn in terms of time spent on a task.

The CSBE (2006: viii) identified the following issues of concern as obstacles in the learning of Mathematics by students with VI.

> Firstly, time for instruction – in many cases blind children do not have sufficient access to a teacher of blind children who not only is knowledgeable in the Braille Mathematics code and in how to teach it, but who is also well versed in the specialised methods and materials for teaching Mathematics in the tactile mode.
>
> Secondly, attitudes of some professionals, parents and blind students who believe braille is a second class medium incapable of providing the same access to learning as print provides.
>
> Thirdly, service delivery– most blind students (in the US) are served by an itinerant teacher who travels from school to school serving children in their home schools, but this may create an obstacle if the child does not have access to a teacher with a knowledge of Braille Mathematics code and of the teaching methodology of tactile Mathematics.

Thirdly, teacher training – teachers of students with VI need access to ongoing inservice training to enhance and refresh their university preparation activities.

Fourthly, technology – access to information auditorily does not replace print or Braille, it supplements these media. In mathematics tactile representations are critical to the child's concept development and growth.

Fifthly, age at onset of blindness – children become blind at different times in their lives, therefore, they may need to learn beginning Braille Mathematics code at any age and at any grade level, providing additional challenges for students and teachers.

Finally, Braille production standards – the quality of Braille Mathematics materials varies widely and access to certified Nemeth code transcribers varies widely as well. Instructional materials for children with VI must be as accurate and error-free as instructional materials for sighted children.

The factors cited above, if not addressed may culminate in lost opportunity to learn Mathematics by VI students.

In their study, Mereku, Amedahe, Etsey, Adu, Acquaye Synder, Moore and Long (2005), investigated whether or not the opportunities provided in Ghanaian primary schools for learning English and Mathematics were good enough to promote learning for all pupils and assure high levels of outcomes for all pupils. The team were trying to ascertain teacher preparedness, adequacy and availability of resources for the delivery of the national curriculum, how well instructional times were managed, the extent of teachers' coverage of the curriculum content, teachers' emphasis on content and content emphasis for individual students or groups of students. These are the factors which constitute opportunities to learn Mathematics for students with VI as well. This current study also investigated how some of the factors mentioned above impact on the opportunities to learn Mathematics for students with VI.

The International Council for Education of People with Visual Impairment (ICEVI) (2005) also came up with the following factors which contribute to the child's success in learning Mathematics: selection and teaching of suitable Mathematics Braille codes; adaptation of the text material to the VI child without changing the learning outcomes of the topics; teaching mathematical devices, such as the abacus; Taylor frame, etc., to the VI child for making necessary calculations; provision of correct Mathematics text material; preparation and use of appropriate teaching aids to supplement instruction; the methodology followed by the teacher in teaching Mathematics; and the complementary roles of the resource and regular teacher in giving appropriate learning experiences. The same factors were identified by Mereku et al. (2005) and the CSBE (2006) as constituting opportunities to learn Mathematics and were, therefore, worth investigating. The present study, however, concentrated on only three: time of instruction, service delivery and access to information.

Success in Mathematics or lack of it, for Zimbabwean students with VI can be attributed to many factors including the curriculum or lack of properly qualified teachers. The current syllabus on offer for Mathematics appears to be less friendly to students with VI. Such students encounter problems in dealing with topics such as graphs, which involve lots of intersecting lines which could confuse students. As a result, some teachers avoid teaching such topics to the required level. An example was cited of a Home Management lesson whereby a teacher was reportedly not allowing students with VI to light an electric stove for fear they might get burnt (Madungwe 2013), yet these students have to use that knowledge in life in order to manage on their own. Learners with VI are denied opportunities to learn by seemingly being overprotected. The purpose of this research is to examine the opportunities to learn mathematinc accorded to students with VI, resulting in them failing to advance in Mathematics despite that the government has identified Mathematics as a priority area by making it a compulsory qualification for training in most professions.

A study conducted by Madungwe (2013) found out that the materials in use seem to favour the sighted students since most of the books come in normal print and have to be translated into Braille; that teachers lack special training, especially at secondary level as some teachers look down upon the in-service course offered at primary colleges; that the time allowed to cover the Grade 7, ‘O’ and ‘A’ level Mathematics curriculum was the same for the VI students as for sighted students, and, as a result, students with VI could not complete the syllabus. All these factors, coupled with the negative attitudes of both the Zimbabwean students and the teachers, made the learning in general very difficult and the learning of Mathematics in particular virtually impossible. Some authorities in education have looked at the possibility of offering students with VI a different syllabus, something along the lines of mathematical literacy. However the students thought it was inferior and rejected it before it was even introduced. This current study examined the opportunity to learn mathematics for and tried to assess the extent to which government commitment translates into meaningful OTL Mathematics in the classroom for the students with VI.

Most of the studies done in Zimbabwe were concerned with primary schools. Several studies were conducted on the inclusion of children with VI in ordinary classrooms (Dakwa, 2011, 2014; Jenjekwa, Rutoro and Runyowa, 2013; Mutepfa, 2003). Dakwa (2013) explored the possibility of education for all in ECD, Sekeni and Dakwa investigated the implementation of authentic assessment for all in (ECD); Dziwa, Mukandi and Chindedza (2013) investigated the role of language in the teaching of Art and Design to the VI students while Mupfumira (2013) researched on the teaching Home Management to students with VI and Deme (2010) investigated access by a girl-child with profound visual challenge to primary education.

These are some of the very few studies done in Zimbabwe, on the learning of students with VI at secondary level. Though all indicated the challenges the VI students encountered, virtually none researched on the challenges and opportunities to learn affecting the VI Mathematics subject student. The challenge of this study is, therefore, to try and fill that gap.

1.3 THE RESEARCH PROBLEM

From the time Zimbabwe attained independence in 1980, various efforts have been made to make education accessible to all children, including children with disabilities. These efforts include the Zimbabwe Education Act of 1987 which sought to encourage education for all, the 1989 UN Convention on the Rights of the Child (to which Zimbabwe is a signatory) which was passed to recognise children with mental or physical disabilities as active participants in communities; the Zimbabwean Education Secretary's Policy Circular Minute Number P3 of 1990 on the placement procedures for special classes, resource rooms and special schools and the Zimbabwe Disabled Persons Act Chapter 17.01 of 1992. The Commission of Inquiry into Education and Training (CIET) (1999) further recommended that free education be made available to all Zimbabwean children with disabilities at all levels (CIET, 1999: 230). It also recommended the setting up of more resource units for the disabled. A resource unit is defined by Galloway and Goodwin (1987:96), in Chimedza and Peters (2001), as a room having a specialist teacher and ancillary helpers. The Chief Education Officer Circular No. 3 of 1989 spelt out the curriculum for Special Education with emphasis to be on appropriate teaching approaches and adaptation to the child's needs.

Despite this circular, most specialist schools and resource units have, however, continued to offer the same curriculum as that offered in regular schools. This has resulted in poor results being registered among those few children who access special education (CIET, 1999). National reports compiled by the Zimbabwe School Examinations Council, (ZIMSEC), over the years, show that Mathematics is among the subjects with the lowest pass rates.

In Zimbabwe, resource units are resource rooms in ordinary schools which are intended for children with varying degrees of visual and hearing impairment and also for children with moderate to severe mental handicap who can cope with some of the demands of ordinary schools (Secretary's Circular Minute P3, 1990). There is no room for individual programming to meet the needs of individual children due to resource limitations and, therefore, resources have to be shared. For those students with VI who learn at resource centres close to their homes the situation is even worse. The children might not have the required books and equipment and the teachers may not be specialists. Resultantly these children may lack the necessary opportunities to learn Mathematics.

Access to Mathematics education is relatively open to all students in Zimbabwe as can be seen from the various legislations put in place. However, disabled learners, especially those with VI, still appear to lack the opportunity to learn and achieve expected standards. Teachers at the special schools say that these disadvantaged children argue that they want to get the same

standard of education as their sighted peers, which translates to learning the same syllabus. The Chief Education Officer Circular No. 3 of 1989 spells out the curriculum for special education which emphasises on appropriate techniques and on adaptation to the child's special needs. Despite this circular, however, these VI students are still confronted with the same Mathematics curriculum as the sighted students. Some students with VI learn in integrated settings close to their homes as was confirmed by the Nziramasanga Commission (1999:217). The CIET (1999) concluded that the idea of offering the same curriculum to both sighted and VI students has resulted in poor academic results being registered amongst those few children that access special education. The problem that the researcher wanted to confront was to examine how the opportunities that these students with VI are accorded impact on their performance. Given that access to learning Mathematics is relatively open, the problem of under-performance could perhaps be traced to the actual
"opportunity to learn" Mathematics in the classroom itself (Chabongora 2013). In other words, the study investigated what it was that learners with VI did in the name of learning or doing Mathematics in the classroom situation.

Malloy (2000), in Chabongora (2013), noted that though learning is supposed to be a pleasurable experience, it is rarely so for many children when it comes to Mathematics because "learning Mathematics for intellectual pleasure is not wide spread; it tends not to happen for most children" (Malloy, 2000:18). According to Malloy, children often like mathematics in the lower grades and they gradually willingly, or are forced to, withdraw from mathematics by the time they leave middle school. This is,, in fact true for students with VI. Results in Mathematics at primary school level are generally good, but a a completely different picture is observed at secondary level. The fact that this does not happen with other subject areas means that there could be something about mathematics that discourages or scares learners. It was,, therefore important to understand how opportunities to learn Mathematics are distributed in the classroom and how the learners experience them during the lessons. A study of opportunities to learn could also shed light into what contributes to poor performance in Mathematics especially by students who are visually impaired.

Students need to learn Mathematics with understanding. Understanding comprises many aspects such as comprehension of concepts, skills in carrying out procedures efficiently, problem solving, capacity for logical thinkinM, and a disposition to consider mathematics as a worthwhile endeavour (Chabongora 2013). The National Council of Teachers of Mathematics (NCTM) (2009) observes that mathematics consists of different topical strands which are interconnected, such as geometry and algebra. The NCTM suggests that in order to enable students to learn with understanding, it is advisable to have a coherent curriculum that effectively organises and integrates important mathematical ideas so that students may see how the ideas build on or connect with other ideas, thus enabling the development of skill proficiency and problem solving abilities. This learning with understanding applies to the sighted as well as to students with VI. All students need to develop problem solving skills in order to survive in the developing world. Students with VI thus have to be assisted in order to learn Mathematics in ways that help them to build the skills that are demanded of them in life. The challenge for this study was to examine how Mathematics could be learnt and understood by students with VI so that there can be a general improvement in their performance in Mathematics at secondary school level.

Most learners often lack the opportunity to engage in meaningful learning of Mathematics. The learning of Mathematics is generally imposed on the learners. Learners hardly learn Mathematics for pleasure. This is even more evident now that Mathematics has been made mandatory for those who wish to get into different professions. Zimbabwean schools and colleges thrive on offering extra lessons in Mathematics to students who did not make it at their first attempt. A preliminary study done by a student teacher on the Bachelor of Education (B.Ed.) programme at Great Zimbabwe University (GZU), revealed that most students in rural areas prefer to write Mathematics later as non-formal candidates when they can concentrate on just the Mathematics, rather than write it together with the rest of the 'O' level subjects (Jani, 2013). That way the learners appear to be studying Mathematics on their own accord rather than being compelled. This strategy has tended to produce higher pass rates in Mathematics as compared to when students write the subject as first attempt together with other subjects. But so far the researcher has not witnessed any case of students with VI supplementing in Mathematics, although they do that in other subjects such as English Language. It was, therefore, worthwhile to investigate why the students with VI are not keen to re-write Mathematics.

1.5 RESEARCH QUESTIONS

The major research question of this study is: How are opportunities to learn Mathematics provided to students with visual impairment?

The sub-questions are;

1. How are visually impaired students exposed to Mathematics in the classroom?
2. How is time on task exploited by both teachers and the visually impaired students in the classroom?

3. What modifications, in terms of teaching strategies, do teachers make when teaching visually impaired students?
4. What intervention strategies could be employed to maximise on opportunities to learn mathematics by visually impaired students?

1.6 AIMS AND OBJECTIVES OF THE STUDY

The aim of the study is to examine the opportunities to learn mathematics that are accorded to students with VI, and to investigate why VI students hardly proceed with Mathematics beyond ordinary level.

The objectives of this study are:

1. to investigate how VI students learn Mathematics,
2. to ascertain how well the instructional times for teaching Mathematics are managed in the classroom,
3. to explore the sort of modifications in teaching strategies that teachers employ when teaching VI students,
4. To explore the kinds of intervention strategies that could be employed to maximise opportunities to learn Mathematics.

1.7 SIGNIFICANCE OF THE STUDY

The kind of opportunities to learn provided to students have a significant bearing on their learning outcomes. The International Council for Education of People with VI (2005) maintain that although the possibility of the learning of Mathematics by children with VI is often questioned by highlighting some of the areas in mathematics that demand vision, many such ideas could be converted into non-visual experiences so as to enable such students to get the required learning experiences. It is advisable to keep the expected outcomes on par with those for sighted children. In coming up with Braille Mathematics standards, the CSBE (2006) maintain what Kapperman, Heinze and Sticken (200) noted, that a thorough grounding in Mathematics enhances educational and occupational opportunities for all people, whether sighted or visually impaired. Hence, teaching of Mathematics to visually impaired students is essential for the same reason that it is essential for sighted students.

Opportunities to learn are provided by teachers in the classroom as teachers are the primary implementers of the curriculum. The study would be of significance to teachers since they might be assisted to know how to provide appropriate opportunities for their students to learn Mathematics, which will ensure improvement of pupil performance. Teachers have the most direct contact with learners and have control over what students learn and how it is learnt.

The study could also benefit the examinations council, ZIMSEC, as the Council will be challenged to provide appropriate examination structures for students with VI. Wood (1998: 2) suggests that "making appropriate adaptations of the learning environment, …, and testing procedures will enable the student with special needs to be graded according to the same methods used for other students in the classroom". He goes on to observe that students with VI need more time to complete the syllabus, more time to write the examination and they need to handle manipulatives that may be demanded in some geometry questions in the examination. Vaughn, Bos and Schumm (1996) also contend that tests should be modified to make them accessible to children with visual impairment. Information from the current study could, therefore, guide the development of new educational assessments to better assess the quality and quantity of instruction for students with VI, through pupil achievement (Mereku et al 2005).

The findings of the study could guide the policies and practices with regard to the learning of Mathematics by students with VI. Curriculum planners will be sensitised on the need to adapt the Mathematics curriculum so that it becomes more user friendly to students with VI and to come up with non-discriminatory policies for special needs education.

The fact tha the study was conducted in Zimbabwe on the eve of a new political dispensation is of potential benefit to researchers and teachers, where science and mathematics are likely to play a crucial role in industrial development. Most economies in the African continet appear to be improving such that production and distribution of knowledge are likely to improve. Practtitioners and researchers across the world will be able to share ideas on best practice on teaching mathematics to students with visual impairment.

The study is also important in that it may inform the stakeholders of the plight of students with VI, when it comes to learning Mathematics. The Zimbabwe Association for the Visually Handicapped (ZAVH) (2013), during their district visits discovered a large number of disabled children, including some with VI, who are kept at home in the belief that they are incapable of doing anything. Such stakeholders could benefit from knowing that there is a world of blind mathematicians and that their children could be no exceptions.

1.8 DELIMITATIONS

The study focused on two special secondary schools, (Schools A and B) that accommodate students with VI in Zimbabwe. The researcher has had experience working with this school before, in her capacity as schools inspector. The study will enable the researcher to explore the question of how successful these schools are in providing access to learning mathematics by students with VI by examining what OTL are provided in the mathematics classrooms.

Schools A and B are co-educational boarding schools in Masvingo Province, which accommodate both the totally blind and the partially sighted students in an inclusive setting. Both schools go up to ‘A’ level. The sister primary schools are located in the same vicinity as the secondary schools. School A enrols the highest number of students with VI as compared to similar schools throughout the country. At the time of my last visit to the school in 2013, the school had an enrolment of 130 VI students and each form had two streams of about 20 children each due to staff shortages. The recommended teacher–pupil ratio for special schools is 1 teacher to 10 students. School B has an enrolment of above 1000 mostly sighted students. At the time of the visit to school B, none of the students were visually impaired. There were only six partially sighted students who could, however, not fit into the sample.

The study is concerned primarily with the opportunity for students with VI to learn mathematics. The researcher will analyse the syllabus and students written work to see if there are any instances of lost opportunity to learn mathematics. The researcher will also conduct the investigation with teachers and learners to find out their views on OTL Mathematics. Lesson observations and interviews will constitute part of the investigation. An examination of specialist facilities will also be done to determine whether they promote opportunities to learn mathematics by VI students.

1.9 LIMITATIONS OF THE STUDY

The study was conducted at a time when the economic situation in the country was not stable. Occasionally, the country experienced power outages, and at times work stoppages by teachers over salaries. These might have had serious implications on the mathematics syllabus coverage and on the commitment of teachers to their work. By the time data were collected the situation had, however, normalised so that a correct picture manifested.

Another limitation was that most of the teachers at the schools knew the researcher as a school inspector even though the researcher left a long time ago. The researcher had to assure them of the anonymity and confidentiality with which the data would be handled.

1.10 FEASIBILITY OF THE STUDY

Access to respondents to take part in the study did not seem to be a problem. During a previous investigation the respondents had been free to take part in the study. Some of the respondents, teachers in particular, still viewed the researcher as one of them since we had once worked together before, so there should be no problem in accessing the required data.

1.11 ORGANISATION OF THE STUDY

The following organisational structure should be used to present the study and its findings:

Chapter one describes the problem and its setting, placing it in perspective by giving an outline of the background, context and key research questions. It also provides the objectives, scope and limitations of the study and tries to justify why the study was conducted.

Chapter two consists of a review of related literature pertaining to the learning of Mathematics by students with VI. The chapter starts with reviewing the concept of visual impairment and discusses educational provisions for students with VI, special adaptations with regards to equipment, teaching and assessment strategies. The chapter also looks at the concept of OTL as applied to the teaching and learning of Mathematics by VI students. Theories on how children learn are discussed and related to specifically how students with VI learn. The review of literature helped to develop a theoretical framework for the study.

Chapter three presents the methodology. The case study research design and the instruments used to collect data shall be outlined. It also outlines how data will be analysed. The chapter therefore clarifies how the research will be carried out and the trustworthiness.

Chapter four presents the data collected through interviews and lesson observations. In this chapter the data are also analysed and discussed in accordance with the research questions and related literature.

Chapter five presents a summary of the findings, conclusions and recommendations of the study.

1.12 SUMMARY

The chapter has tried to put the study into perspective, which is a study on the opportunities to learn Mathematics for VI students in Zimbabwe. A background to the research problem was given and the problem was explained. Research questions as well as objectives were stated. The significance of the study was explained, delimitations and limitations were also explained.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The previous chapter outlined the background to the learning of Mathematics by students with visual impairment in Zimbabwe. The problem to be investigated, key research questions, motivation and delimitations and limitations of the study were presented. The purpose of this chapter is to review literature on how the opportunities to learn Mathematics that are accorded to students with visual impairment, impact on their performance, in order to ascertain the reasons behind the students' failure to proceed with Mathematics beyond 'O' level.

In this chapter the researcher describes the concept of visual impairment, the concept of opportunity to learn (OTL) and the theoretical framework. The chapter discusses some theories of learning in relation to Mathematics and winds up with the theoretical framework that guides the study. This study is guided by what Gresalfi, Barnes and Cross (2011) refer to as the interrelationship between learners and contexts. They specifically posit that learning is a function of what people do given what they have opportunities to do. In this study the researcher examineded how the opportunities to learn Mathematics accorded to visually impaired students impact on their performance in mathematics.

The chapter ends with a description of what education for visually impaired students entails, the Zimbabwean curriculum and the structure of the education system in as far as it relates to the education of visually impaired students.

2.2 THE CONCEPT OF VISUAL IMPAIRMENT

Educators differentiate between blind (visually impaired) and low vision students. The educational definition of visual impairment considers the extent to which a child's vision affects learning and makes special methods and materials necessary (Mangal 2007, Hergarty 1993, Barraga 1983). These authors further explain that a blind student is totally without sight or has so little vision that he/she learns primarily through other senses. They add that most blind students use their sense of touch to read Braille. A low vision student, on the other hand, is able to learn through the visual channel and generally learns print.

Turnbull, Turnbull III, Shank, and Leal (1995) describe three characteristics of students with blindness and visual impairment. The first is that these students have limited opportunities for incidental learning. Sighted children see objects over and over again and in different contexts such that they are able to build concepts faster. For instance, in learning the concept 'rectangle', a sighted student will be able to associate the concept with the shape he or she sees on the table top, the door, the window-frame or the textbook. That way, the child builds up knowledge about the rectangle. A student with visual impairment, however, will only build the concept of a rectangle when he or she has had the opportunity to handle manipulative, that is, physical objects, and these have to be brought to him/her. The rate at which the two students learn the concepts may differ. For the non-sighted student this may result in a case of 'missed opportunities'. For many or all concepts, the student with visual impairment needs to touch objects or someone has to describe the object for him or her.

The second characteristic, according to Turnbull et al. (1995) is that students with visual impairment have limitations in the range and variety of experiences. Turnbull et al. (1995) cite examples of things which are very big, like mountains and skyscrapers; or very small, like ants and molecules; or very fragile, like snowflakes or moths; or very dangerous, like fire; or distant, like the sun or the horizon, for their characteristics to be learned factually. The other senses cannot fully compensate for what can be learned visually by students with VI. The knowledge of the world for VI students may be different from that of the sighted students. In an earlier visit the researcher made to a primary school for the visually impaired, she was shown a model of an electricity power grid which transmits electricity from Hwange Power Station to the school. The teacher had made a model which she used to explain the long distances through which electricity is transmitted. However it takes an industrious teacher to do such an activity in order to drive the concept home.

The third characteristic is that of limitations in the ability to get around, which result in limitations in interaction with the environment. Turnbull et al. (1995:603) quote Harrell and Akeson (1987) who observed that "Individuals who have a poor sense of their ability to affect the change in their environment are at risk of the development of poor self-esteem, poor academic achievement and reduced language and social skills". The inability to interact with the environment results in experiential and environmental deprivation. It can thus be concluded that visual impairment and blindness affect how students learn a skill, though they do not prevent students from learning the skill. This inability to interact with the environment culminates in missed opportunities to learn which may affect students' performance in school. The next section will be devoted to explaining the concept of opportunity to learn.

2.3 OPPORTUNITY TO LEARN (OTL)

2.3.1 The concept of OTL

"A major goal of school mathematics programs is to create autonomous learners" (Posametier and Jaye, 2006:14). A mathematics program should ideally help learners to gain the power to think and act independently. This power helps learners to have control over their performance and helps them to develop autonomy in learning. Chabongora (2011) contends that creation of autonomous learners is gradual and needs to be fostered by giving learners the necessary opportunities to develop. This study thus seeks to understand OTL and its implications on performance, especially in the context of teaching and learning Mathematics by students with visual impairment.

The concept of OTL has been defined in varied ways by different authors. For example, OTL is defined as "equitable conditions or circumstances within the school or classroom that promote learning for all students" (Schwartz 1995, Cooper & Lou 2007); "the absence of barriers that prevent learning" (Mereku et al 2005); "conditions or circumstances within schools and classrooms that promote learning for all students" (Cooper and Liou, 2007); and "conditions that may benefit students mathematical learning and achievement, provided by the education system", (Gau 1997). This means that OTL are the conditions provided by the school system that will enable the student to learn without any hindrances.

Winfield (1987, in Mereku et al. 2005: 4) notes that opportunity to learn relates to "the provision of adequate and timely instruction of specific content and skills prior to taking a test." She adds that opportunity to learn may be measured by time spent in reviewing, practising, or applying a particular concept or by the amount and depth of content covered with particular groups of students. Winfred (1987) stresses adequacy of content and skills and the time spent on task.

Examinations set in Zimbabwe at 'O' level cover the whole syllabus, with no regard to whether all the work has been covered and under what prevailing conditions in schools. The syllabus specifies the content to be covered including objectives for the different topics. However, nothing is said about the processes and inputs required for the attainment of those objectives. These processes and inputs are what other countries include under curriculum standards. In Zimbabwe there are neither general curriculum standards nor specific standards for students with VI, so the probability of 'missed opportunity' is high.

From the definitions given above, it is clear that OTL is concerned with factors that impact on learners' performance. Most of these factors depend on the teacher, for he/she can influence directly what students learn as well as the conditions under which the learning takes place. For instance, the teacher can prevent learners from benefiting from instruction through his/her attitude. If he encourages the learners, they get motivated and can progress well, whereas if the teacher discourages learners, they may develop a negative attitude towards the subject and may not realise the opportunity to learn. The ideas implied in OTL can help create a conducive environment that can give every learner a chance to learn with understanding.

OTL is especially suited to learning of Mathematics by students with VI. Teachers of the students with VI need to be very patient and accommodating. They need to be good at motivating these students since the students could already be demoralised by their loss of sight. Some students may find it extremely challenging to learn Mathematics, especially as it requires an extra effort to learn the extra mathematical symbols, complete the syllabus and write examinations in the same time as their sighted peers.

Schwartz (1995) maintains that OTL includes the provision of curricula, learning materials, facilities, teachers and instructional experiences that enable students to achieve high standards. Although OTL has been practised in developed countries like the UK and the USA, its use in developing countries like Zimbabwe has been very limited. In the case of educating students with VI, OTL has been practised in cases where there is donor funding since the local economy cannot sustain the required provisions. In the past, donations of equipment were made to institutions providing education for students with VI, but there was no provision for backup services after the donors left. With the passage of time, the equipment gets over-used because there is no adequate service or backup. In the final analysis the equipment becomes defunct. However if the students with VI were to be given a chance with OTL, there could be an improvement both in performance and development of positive attitudes towards Mathematics. This study, therefore, seeks to contribute by providing an understanding of the benefits of engaging in the teaching of Mathematics to students with VI. OTL offers a means of describing school and classroom practices. Researchers can study how Mathematics is taught and how students learn. In short, OTL is concerned with the conditions under which learners have to learn and is positively associated with achievement.

2.3.2 Indications of OTL

Allocated Time

Caroll (1963) in Kurz et al. (2012: 43), suggests that students' opportunity to learn the intended curriculum largely depends on how much time schools and teachers are able to allocate to instruction. Carroll explains that the relation between time and student achievement becomes stronger with more instructionally sensitive and student oriented indicators such as:

- Instructional time, that is, the proportion of allocated time actually needed for instruction.
- Engaged time, the proportion of instructional time during which students are engaged in learning.
- Academic learning time, the proportion of engaged time during which students are experiencing a high success rate.

For teachers of students with VI, instructional time is particularly relevant because teachers are expected to complete a range of other tasks. In addition to instruction, teachers are expected to assign tasks to students and supervise them during class work, that is, during the time when students are actually engaged in the tasks.

Content overlap

Research related to content indicators originally targeted the overlap between the content of classroom instruction and the tested content. Content coverage indicators include coverage, exposure and emphasis. Kurz et al (2012) add that teachers' content coverage ratings of test items were and are still used to obtain estimates of students' opportunity to learn the assessed curriculum. Content indicators of OTL were taken as significant predictors of student achievement ahead of other variables such as prior achievement. Kurz (2011), in Kurz et al.

(2012), notes that general conclusion can be confirmed for students with disabilities.

Quality indicators

Carroll (1963) notes that researchers have measured instructional quality based on

- Cognitive demand (teachers' learning expectations for certain objectives)
- Instructional practices
- Instructional resources, e.g. use of textbooks, computers, etc
- Teacher-child interactions
- Grouping formats
- Engagement

Wang (1998), in Kurz et al. (2012), in a study that compared quality indicators with content indicators and concluded that quality indicators, such as lesson plan completion, equipment use, textbook availability, material adequacy, are a significant predictors of students' test scores. To facilitate OTL, Rouch et al. (2009), in Kurz et al. (2012: 45) suggest that instructional data on aspects of time, content and quality have to be fed back to the teachers to allow teachers to make targeted changes in instruction. In addition, these data could be used to assist teachers with "job embedded" professional development.

Curriculum engagement indicators

These indicate the degree to which students are actually engaged in the enacted curriculum.

Brophy (1983) suggests that for students to be maximally engaged in a teacher's enacted curriculum, which can affect both OTL and student performance, they must experience a supportive instructional environment with high expectations. Cook (2001) propounds that, historically, educators have had different and sometimes lower academic expectations of students with disabilities. Some say these students, together with low achieving students, may be called upon less frequently, receive more criticism and have less feedback and waiting time to respond (Wehby 1998, Brophy and Good 1986).

Kurz et al (2012) believe that for many students with disabilities, including students with VI, the intended curriculum of the general student population may be viewed as boring, irrelevant or unfair and some students may choose to expend limited effort, despite having the knowledge and skill to be successful. Mehan (2008) in Kurz et al (2012) stated that students' unwillingness to participate comes from their assessment of the costs and benefits of playing the game. "It is not that schooling will not propel them up the ladder of success, it is that the chances are too slim to warrant attempt" (Mehan 2008:57). Visually impaired students may despair if they feel they will have limited chance to progress. Students with disabilities and low-achieving students may adopt learned helpless behaviours characterised by unwillingness to engage in tasks because the student believes that effort is meaningless and failure is predetermined (Seifert 2004).

Kurz et al. (2012), in their discussion of the challenges encountered by students with VI, singled out the issue of alignment between the intended and the assessed curriculum. Webb (1997) in Kurz et al. 2012:38) defines alignment as "the extent to which expectations (i.e. standards) and assessments are in agreement and serve in conjunction with one another to guide the system toward students learning what they are expected to know and do". What this means is that an aligned test must comprise items that sample exclusively across the constructs expressed in the intended curriculum which students have the opportunity to learn during the classroom instruction. Kurz et al (2012) concur that the inclusion of students with disabilities into the existing large-scale assessment system can present challenges because their intended curriculum often differs from that of the general student population.

At the system level, Kurz et al (2012) talk of the intended curriculum, which is analogous to our own syllabus document. At the teacher level, Kurz et al. talk of the planned and the enacted curriculum. In the planned curriculum the teacher makes the plans for covering knowledge and skills prescribed in the syllabus. If the system is well-aligned, teachers can focus their planning and teaching on the intended curriculum. But due to pressure from authorities whereby schools and teachers are ranked according to pass rates, as is the case in Zimbabwe, misalignment between the intended and assessed curriculum could be the result, whereby teachers feel compelled to limit their instruction to the assessed curriculum. This is so because teacher effectiveness is based on student test scores or pass rates. For students with VI, the enacted curriculum requires particular attention since this group of students may encounter instructional deficits related to low expectations, variable quality of instruction, inadequate opportunity to learn the standards-based curriculum and inaccessible instruction not properly adapted to meet student needs (Kurz, Elliott, Wehby and Smithson 2010; Ketterlin, Geller and Jangochian 2011, in Kurz et al 2012).

At the student level, Kurz et al (2012) discuss the engaged, the learned and the displayed curricula. Kurz et al posit that the intended curriculum translates into the engaged curriculum which represents those portions of the enacted curriculum during which students were engaged. They argue that students' curricular engagement, or lack thereof, represents another challenge of inclusive assessments and accountability. Fisher et al (1980), posit that student engagement in instruction can range between 50% and 90% of allocated class time. For students with VI, disengagement is an area of concern due to multiple factors including varied instructional needs, behavioural concerns and passive seatwork activities dominating instructional time (Vaughn, Caleman and Bos, 2002).

The issue of access to the intended knowledge and skills which are tested in examinations also represents an essential aspect of fairness in testing and an important piece of validity evidence for test score interpretations about the extent to which observed achievement can be attributed to teachers and schools (Kurz et al 2012). The standards for Educational and Psychological Testing (AERA, APA and NCME 1999: 76) had this to say concerning

curricular access:

> Achievement tests are intended to assess what a test taker knows or can do as a result of formal instruction…When test takers have not had the opportunity to learn the material tested, the policy of using their test scores as a basis for withholding a high school diploma, is viewed as unfair,

Sileo and van Garderen (2010) consider the fate of students with disabilities who are now educated in general classroom settings as a result of the implementation of the No Child Left Behind Act of 2001 and Individuals with Disabilities Education Improvement Act of 2004 in the United States of America. Many of these students struggle academically in various subject areas, including Mathematics. Sileo and van Garderen (2010) encourage the creation of optimal learning opportunities for everyone since the emphasis in education is to ensure that all students learn. They suggest that the combination of research-based instructional practices in Mathematics and co-teaching models may create powerful learning environments that might enable all students to develop mathematical understanding. They argue that coteaching is an instructional delivery model applicable to teaching students with disabilities in least restrictive integrated classroom settings in which general and specialist educators share responsibility for planning, delivering and evaluating instructional practices for all students.

General educators have a knowledge of the curriculum while specialist educators have a knowledge of instructional processes for students who learn atypically. Co-teaching is a means of providing the desired learning and teaching outcomes that can benefit both students and teachers. Sileo and van Garderen (2010) conclude that, although co-teaching structures can enhance student learning, it is also important to consider the subject matter. General and specialist educators can work together to blend their knowledge bases. This relationship is invaluable because it weds content and strategy specialists and allows teachers an opportunity to meet all students' mathematical learning needs. "The greatest premise of co-teaching is the teacher's ability to provide academic and behavioural support for all students" (Sileo and van Garderen, 2010: 15). Unfortunately in developing countries such as Zimbabwe, the economy cannot support a multiplicity of teachers in the form of general and special teachers. So the students' opportunity to learn becomes compromised.

Bass (1993) points out that the curriculum was still organised in ways that prevented many students from gaining access to the Mathematics that they need. Bass brought in an element of what students need rather than what is given to them, irrespective of the relevance. The curriculum should consist of what the learners find useful in their lives. This does not mean that the sole intention of the curriculum is to provide students with only what they need, since this would make it narrow, but what they need can help to motivate them to want to learn. It can spark an interest in students to pursue Mathematics further than the classroom. It is important to consider what the learners with VI need so that they can find learning interesting and worthwhile, and hence contribute to an improvement in performance..

2.3.3 Other Studies on OTL

Several researches reveal that OTL can be used to aid the understanding of the teaching and learning process. It is clear that most researchers connect students' achievement with their opportunity to learn the content. Some researchers point out that the study of students' opportunities to learn provides great insights into variation in student achievement.

Researchers have described the opportunity to learn in a variety of ways. Schwartz (1995) and Scherff and Piazza (2005) maintain that OTL include the provision of curricula, learning materials, facilities, teachers and instructional experiences that enable students to achieve high standards. It also includes a teacher's reported content coverage, time allocated for instruction or instructional time that is actually used to deliver instruction. The achievement of students is not a simple issue, for learners perform differently even under the same conditions. Some learners may not recognise the opportunities offered to them to learn because of other reasons that impact on them socially or otherwise. Scherff and Piazza (2005) bemoan the fact that the indicator of whether a school is considered successful is usually student achievement scores, yet a single score can mask the complexities of teaching and learning, as well as the factors that impact on test results. The concept of opportunity to learn (OTL) can, therefore, guide the assessment of schools and place them in proper perspective, especially when striving not to leave any child behind.

The USAID paper (2008) identifies eight crucial elements that create what they refer to as a basic opportunity to learn. These elements are; total instructional time, the hours in a school year and days that the school is open, teacher attendance and punctuality, student attendance and punctuality, the teacher-student ratio, instructional materials per student, and the classroom time spent on the tasks and skills taught per grade. Hence, without a strategy to monitor these elements closely, and directing funding to ensure that a minimum level is attained, children cannot be provided with a basic opportunity to learn. The USAID paper further argues that the basic OTL index starts from a relatively simple premise that learning is to some degree a function of time and effort. Without adequate time on task, no learning is possible. Investments in teachers, materials, curricula, and classrooms are wasted if they are not used for a reasonable period of time. Therefore there is a direct relationship between learning and OTL.

Cueto, Ramirez and Leon (2005) note that the difference between what is intended and what is implemented is due to many factors. These factors include the fact that the curriculum is too long, the students do not master some of the competencies and so the teachers do not have sufficient time to cover them all, the teacher may have different priorities regarding what should be taught, or the teachers do not have the educational material needed to teach some competencies (Cueto et al., 2005). Our understanding of the causes of poor performance by students with VI may become clearer if student achievement is related to the opportunity to learn, regardless of family background. It becomes a more relevant issue to consider what happens in the classroom, that is, the teacher's teaching practices and the quality of the delivery of lessons, for these can be changed or improved (Stevens, 1993).

2.4 THEORETICAL FRAMEWORK

It is generally understood that students with VI do not perform as well as sighted students especially in Mathematics. Students with VI do not seem to get the same OTL as their sighted peers due to a number of reasons. According to the CIET (1999: 219), some of the reasons for this discrepancy are that:

> To begin with, most children with VI are still kept in homes away from the public eye such that when they are finally taken on board they are well above the age of their classmates

due to lack of knowledge of Braille. Belay (2005) confirms this assertation about some African and Asian nations whereby disabilities are consigered as some form of a curse or punishment and so they hide their disabled children. hideWhere some have had the opportunity to attend school at an early age, the resource units established at their schools are not fully equipped due to financial challenges faced by the government.

Secondly,There are not many teachers professionally qualified to teach students with VI. Those that have specialised are deployed (after in-service training)to their original schools after qualifying even if there is no need for a specialist teacher. The newly qualified diploma holders were not effective in their areas of specialisation.

Then there are not enough resources (textbooks, braille writers, computers, etc) to go round and finally, students with VI are given the same examination as the sighted regardless of their circumstances (e.g. diagrammatic images for Mathematics).

These factors impact negatively on the education of children with disabilities and specifically on children with VI who are learning mathematics. The researcher believes these students encounter more problems in Mathematics than in other subjects. They have to learn extra braille, to develop good listening skills and good memory in order to get by in Mathematics lessons.

It is a fact that ‘doing Mathematics’ involves working out problems on paper. Because there are so many symbols and formulae to deal with in Mathematics, merely listening to the teacher teaching does not help the student to acquire Mathematics concepts. Mathematics requires exactness, definiteness, totality and comprehensibility of presentation, so oral communication becomes very arduous (Kohanova, 2006). Even the sighted students face challenges when they have to just listen to the teacher, they have to write something. Oral communication has to be supported by text or pictures. These issues call for the teacher to be well versed in supporting student engagement in a Mathematics lesson. The study agrees with Kohanova (2006) who believes that the process of acquisition of knowledge by non-sighted students is different from that of sighted students. Kohanova describes the sort of interactions which take place in an integrated setting between

- teacher and the knowledge to be taught,
- teacher and non-sighted student,
- non-sighted student and knowledge to be learnt,
- Tutor and non-sighted student (involving individual help),
- Non-sighted student and sighted student (which involves cooperation).

All these interactions have a bearing on how the student with VI can learn Mathematics.

The main theory that guides this research emphasises the interrelationship between learners and contexts, and specifically posits that learning is a function of what people do given what they have opportunities to do (Greeno & MMAP, 1998; Gresalfi, 2009), in Gresalfi, Barnes & Cross (2011). Grasalfi et al. base their theory on Ecological psychology by Gibson (1979). Ecological psychology claims that what happens in any particular moment is based on a constructed set of actions defined by the *affordances* of the environment for a particular action, the intention of the agent to take up the *affordances* and *effectivities* of the agent to actually realise these affordances. Affordances refer to the set of actions that are made possible by a particular object, what, in the context of this research could be refered to as opportunity to learn. They further explain that the extent to which an affordance can be acted on has to do with one's effectivities, that is, an individual's ability to realise those affordances. In other words, there is a possibility of missing out on opportunities that may be made available to learners.

Gresalfi et al. (2011) describe how particular moves by the teacher might become affordances for particular forms of engagement for students. The forms of engagement considered were procedural, conceptual, consequential and critical engagements. They analysed an ecological framework together with the conceptualisations of engagements by considering how the kinds of instructions teachers give, the structure of whole class discussions and more importantly, what teachers emphasises in those discussions which might make the particular forms of engagement more or less likely for students. Their analysis has to do with everything that goes on in a lesson, which is what this study shall be looking at during lesson observations. The objective will be to assess how the OTL or affordances impact on student understanding and ultimately on performance in Mathematics. It is important to note that an affordance can only be afforded if it can be recognized and acted on. Greeno and Grasalfi (2008) posit that what makes an affordance actionable is inherently a dynamic relation between the environment and the person. The focus here is on interaction, which presupposes that a particular task might make something possible but does not make it obligatory.

This study will take the same line of enquiry as was done by Gresalfi et al. (2011) since part of the methodology being used here involves observing interactions between the teacher and the students with VI in a classroom situation. Hebert et al. (1997), in Gresalfi et al. (2011) describes five critical features of classrooms, namely, the design of tasks, the role of the teacher, the social culture that develops, the kinds of tools available to support learning and the importance of creating equitable opportunities to learn. This study focuses on all five features since they are seen to contribute to OTL and to influence the performance of students.

There is no doubt that task design is a key affordance for supporting student engagement. Stein, Smith, Henningsen and Silver (2000) in Gresalfi et al. (2011: 251) observe that tasks can support particular forms of cognitive engagement ranging from low-level engagement, for instance, those that require rote learning or memorisation, to those that support more sophisticated forms of engagement (referred to as 'doing math'). Hence they conclude that for students to engage deeply with Mathematics content, they must be given tasks that create opportunity for such engagement. They add that teacher practices such as the kinds of questions they ask, the ways they organise student work and how they frame activities help to shape the ways that tasks are implemented, resulting in a ultimate engagement. The type and quality of classroom discourse shape the kinds of learning and the depth of understanding that is realised in a classroom (Ball, Lubienski & Mewborn 2001; Carpenter, Franke & Levi, 2003). Literally what it boils down to is that the design of a task together with the way its implementation is supported can constitute opportunity to learn mathematics.

Besides the ecological theory, the researcher also refered to the works of Raymond Duval and that of van Hiele. Having realised the problems that students with VI encounter in dealing with questions on geometry, the researcher feels it is prudent to consider the plight of these children with VI in light of the van Hiele model of the development of geometrical thought; and Duval's model of geometrical reasoning. Geometry makes up about half of the 'O' level syllabus content and for student to pass they need to have a good grasp of both the algebraic and geometrical concepts. Jones (1998) says the van Hiele model of thinking in geometry is a teaching strategy based on levels of thinking commonly referred to as the van Hiele levels. This model fosters the idea that students' initial curricular encounter with geometry should be of the intuitive, explanatory kind (van Hiele 1986 : 117). The learner then progresses through a series of levels characterised by increasing abstraction. The levels are

- Visualisation (the student recognises individual shapes),
- Analysis (shapes become bearers of their properties),
- informal deduction or abstraction (the student develops relationships between and among properties, properties are ordered) ,
- deduction (students prove theorems and are able to work with abstract statements) and
- rigour (students understand the relationships between various systems of geometry, can compute, analyse and create proofs). (Gujarati, 2014).

Gujarati (2014) explains that the van Hiele levels do not explicitly tell teachers how to teach geometry, but can help teachers to assess the level their students are working at by looking at some of the characteristics of that level. The geometrical levels are sequential and students must progress though them in order. Progress through the levels is more dependent on the instruction received rather than age or maturation.

On the other hand, Duval (2006) says that to understand the difficulties that many students have with comprehension of mathematics, we must determine the cognitive functioning underlying the diversity of mathematical processes. We need to understand the cognitive systems that are required to give access to mathematical objects, and whether these are common to all processes of knowledge or they are just specific to mathematics.Duval 2006: 104) further says that "research about learning of mathematics and its difficulties must be based on what students do by themselves, on their productions, on their voices".

A close analysis of the works of van Hiele and of Duval reveals that there are lots of similarities in the way students learn geometry. The two models together with the main framework, the ecological framework, are considered in this research as providing a strong basis on how students with VI can successfully learn Mathematics. The ideas presented in the models were used during he collection and analysis of data to gain an insight into how OTL impacts on performance by students with VI in Mathematics. In the next section I describe how students with visual impairment are exposed to educational opportunities in different parts of the world.

Gauvain and Cole (1997), in describing Vygotsky's idea of interaction between learning and development comment that when we determine a child's mental age by using tests, we are dealing with the the actual development level. When the child is subjected to some scaffolding such as repetition, offering leading questions or initiating a solution and having the child complete it, then the child gets to a higher level of operation. Vygotskian principles on the zone of proximal development is best understood as the difference between what a learner can do without help and what he or she can do with help. In Vygotsky's perspective, the role of the teacher is mediatingthe child's learning activity as they share knowledge through social interaction. Scaffolding refers to the way the adult guides the child's learning through focused questions and positive interactions. This approach is a particularly useful approach when dealing with students who are visually impaired.

2.5 EDUCATION FOR STUDENTS WITH VISUAL IMPAIRMENT

2.5.1 Educational provisions

Mangal (2007) and Herward and Orlansky (1988), report that in the USA, educational alternatives for students with VI include residential (special) schools and regular public schools. In a residential school, the blind learn on their own, while in the regular school they learn together with sighted peers in what is referred to as inclusive settings. Supportive help for the students with VI is usually given by an itinerant teacher-consultant. This specialist teacher may be expected to perform the following roles among others: instruct the students with VI directly individually or in class; prepare specialised learning materials; translate reading materials and assignments into Braille, large print or tape recorded form; or arrange for readers, and interpret information about the child's visual impairment to other educators and parents. Public schools have resource rooms where the students with VI in integrated settings receive specialist help.

In the UK, the number of special schools has dropped drastically and it was predicted that they would fall further. Hergarty (1993: 188) observes “Special needs provision is considered an entitlement and, both the moral imperative and current legislation, require that it should be made in the ordinary school to the greatest extent possible”. There was a lot of speculation on the new Info-Tech, (IT), developments and their magical qualities, as Hergarty (1993: 193) puts it, “we marvel that the blind can see and the deaf hear”. What Hergarty meant was that through information technology, the blind and the deaf now have access to programmes that were privy to the sighted. For instance, the VI and the hearing impaired individuals can now use a cell phone , a computer and can even ‘watch’ (listen to) a movie.

In Zimbabwe, the Government has put in place legislation through the Zimbabwe Education Act (1987) to ensure the disadvantaged population have access to education. The Disabled

Person's Act 17.01 of 1996 administered by the Department of Social Welfare, the CIET (1999) and various circular minutes issued by the Secretary for Education, specify issues of access to education, placement procedures to special classes, resource units and special schools for children with disabilities, including visual impairment.

Investigations by the CIET (1999) revealed that the current situation was that of integration where children with disabilities are deliberately brought together with non-disabled children in the areas of visual, hearing and mental impairment. These children are taught formally at primary school level, while some private and church or trust schools offer special education at secondary school level mostly for students with visual or hearing impairment. This was confirmed by Chimedza and Peters (2001) who reported that education for children with VI was started by Dutch Reformed Church missionaries at Chibi Mission in 1927. That school was then moved to Copota and renamed Margareta Hugo School for the Blind after the founder. Later on, another non-governmental organisation (NGO), the Jairos Jiri Association, started to offer education to blind students in the late 1940s.

The braille needs of the common people were being supplied by private organisations and NGOs such as the Dorothy Duncan Centre and the Council for the Blind. The Nziramasanga Commission established that the National Braille Press was not operating to capacity. In spite of all the provisions put in place to accommodate students with VI, it is common knowledge that very few of these students pass Mathematics, or proceed to university or training colleges. To date none has done Mathematics at either college or university level. The Commission further explains that education for the disabled, including those with VI, has been taken as a charity issue and not as a right. They point out that this was evidenced by the lack of clarity on the part of the Education Act (1987) on Special Education, which has resulted in a situation where there is inadequate provision of equipment and materials for Special Needs Education in the schools.

The students with VI or hearing impairment (HI) were initially taught crafts which included basketry and mat-making for boys and sewing and knitting for girls, as well as music. The subjects were however increased after independence in 1980 to include braille, mobility, typing and all the other school subjects, including Mathematics. The Chief Education Officer's Circular number 3 of 1989 spells out the curriculum in Special Education with emphasis on appropriate teaching techniques and adapting to the child's special needs. Despite this circular, most special schools continued to use the same curriculum as that used in regular schools, resulting in poor academic results among children with special needs.

The CIET (1999) discovered that many children with disabilities were being kept at home, with some of them still being hidden from society by their parents or guardians. It was reported that some parents/guardians confessed that they did not know where they could obtain help for their children but others showed negative attitudes by not accepting disability as a normal natural occurrence. This was confirmed by the Zimbabwe Association for the
Visually Handicapped (ZAVH) officers in 2013 when they visited two districts in Masvingo Province, where there were lots of disabled children, including albinos, who were being kept at home, away from the public eye. This finding also confirms what Linder (1983) reported about parents of handicapped children, that some parents had confessed that they passed through stages of grief similar to the stages of mourning that are associated with one's own dying or the death of a loved one. Linder goes further to say that these parents mourn the loss

of the expected normal child and the birth of a handicapped child. Linder adds that these parents pass through stages of denial and isolation, anger, bargaining depression and finally acceptance. So, depending on the stage at which the parents are, some may not be in a position to raise a disabled child, let alone cooperate with school authorities to help the child.

Until the time of the CIET (1999), training for Special Education Teachers was being done at one Teacher Training College, the United College of Education. These teachers were trained for twelve to sixteen months and were awarded a Diploma in Special Education. On completion, the teachers were deployed back to their original schools even if the school did not need a specialist teacher, so their skills were wasted (Chimedza and Peters 2001). Meanwhile, at special schools there were non-specialist teachers who were not interested in going for specialist training and the children would suffer. In an earlier visit to the school under study, the researcher noted that the secondary school teachers were not interested in going for in-service training at a primary teachers college. Currently, however, all Primary Teacher Training colleges ensure that all trainees do some courses in Special Needs Education during initial training. Currently, most local universities like the University of Zimbabwe, the Great Zimbabwe University, the Reformed Church University and the Midlands State University, now offer undergraduate and postgraduate programs in Special Needs Education (SNE). This trend may help alleviate the shortage of specialist teachers for students with VI.

To date, special schools exist in Zimbabwe, but yearly statistics from the Schools Psychological Services (SPS) show that there has also been a move towards inclusive education, where the regular primary schools establish what are termed Resource Units to cater for students with VI in schools close to their homes. The former special schools now accommodate both blind and low vision (partially sighted) students, of whom albinos are in the majority. But the fact that the learners have access to mathematics education does not necessarily translate into an opportunity to learn. Whatever the educational provision, whether special school or inclusive setting, it calls for a great deal of work on the part of the teacher to adapt instruction so that it benefits the students with VI. Although not every VI learner is expected to reach a high level of proficiency in Mathematics, it is important that they be afforded the appropriate opportunity to learn it.

2.5.2 Special adaptations for visually impaired students

Students with VI obtain most of their information through the senses of hearing, touch and smell. As such, these children need to systematically develop listening skills. Hergarty (1993) contends that this is an important component of the educational program for the VI children.

Herward and Orlansky (1988: 296) say “Blind people are not gifted with an extraordinary sense of touch; rather they may learn to use their sense of touch to gain information about the environment”. However, Socks (1992: 140) had this to say;

> It has been well established in blind people who read braille that the reading finger has an exceptionally large representation in the tactile parts of the cerebral cortex. One would suspect that the tactile (and auditory) parts of the cortex are enlarged in the blind and may even extend to what is normally the visual cortex……It seems likely that such a differentiation of cerebral development would follow the early loss of a sense and the compensatory enhancement of other senses.

In support of this assertion, Jackson (2002) claims that this about the blind mathematician, Bernard Morin's blindness may have enhanced his extraordinary visualization ability. He says Morin noted that "disabilities like blindness reinforce one's deficits, so there are more dramatic contrasts in disabled people" (Jackson 2002:1248). From the way the blind go about their daily tasks, one would concur with Socks and Jackson that the loss of sight seems to enhance other senses such as touch, feeling and smell. Jackson (2002) reports that the French believe that it was the mathematician Lebesgue who suggested to the blind mathematician Louis Antoine that he should study two- and three-dimensional topology, partly because "in such a study, the eyes of the spirit and the habit of concentration replace the lost vision" (Jackson 2002:1247).

Early professionals realised that the students with VI could be educated together with their sighted peers with only minor modifications and adaptations and that the limitations imposed by visual disability did not require a special curriculum (Sileo & van Garderen 2010, Gearheart and Gearheart 1988). So the students with VI follow the same mathematics curriculum as their sighted colleagues. However, theydo need compensatory skills, what Gearheart et al. (1988: 161) call "plus factors".

Blind students use Braille, which is a system of reading and writing in which letters, words, numbers and other systems are made from arrangements of raised dots, developed by Louis Braille in 1830, who was himself blind (Herward et al. 1988:306). Braille is complex; it is like some form of shorthand (Vaughn, Bos & Schumm 1996). Abbreviations called 'contractions' help to save space and permit faster reading and writing. Some say the regular classroom teacher is not expected to learn braille, but many find it helpful and interesting to do so in order to afford students the requisite opportunity to learn.

The National Council of Teachers of Mathematics (NCTM) (1989, 2000, 2006 and 2009) came up with guiding principles regarding Mathematics curriculum. The NCTM (2009) views the curriculum as being more than a collection of activities. It must be coherent, focused on important mathematics and well-articulated across the grades. The Council explains that a coherent curriculum "effectively organises and integrates important ideas so that students can see how the ideas build on or connect with other ideas, thus enabling students to learn with understanding, develop skill proficiency and solve problems" (NCTM 2009:1). Students need to realise that the different topical strands of Mathematics, such as algebra and geometry, are highly interconnected. The NCTM further add that Mathematics is important in so far as it has utility value in developing other Mathematical ideas, in linking different areas of Mathematics and in preparing students for college, workforce and citizenship. A Mathematics curriculum should provide a road map that helps teachers guide students to increasing levels of sophistication and depths of knowledge. Such guidance requires a well-articulated curriculum so that teachers at each level understand the Mathematics that has been studied by students at the previous level and what is to be the focus at successive levels (NCTM 2009).

TMe NCTM (2009: 2) further explains that students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge. Further to that, they say the topics studied in the curriculum must be taught and learned in an equitable manner, in a setting that ensures that problem solving, reasoning, connections, communication and conceptual understanding are all developed simultaneously along with procedural fluency. What the Council is saying is that:

- Students should have frequent opportunities to formulate, grapple with, solve complex problems, that require a significant amount of effort,

- Students should be able to reason by developing ideas, exploring phenomena, justifying results and using Mathematics in all content;
- Students need to think and reason about Mathematics and communicate the results of their thinking with others by learning to be clear and convincing in their explanations. Listening to others explain gives students opportunities to develop their own understanding,
- Students should recognise and use connections among mathematical ideas, like the connections between algebra and geometry. They should recognize and apply Mathematics in contexts outside Mathematics.

What then are the issues in learning Mathematics for students with VI? As was alluded to earlier on, teaching Mathematics to students with VI is essential for the same reasons that it is essential for sighted students. But Mathematics can present challenges for blind students because so many aspects and concepts of Mathematics are visual and spatial (CSBE 2006). The California Legislature recognises the importance of braille and tactile graphics as the media by which students with VI can best organise, utilise and process the concepts described by Mathematics and Science. The CSBE came up with standards which ensure that students with VI become literate in Mathematics. The CSBE (2006) asserted that with the said standards, children with VI have the same rights to rigorous studies and appropriate education as do sighted students. The Board acknowledges that multisensory experiences are needed for a blind child to maximise the use of tactile information when learning and applying mathematical concepts. Mathematics instruction is necessary for all students since knowledge of algebra and geometry is needed in order to enrol for different vocational courses, and also because day to day calculations are needed to maintain a normal life.

A student with VI uses multisensory experiences to be able to develop and organise computations, solutions and spatial relationships that involve Mathematics. A student with VI cannot take in his or her surroundings at a glance, so touching is essential. Ultimately, the student will need additional time in order to have the opportunity for tactile exploration (involving touch) of shapes, objects and graphics (CSBE 2006). Students with VI are not necessarily slow learners; they simply use a different method of learning. The CSBE (2006) recommends that tactile explorations must therefore begin in early childhood and parents need to play a key role. Parents need to introduce their blind children to simple tactile shapes and objects and braille material from an early age as the case is with sighted children.

Students with VI encounter unique challenges in the learning of Mathematics. These students need to learn to use the Nemeth Code for Braille Mathematics and Science which allows students with VI to braille all necessary mathematical symbols. According to Osterhous (2002), cited in CSBE (2006) the Nemeth Code is often not taught to the blind students as they progress through the lower levels of Mathematics classes, and this creates problems as the students progress into Algebra. It therefore means that students with VI need to learn first the ordinary braille and then the Nemeth Code in order to be successful in mathematics. This additional load could be one reason why most students with VI shun learning of Mathematics when the Nemeth Code is presented later at secondary school level.

The CSBE (2006) notes that teaching and learning of mathematics in a tactile mode is as essential for a child with VI just as teaching and learning of prior Mathematics is for a sighted child. They further note that since traditional mathematics relies heavily on visual, spatial and abstract concepts that are particularly challenging for the blind tactile learners, so instruction and materials in Mathematics for blind learners must take these differences into consideration and ensure that learners have access to precise mathematical information in a tactile mode.

Of late, African countries such as Ethiopia,have developed technology reseouce centres for the blind (Belay 2005). Such centres are mostly develop by non-governmental organisations.

2.5.3 Adapted Educational materials and equipment

Materials for students with VI must be provided in different media or in modified form so that the students can learn through other sensory channels other than vision. For those who cannot read material in print form, it can be provided through the tactile (touch) or auditory channels. If the student can read print with difficulty, the material may be enlarged or the student can use magnifying devices or reading machines.

Mathematical Aids for blind students include the Cramer Abacus (adapted to assist blind students to learn number concepts and making calculations), raised clock faces, geometric area and volume aids, wire forms for matched planes and volumes, braille rulers, compasses, and protractors. For more advanced Mathematics functions, the students may use SpeechPlus talking calculators which talk by voicing entries and results aloud and also presenting the material in digital form visually. Talking clocks and spelling aids are also available. Three dimensional (3-D) models can also be used where the blind can actually manipulate the objects. In addition to textbooks and specially adapted materials from an agency, there is always need for teacher-made materials used on a day to day basis, such as, teacher made tests, worksheets, and special games and activities. These must be reproduced in the desired form by the resource teacher.

For basic writing, the students with VI use the Braille writer (Perkins machine) or the slate and stylus. This braille writer is a six key machine corresponding to the 6-dots in braille cell, operated manually to type Braille. Students have to be taught how to use a slate and stylus when they start primary school. This is the basic writing tool for students with VI and it is the cheapest. The teacher may use raised line drawing board and raised line paper to draw geometric shapes, script letters and diagrams for use by the students.

However, students with VI encounter problems when it comes to correcting work written using a slate and stylus or on the Perkins machine. The slate is like a double-paged paper, the upper side having holes while the underside is plain. Students write by putting braille paper between the two pages and punching holes from right to left using the stylus. If a student makes an error or wants to check on what has been written, one has to remove the paper from the slate or braille writer, turn it over and read the dots with the fingers from left to right. The paper is then returned into the slate to continue writing, but there is no way the student can tell exactly on which line he/she stopped writing. So there is a danger of either writing new stuff on top of what was written before, or leaving too big a gap between the lines. In correcting an error, the student is not able to cross out the wrong work that has been written in order to write the correct thing, as is done with ordinary writing (print). He or she would have to start writing the wrong part all over again. The process of correcting or revising written work may call for more time, which is why the CSBE (2006) advocated for at least as much time as is needed by sighted students.

Students may use tape recorders for taking notes, formulating compositions, listening to recorded texts or other recorded programs. They can also use portable braille recorders which may be interfaced with a computer that will convert braille to standard print or vice versa. Where there is adequate funding, the school can purchase a number of IT gadgets that can make the life of a student with VI easier. According to Gearheart et al.(1988: 162), such equipment includes among others :

- speech compressor or modified tape recorder which compresses the material and speeds up the listening process;
- the Optacon, an instrument that scans printed material electronically and raises the print feature so that it may be read tactically;
- talking calculators which present results visually and auditorily;
- the Kurzwell reading machine, a computer based device which provides direct access to typed or printed material by converting it to synthetic speech. The speed and tone can be controlled and the machine can spell a word, letter by letter.

Low vision students may benefit from special optical aids such as glasses, contact lenses, small telescopes or magnifiers and books that are available in large print. However, in this study, the researcher targets students who are completely blind.

Susan Osterhaus of Texas School for the Blind observes that teachers of the VI need to be aware of the different kinds of technology available and be able to teach students how to use them. It is necessary that the regular classroom teacher has a basic understanding of the various kinds of tangible apparatus to ensure their proper use and thus maximise their value to the student. In so doing, the teacher will provide students with an opportunity to learn.

2.5.4 Teaching strategies and adaptations

Wood (1998) defines a teaching technique or strategy as a method of imparting knowledge, skills or concepts to a learner. Wood cites mastery learning as one of the major techniques. Mastery learning, according to Woods (1998), is a way of monitoring student progress so that teachers can "certify competence of learners […] diagnose individual learning difficulties and prescribe specific remediation procedures" (Wood 1998: 315). Wood further explains that mastery learning works well with students who have mild disabilities because it allows the teacher to individualise instruction within the group setting of the regular classroom.

Belson (2012) asserts that general approaches to teaching students with VI include tactile representations, audio aids, tonal representations, haptic devices and integrated approaches. Reading and writing texts in print is completely different from reading and writing Mathematics. Mathematics can be considered a language on its own, it is important to establish how visually impaired students learn Mathematics. So how do students with VI learn mathematics?

Tactile representations are used to represent texts with raised characters as per traditional sixdot Braille. This has limitations in character set and also presents a more difficult way of representing equations. There can only be sixty four characters with the traditional braille, and these can be extended to the 8-dot system which will allow for 256 characters (Herward and Orlansky 1988). Professor Abraham Nemeth, a blind mathematician and Computer Science professor, developed the Nemeth Braille system in the 1940s, to represent Mathematics in tactile form, as well as a spoken structure for reading equations (Jackson 2002). The Nemeth code employs the ordinary six-dot Braille codes to express numbers and mathematical symbols, using special symbols to set mathematical material off from literary material. Jackson (2002: 1250) contends that:

> The Nemeth code can be difficult to learn because the same characters that mean one thing in literary Braille have different meanings in Nemeth. Nevertheless it has been extremely important in helping blind people, especially students, gain access to scientific and technical material.

So in addition to learning the normal braille, students with VI have to learn extra braille Mathematics notation, the Nemeth code, the code which is used to represent the various mathematical signs and symbols. The Royal National Institute for the Blind (1989) developed a table of braille signs and advised that in a few cases, however, more than one braille sign may have the same print equivalent and, for these, the correct braille sign should be used according to the meaning or use stated in brackets on the table of signs. This calls for a lot of effort on the part of the students with VI and may constitute cases of missed or lost opportunity to learn, hence the majority develop a negative attitude towards Mathematics and may drop the subject.

Gearheart et al. (1992) note that it is generally not necessary for the classroom teacher to significantly change teaching strategies to accommodate a student with VI. It may,, however be helpful to consider a few suggestions that have been found to be effective, especially in inclusive settings. Whenever possible, instruction should start at a concrete level. It should start with concrete materials, moving more to the abstract as students develop the concept. The use of manipulative, tangible or auditory material is preferred to totally verbal instruction, especially in m Mathematics and Science subjects. In Arts subjects, the students can tape record the lesson and listen to it later. In Mathematics, hands-on learning should be emphasised as much as possible, and students may need repeated contact with objects. Although a model may be necessary as a teaching/learning aid, a real object or situation is much preferred. The resource teachers could assist in obtaining actual objects or making models. Gearheart et al. (1992) also stress that experiences that are unified can help students to form concepts. These authors claim that a trip to a clothing factory or store, supermarket, restaurant, record shops, can provide a basis for reinforcing and unifying concepts related to quantity, money, percentages, size, shapes, and social skills, and ultimately provide opportunities for integration. The experience could, for instance, assist the learner to appreciate topics such as linear programming and transformations that most students, including the sighted, shun. Learning by doing and teaching by unifying experiences are particularly important for VI students because some students may not have the same experiential background as other sighted students of the same age.

Seeing that most VI students learn in integrated settings, it means when writing on the chalkboard, the teacher should be certain to explain verbally the concepts or actual writing being presented, for the benefit of those who cannot see. The teacher should be as specific as possible when giving instructions and possibly repeat the instructions to allow the students with VI to internalise.

Visually impaired students need extra time to complete assignments and examinations. Vaughn, Bos and Schumm (1996) state that some systems allow time and a half or double the time, while others, like in Zimbabwe, give an extra 25% of the time allocated for examinations, the adequacy of which may be subject to debate. It is clear that reading braille takes

considerably longer than reading print, and it is worse when a student has to revise what he/she would have written in braille. There is no room for correction when writing in Braille.
In fact, the student has to write afresh, hence it is necessary to extend time for examinations. Assignments may, however, be completed in a resource room or at home at the student's own pace.

In developed countries like the USA and the UK, it may not be necessary for the classroom teacher to learn braille since the itinerant teacher can write or print whatever has been written directly above the dots. However, in third world countries like Zimbabwe, where the economy cannot afford a resource or itinerant teacher, it may be necessary for teachers of the students with VI to learn braille since they have to mark students' work on their own.

Wood (1998) observes that making appropriate adaptations of the learning environment, format of content, teaching techniques and testing procedures may enable the student with special needs to be graded according to the same methods used for other students in the classroom. The NCTM (1988) stipulated that during test construction, instructions for the students with VI need to be short and simple and given at the beginning. Test items need to be adapted so as to make them more appropriate for students experiencing difficulties, not to water down the test. When designing the test items, there is need to use items that reflect techniques used during teaching. Manipulative objects that make the problems more concrete for the blind students, and coloured pictures for the partially sighted could be provided. Certain key words may need to be underlined and formulas may need to be given as reminders of operations to be used. In all cases, the teacher should avoid use of wordy problems which may be testing language and measuring skills above the level of the learner (NCTM 1988). These measures are suggested to ensure provision of appropriate opportunities to learn mathematics.

Wood (1998) suggests that the learning environment, both the socio-emotional and the behavioural, also need to be adapted. Teacher attitudes and expectations, student attitudes, social adjustments, behaviour management and motivation of students, are issues that may drastically affect the performance of learners if the right tone is not set, or if the right opportunities are not availed.

There are a number of problems that students in general encounter in learning mathematics which become more pronounced for students with visual impairment. Obstacles that students with VI may encounter in learning Mathematics include time for instruction, where it is felt that it is vital for children learning Mathematics in a tactile mode to at least have as much direct instructional time as children learning through sight have. There is also a problem that some professionals, parents and even children who are visually impaired believe braille is a second class medium unable to provide the same access to learning that print provides.

Usiskin (1996), in Rubenstein and Thompson (2001), talks of mathematical symbols as the means by which we write and communicate mathematical meaning. Pimm (1991), in Rubenstein and Thompson, (2001) identifies several functions performed by symbols. The author notes that symbols illustrate the structure of mathematics, help make manipulations routine, enable reflection about Mathematics and facilitate compactness and permanence of thought. But the symbolic language of Mathematics often challenges students. Students who cannot communicate by using standard symbolism will at some point be hindered in their mathematical development (Rubenstein and Thompson 2001). It is therefore imperative that high school and college teachers be sensitised of the challenges that students often have with mathematical symbols and be advised to come up with instructional strategies that could reduce such difficulties. The study's contention is that the problems that are encountered by sighted students in regard to use of mathematical symbolism affect students with VI as well, if not more since students with VI have to learn braille twice. First, they learn ordinary English braille, and then they have to learn the Nemeth code.

Rubenstein and Thompson (2001) suggest instructional strategies that can help students to read and use mathematical symbols. They advise that teachers must be aware of the difficulties that symbolism creates for students. Mathematical symbolism is largely limited to the Mathematics classroom hence "opportunities to use that language should be regular, rich, meaningful and rewarding" (Rubenstein and Thompson 2001: 268).They suggest we be guided by Bruner's (1960) theory that learning should proceed from the concrete to the abstract. On use of language strategies, Rubenstein and Thompson (2001) suggest that when symbols are first introduced, a useful strategy is to 'say and write' the notation, emphasise relevant issues of placement and order and give students a chance to read and record symbols, including recording in English how to say it and to give examples of its use. One example they gave is that students can record in '$\log_2 8$' in symbols, which, in English is read as 'log of 8 to base two', Some students may read it as 'log of 2 to the eighth ($\log 2^8$), which is completely different. It may be worse for the student with VI who has to translate to braille.

The International Committee for Education of People with Visual Impairment, (ICEVI, 2005) identified factors which contribute to a child's success in learning mathematics and suggested learning approaches that could be used to enable students with VI to get the required learning experiences. They stated that teaching the Braille code should start as early as possible from primary level. They added that it is not necessary to teach the whole Mathematics code at the same time and suggested that these could be taught as and when they are required in the lesson. They further suggest that when a child has completed the writing of the code, he/she can be given a prepared Mathematics passage and be asked to read it as this may enable the child to know how to discriminate the Mathematical braille code from the literary code. This idea is in line with what Rubenstein and Thompson (2001) suggested that when symbols are first encountered, students should be given a chance to read and record the symbols.

Another strategy suggested by the ICEVI (2005) is to adapt or substitute learning experiences for the students with VI so as to derive maximum understanding of the concept while keeping the expected outcomes at the same level with sighted students. It is commendable to develop mental arithmetic abilities in students with VI. This activity will require systematic instruction, practice and application. The ICEVI believe that prolonged training and practice in performing mental calculations help children to acquire the mathematical mind that is essential for problem solving analysis of information and ascientific approach in performing day-to-day activities.

Mathematics texts need to be availed in braille form and the teacher can prepare portions of the text which is to be taught in a particular class period. Provision of concrete materials is most important as it guides students in remembering various steps of a problem and procedures for arriving at results. Mathematics is a subject which is to be practised continually if one wants to have mastery over it. It demands a lot of attentiveness, reasoning ability, skills in problem solving and ability to draw conclusions. With the development of various devices and methodologies, children with VI can also learn mathematics effectively (ICEVI 2005).

The ICEVI (2005) underscore the importance of three-dimensional (3-D) aids and the need and nature of improvisation of aids in the teaching of children with VI particularly in mathematics. Certain aids which are available for sighted children have to be adapted to suit the needs of children with VI. The concept of tactile attraction needs to be emphasised. Diagrams made on charts can be adapted by pasting sandpaper of different textures. The students with VI require a variety of aids so as to maximum their opportunity to learn.

The ICEVI (2005) add that,, in many cases students with VI do not have access to a teacher who is knowledgeable in the Braille Mathematics code and in how to teach it, and also one who is well versed in the specialised methods and materials for teaching Mathematics in a tactile mode. Most teachers of children with VI, particularly in Zimbabwe, need access to inservice training to enhance their college preparation activities.

The age of onset of blindness is another factor that impacts on learning of Mathematics by students with VI. Children become blind at different times in their lives, so they may need to learn beginning braille Mathematics code at any age or at any grade level. This presents additional challenges for both the teacher and the student. This problem, however is not the one being investigated in the current research.

The quality of Braille mathematics material is another cause for concern for students with VI. There is need to have knowledgeable certified braille transcribers the proofreading skills to ensure transcription is perfect. Such personnel are not easily available in schools.

2.6 SUMMARY

The chapter has defined the concept of visual impairment. An analysis of what OTL is and how it can be applied to enhance learning of Mathematics by students with VI was made. The theoretical frameworks that guide the research were also explained. The chapter ended by considering educational provisions for students with VI, special adaptations and strategies for teaching students with VI. It is from these that will make inferences on the methodology to be used to gather data and analyse the information to come up with conclusions and appropriate recommendations. The next chapter discusses the methodology to be used.

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

The previous chapter reviewed of literature related to this study. The literature included theories related to the learning of mathematics and the theoretical framework. Chapter 3 describes the methodology employed in this study to investigate the opportunities to learn mathematics accorded to students with visual impairment in Zimbabwe. The topics that are dealt with in this chapter include the qualitative research paradigm, the case study design and the research instruments used. The chapter also describes the population, sample and sampling procedures, the research sites, participants and the data collection and data analysis procedures. The chapter ends with a discussion of the validity, reliability and ethical considerations.

The major research question of this study was:

How are opportunities to learn Mathematics provided for students with visual impairment?

The sub-questions that guided the investigation are:

1. How are students with visual impairment exposed to Mathematics in the classroom?
2. How is time on task exploited by both teachers and students with visual impairment in the classroom?
3. What modifications, in terms of teaching strategies, do teachers make when teaching students with visual impairment?
4. What intervention strategies can be employed to maximise opportunities to learn mathematics by students with visual impairment?

3.1 RESEARCH DESIGN

3.1.1 Qualitative Research

The qualitative research paradigm was found to be appropriate for this study since the study sought to explore the opportunities to learn Mathematics that are accorded to students with visual impairment. The aim of the study was to gather data from the participants themselves. The participants were supposed to narrate their experiences and interpretations of the opportunity to learn. Gray (2009: 166) propounds that "qualitative research is highly contextual, being collected in a natural, real life setting, and often over long periods of time". This means the researcher had to spend days at the sites in order to collect real practical data.

The role of the researcher was to gain a “deep, intense and holistic overview of the context under study, often involving interaction within the everyday lives of the individuals, groups, communities and organisations” (Gray, 2009: Punch, 2005: 186). The researcher interacted with both the VI students and the Mathematics teachers in order to gain an understanding of the concept of opportunity to learn Mathematics. The researcher became a part of the group for the period that the research was being conducted.

The fact that the common man does not appreciate that students with visual impairment learn Mathematics is what drove the researcher to conduct this study. The choice of the qualitative paradigm was premised on its subjective nature, where the subjectivity takes experience as the sole formulation of factual knowledge. Creswell (2011) propounds that qualitative research is best suited to address a research problem in which you do not know the variables and you need to explore. In this case, the literature was not yielding much local information on how our students with visual impairment learn Mathematics, so the qualitative methodology allowed for an exploration of the perspectives of participants. Qualitative research relies on the views of participants with regards to their “thoughts, feelings, beliefs, values and assumptative worlds through face to face interaction” (Marshall and Rossman, 2006: 53). The objective of conducting interviews with teachers and students was so that they could express their own views.

3.1.2 The Case Study

The case study research design was adopted in this study. The two schools catering for visually impaired students constituted a case that the researcher investigated. Terre Blanche, Durrheim and Painter (2006: 33) describe a research design as a "strategic framework for action that serves as a bridge between research questions and the execution or implementation of the research". Stake, cited in Yazan (2015), advocates for a flexible research design which allows the researcher to make major changes even after proceeding from design to research. As an initial design, Stake suggestsresearchers deal with issues and issue questions which lead to the design of research questions. He believes the course of action cannot be charted in advance (Yazan 2015: 141).

Fraenkel and Wallen (1996) define a case study as an in-depth investigation of an individual, group or institution to determine the variables influencing the current behaviour or status of the subject of study. This statement by Fraenkel and Wallen implies that case studies do not just describe a situation, but also try to attribute causal relationships. The researcher believes that learning of Mathematics by students with visual impairment may not be common knowledge, and so the case study design is appropriate for the study.

The case study design was adopted because the objective of the study was to explore the opportunities to learn Mathematics that are characterised within a specific case or cases involving students with visual impairment. For Bromley (1990, cited in Maree, 2012: 75), "case study research is a systematic inquiry into an event or a set of related events which aim to describe and explain the phenomenon of interest". Maree (2012) adds that a typical characteristic of case studies is that they strive towards a comprehensive (holistic) understanding of how participants relate and interact with each other in a specific situation, and how they make meaning of a phenomenon under study. The case study was thus used in order to gain a rich and vivid description of events (Cohen et al., 2011:289), in order to answer 'how'

and ‘why questions concerning the opportunitieM to learn mathematics by students with visual impairment. Stake believes researchers should view a case as a bounded system and inquire into it as an object rather than a process. In this regard he suggests exclusive use of qualitative data sources, using observation, interview and document review as data gathering tools. The case of students with visual impairment is a speific, complex, functioning thing which has a boudnary and working parts and purposive, right in the classroom situation. In case study research, researchers consider the interrelationship between the phenomenon and its context, basing the study on observations in the field. Here, the phenomenon was the opportunity to learn Mathematics, while the context was the school setting in which the students and teachers interact. All case study researches start from the same compelling feature, that is, the desire to derive a closer or otherwise in-depth understanding of a single or small number of cases set in their real world contexts (Bromley
1986, cited in Yin 2012, p3). The closeness aims to produce “an insightful appreciation of the cases, hopefully resulting in new learning about real world behaviour and its meaning” (Yin 2012: 3). In this study the researcher wanted to gain an understanding of how visually impaired students learn Mathematics.

The case study allowed for generation of multiple perspectives through multiple data collection methods and through the creation of multiple accounts for a specific method (Gray, 2009:169). Patton (2002: 306) justifies the use of multiple sources by saying:

> Multiple sources of information are sought and used because no single source of information can be trusted to provide a comprehensive perspective on the program. By using a combination of methods the field worker is able to use different data sources to validate and cross- check findings.

Use of multiple data sources and multiple was meant to ensure valid and reliable data was collected, such that shortcomings of one source could be compensated by the other sources. Multiple data sources (students and teachers) and multiple methods (document analysis, lesson observations, personal interviews and focus group discussions) were used to gather data.

It would be difficult to ascertain how teachers avail the opportunity to learn without actually observing them doing it. Similarly it would be difficult to understand students' feelings on the opportunities provided without hearing it from them. Further benefit could be derived from comparing students' views to teachers' views and observations. Cohen et al. (2011) say that a case study provides a unique example of real people in real situations and enables readers to understand ideas more clearly than simply by providing them with abstract theories or principles. Triangulating the data types was done to increase validity, as the strength of one approach can compensate the weakness of another (Marshall & Rossman 1959, in Patton, 2002).

Learning of Mathematics by students with visual impairment was considered a unique case which the researcher explored with the students and teachers in real classrooms. Cohen et al. (2011) add that contexts are unique and dynamic, hence case studies investigate and report on real-life, complex dynamic and unfolding interactions of events, human relationships and other factors in a unique instance. Hitchcock and Hughes (1995, in Cohen et al., 2011), suggest that the case study approach is particularly valuable when the researcher has little control over events, that is, behaviour cannot be manipulated or controlled. In addition, they note that there may be more variables at play than the intended data points to. Lesson observations were meant to unveil more knowledge on how opportunities to learn were provided by the teachers and received by the students.

3.1 2.1 Advantages of case studies

One advantage of case studies is that the researcher can include direct observation and interviews with participants as was done in this research, which allowed the collection of data by using multiple methods (Yin 2009). Case studies strive to portray ‘what it is like’ to be in a particular situation, to catch up the close-up reality and ‘thick description’ of participants’ lived experiences, thoughts about and feelings for a situation (Cohen et al., 2011: 289). The use of interviews and observations enabled the researcher to gain an in-depth understanding of the phenomenon under investigation, which was opportunity to learn Mathematics. Case studies involve looking at a case or phenomenon in real-life context. The situation in the classroom was such that events were allowed to speak for themselves rather than be interpreted, evaluated or judged by the researcher.

Case studies are a step to action. They begin in a world of action and contribute to it (Nisbert and Watt 1984; Cohen et al. 2011). The results of case studies are more easily understood by a wide audience as they are written in everyday, unprofessional language. The results of case studies can also be interpreted and put to use by individuals or organisations for staff development purposes. It was going to be easy to capture every event that was taking place in the classroom where students were few.

Adelman et al. (1980) posit that case studies, considered as products, may form an archive of descriptive material sufficiently rich to allow subsequent re-interpretation by other researchers. This study dealt with issues of learning of Mathematics by students with visual impairment, so the insights gained from the study could form a basis for further studies by other researchers.

3.1.2.2 Disadvantages of case studies

Case studies also have weaknesses. Cohen et al. (2011) state that case studies are not easily open to cross-checking, hence they may be selective, biased and subjective. They add that case studies are more prone to problems of observer bias. This is so because of the subjective nature of qualitative research. Shaughnessy et al. (2003, in Cohen et al., 2011) comment that a case study often lacks a high degree of control and treatments are rarely controlled systematically. This renders it difficult to make inferences to draw cause and effect conclusions from the results. There is, therefore, potential for bias. Yet, researchers continue to use the case study research method with success in carefully planned studies of real-life situations, issues and problems. However, Punch (2005) argues that success or failure depends on the intention of the research. Some case studies are conducted in order to understand the case in its complexity, entirety and context. The researcher has to be clear on whether one wants to generalise from a particular case study. Punch (2005: 146) points out that there are two types of case study where generalisation may not be applicable. In the first place,:

> the case may be so important, interesting or misunderstood that it deserves study in its own right; secondly, the case may be unique in some very important respects and is therefore worthy of study (Punch, 2005: 146).

The current study involves a phenomenon that is unique and rarely understood. Many people do not believe that visually impaired students are capable of taking care of themselves, let alone learn Mathematics.

Adelman et al. (1980, cited in Cohen et al., 2011) note that case studies provide a ‘natural’ basis for generalisation. However, Cohen et al. (2011) says data from case studies is stronger in reality but difficult to organise because of the thick descriptions. Other authors such as Yin (2003) and Shuttleworth (2008) criticise the case study approach saying its dependence on a single or few cases render it incapable of providing a generalising conclusion. They argue that it is not representative enough. In this study, the case study was seen to be appropriate because to begin with, non-sighted students are in the minority of the population. Among the schools enrolling students with VI, the schools that were used for the study enrol the highest number of non-sighted students as compared to other schools. However, it would not be justifiable to generalise findings from such a study to the low population of non-sighted students. The case study was the most appropriate method, however, since generalisation was not going to be objective, particularly as Punch (2005:146) puts it, that “the case may be so important, interesting or misunderstood that it deserves study in its own right; or may be unique in some important respects and therefore worthy of study”. The case of students with visual impairment was considered unique, interesting and important by the researcher, thus warranting investigation.

3.2 RESEARCH INSTRUMENTS

Data for this research was collected in textual form on the basis of observation and interaction with participants through lesson observations, in-depth interviews and focus group discussions. The choice of these methods was informed through the knowledge that together they would provide complementary data which would be more complete than using one method. These are methods that allow the language and behaviour of participants to be captured. Gall, Gall and Borg (2007) state that research instruments are tools used to solicit data from respondents in a research. Below the researcher discusses the research instruments in more detail and how they were used to collect data for the research.

3.2.1 Document analysis

Gray (2009) propounds that documents are a stable source of information which can be reviewed repeatedly. They are authentic because they are not created as a result of the study, but they are exact and contain precise details of names, position and events, compiled by the author. In trying to understand how opportunities to learn mathematics were provided, it was prudent that the type of curriculum learnt be examined, in addition to how the teachers interpreted and enacted it. Documents used in this research were the ‘O’ level syllabus, which is the official source, and the learners’ written work, which were personal records.

3.2.1.1 The Mathematics syllabus

The Mathematics syllabus had to be examined because the researcher wanted to ascertain what the official source said about what knowledge and skills were to be imparted to students with visual impairment. Knowledge of the curriculum was going to be beneficial in order to assess whether the students were exposed to the intended curriculum as specified in the syllabus, the assessed curriculum as seen from the examination papers, or the enacted curriculum, which depicts what the teacher does in the classroom. The assessment would enable the researcher to ascertain the extent to which opportunities to learn are availed to the VI students. A copy of the syllabus was obtained from the Zimbabwe School Examinations Council, (ZIMSEC).

3.2.1.2 Pupil's written work

Students' written work (Appendix 5) were the other type of documents that were examined during the study. Opportunity to learn could also be ascertained by assessing the extent to which students and teachers had mastered the extra Braille (Nemeth code) as wrong transcription may be a source of lack of opportunity to learn Mathematics. At schools where teachers lacked knowledge of Braille, the school needed to engage a Specialist who would assist with the marking of students' work and giving feedback to students. Ideally, teachers should be conversant with the extra Braille so that they can mark students' work.

Patton (2002) avers that documents prove valuable in research, not only because of what can be learned directly from them, but also as stimulus for paths of inquiry that can be pursued through direct observation and interviewing. Patton argues that documents may not make sense without interviews. The focus of interviews comes from field observations, hence, documents were used in this research in conjunction with observations and interviews to corroborate information on the learning of Mathematics by students with visual impairment.

3.2.2 The interview Method

One of the main tools for collecting data in qualitative research is the interview. Personal interviews were used to collect data from teachers. Punch (2005: 168) avers that the interview is believed to be one of the most powerful ways of understanding others in contemporary research. In addition, Arksey and Knight (1990), in Gray (2009) contend that interviews are the most powerful ways of helping people to make explicit things that may have been implicit, articulating their tacit perceptions, feelings and understandings. Thus, the interview allowed participants to reflect on events without having to commit themselves to paper. This study was exploratory in nature since not much was known regarding the learning of Mathematics by students with visual impairment. The use of the interview method was, therefore, justifiable.

Gray (2009) defines an interview as a conversation between two people in which one person has the role of researcher. The interviewer poses questions in a structured or semi-structured or unstructured format and listens to responses to capture data, then poses new questions. In this study, semi-structured interviews were held with teachers while making use of an interview guide (Appendix 3) where topics and issues to be discussed, the sequence and the exact wording of questions to be asked were all specified advance (Patton, 2005:168). Participants were given the chance, through open ended questions, to express their views and feelings about the provision of opportunity to learn Mathematics. Construction of the interview guide was guided by literature and the research questions set at the beginning of the research. The interview guide was considered appropriate as it allowed the interviewer to be flexible in the order of asking questions.

Interviews are of no significance unless the responses are captured accurately (Patton, 2002, cited in Gray, 2009: 384). Thus, use of a digital voice recorder to record the interviews enabled data to be captured accurately. The use of the voice recorder assisted the interviewer to concentrate on the research process where the interviewer had to listen carefully, re-focus and at the same time capture other non-verbal cues that became evident during the research (Gray 2009).

3.2.2.1 Advantages of interviews

Interviews have advantages, some of which are stated below. Creswell (2012) claims that the interview is a flexible tool for data collection that enables multi-sensory channels, that is, verbal, non-verbal, spoken and heard, to be used. Semi-structured interviews allowed for probing of views and opinions where interviewees could be asked to expand, illustrate or explain their answers on the spot (Gray, 2009:373). Through the semi-structured interviews, valuable insights with regard to opportunities to learn Mathematics could be obtained. Moreover, in semi-structured interviews, participants are given the voice to articulate their own views on critical issues that concern them.

3.2.2.2 Disadvantages of interviews

One disadvantage of the interview is that the quality of the interview depends on the interviewer who should adapt with the conversation. Interviews take time both to organise and to conduct.

To ameliorate this situation, preparations were made well in advance. Pilot testing of the interview questions gave the researcher an opportunity to rehearse.

Another disadvantage is that the presence of the researcher may affect how the interviewees respond. The researcher had to create good rapport with the teachers to enable them to express themselves freely on their experiences and opinions about teaching students with visual impairment. This situation called for the researcher to be objective and professional so as to gain their trust (Gray, 2009).

Manual data entry can prolong the analysis process (Marshall, 2016). For this study, data was recorded using an audio recorder so that exact words could be captured. Descombe (2010: 193), however, warns that the audio-recorder can create an artificial situation, while tactless interviewing can be an invasion of privacy which can make people uncomfortable. Building trust and good rapport with participants was essential such that participants would be free to express their views.

3.2.3 Focus group interviews

Data from students was collected through focus group interviews. From the researcher's experience, people with visual impairment generally believe that sighted people are not empathetic to their plight. It was imperative that the students with visual impairment themselves be given a chance to speak for themselves on how they felt about the way they were taught Mathematics and the problems they encountered in trying to learn Mathematics. This was meant to find out how they interpret the opportunities they are accorded to learn Mathematics.

Creswell (2012: 218) describes a focus group interview as the process of collecting data through interviews with a group of people, about four to six. Descombe (2010: 177) identified the following as features of focus groups;

- There should be a focus to the session and discussion is based on experiences about which all participants have similar knowledge
- Particular emphasis is placed on the 'interaction' within the group as a means of eliciting information.
- The moderator's role is to 'facilitate' the group rather than lead the discussion.

In this study, the focus was on opportunity to learn Mathematics, while particular emphasis was placed on interaction within the group, with participants interacting with each other on issues highlighted by the interviewer. Interaction was emphasised as a way of giving a voice to previously marginalised groups so as to empower them to express their concerns. According to Freitas, Oliveira, Jenkins and Popjoy (1998), the focus group is s more suitable when the objective is to understand how people consider an experience, idea or event. This is because the focus group meeting is effective in supplying information about how people think or how they feel or act. The study employed semi-structured focus group interview guides (Appendix 1). The interviewer was guided by literature in preparing the interview guides.

3.2.3.1 Advantages of focus group interviews

Freitas et al. (1998) observed that the focus group is more suitable for use with young or vulnerable participants who may feel uneasy to be isolated. Students with visual impairment are a vulnerable group so the focus group approach was an appropriate method for use with the group. Another advantage was that data could be collected in a short period of time and at low cost (Cohen et al., 2011: 436). The data that is collected is also rich, flexible and stimulating. It aids recall, is cumulative and can be elaborated by the speaker or by the other participants. The focus group also had the advantage that data could be collected in a short time and at low cost. The focus group was used after the lesson observations to confirm the observations noted.

3.2.3.2 Disadvantages of focus group interviews

Focus group discussions also have shortcomings**.** Dealing with a group of socially disadvantaged children might present problems of mistrust and the children can maintain a social distance, especially if they have not personally accepted their situation. Some may still be bitter about their disability and asking them to take part in an interview may be too much for them. Fortunately, during pilot testing of the interview instrument for teachers, one adult teacher with visual impairment had pointed this out so the researcher had time to review on how to soften the learners so that they could feel free to participate. Some learners might not be articulate enough to respond in English, so allowing them to use the mother language, Shona, could aid data collection.

In addition, Cohen et al., (2011) observe that another disadvantage could be non-participation by some members, and dominance by others. Such a scenario requires that the moderator be skilled in handling the group so as to give all participants a chance to speak out. If the conversations are audio-recorded, the interviewer could faul to recognise the voices of group members during transcription.

3.2.4 Observation

The study also employed lesson observations as the other method of collecting data as it is among the methods recommended for qualitative research. Observations were used as they provided evidence of how the opportunity to learn Mathematics was enacted by the teachers in the classroom, through noting how the teachers presented their lessons, the words and actions that they used, the questions that they asked, their treatment of learners' responses and the tasks that they gave to the learners. Cohen et al., (2011) remark that observation provides detailed first-hand information and there is no need for special equipment or personnel. Observation involves looking at, and noting systematically, people, events, behaviours, settings, artefacts, routines (Marshall & Rossman, 1995; Simpson & Tuson, 2003). Through observation, the researcher got the opportunity to gather live data from naturally occurring social situations, to explore what people actually did (Cohen et. al., 2011; O'leary, 2005), and to learn from the experience so as to expand knowledge on the teaching and learning of Mathematics by visually impaired students. Any reader can learn from what transpired in the classrooms visited by listening to the voices of the participants from the recorded lessons.

The researcher assumed the role of non-participant observer as the method ensures the collection of data without influencing the procedure in the lesson. Tuckman (1994) reports that the critical aspect of observation is looking, taking in as much as you can, without influencing what you are looking at. In support, Creswell (2012) regards a non-participant observer as an observer who visits a site and records notes without getting involved in the activities of the participants. Yin (2011) further supports the use of observation by commenting that what one sees with one's own eyes and perceives with one's own senses is not filtered by what others might have reported or what the author of some document might have seen.

To capture the proceedings in the lessons, the researcher developed an observation check-list by adapting the Massachussents Education evaluation form and that from the Gadsden State (Appendix 2). Some items on the checklist were constructed basing on the literature reviewed and the research questions. For instance, items that dealt with 'reviewing previous lesson', 'linking today's lesson with the previous lesson' and 'using appropriate examples', were linked to literature on when an opportunity becomes an opportunity as depicted by Gresalfi, Barnes and Cross (2011). The check list assessed the following the broard areas; organisation of the classroom, presentation of the lesson, interaction and content knowledge, on a three point scale. The researcher took note of the frequency of specific types of behaviours, acts or events, using the structured observation schedule or check list so that only details pertaining to the study were recorded.

Observation was also useful for investigating non-verbal aspects such as inaudible whispers, pause and changes in tone of voice or changes in facial expressions in the form of comments (memos) on the same check-list. The specified areas listed depicted instances of when and how opportunities to learn Mathematics were provided. Proceedings in the lesson were captured through audio recording as this allowed the researcher to concentrate on noting other non-verbal cues among the students as well as capture accurate verbal data. The observation method helped to corroborate data from interviews and focus group interviews.

3.2.4.1 Advantages of observation

Direct observation allows the researcher to put behaviour in a context and thereby understand it better. Actual patterns of behaviour can be observed during lesson observation. Naturalistic observation is often used to generate new ideas. Because it gives the researcher the opportunity to study the total situation, it often suggests avenues of enquiry not thought of before (Mcleod, 2015).

3.2.4.2 Disadvantages of observation

The lack of control in observing a natural setting may render the observation less useful. This is coupled with difficulties in measurement problems with small samples, difficulties of gaining access and negotiating entry and, difficulties in maintaining anonymity (Bailey 1994, in Cohen et al, 2011 :47). To counter this situation, the observer used the issue of small samples to advantage since observation of almost all students in the class was possible due to their small numbers. In addition, the observer was a well known figure in the community so there was no problem in gaining access. However, the problem of maintaining anonymity remained unresolved as the sites used are unique and of public interest. Furthermore, people rarely act or behave the same when they know they are being observed.

3.3 THE PILOT STUDY

In conducting a pilot study, the researcher would be trying to assess the feasibility of the study and to pre-test the research instruments that would have been prepared for the study (Baker, 2002, Tiejlingen & Hundley, 2001). Gilbert (2016: 1) states one advantage of a pilot study as that it might give advance warning about where the main research project could fail, or whether the proposed methods or instruments are inappropriate or too complicated. It enables the researcher to identify unclear and ambiguous questions which are then corrected or replaced. For this study, the interview questions for teachers and the focus group questions were pilot tested using two teachers, one who is visually impaired and another who is sighted.

The two teachers had experience in teaching both the sighted and visually impaired students.

The visually impaired teacher doubled up as a 'visually impaired student' since she has been a student also, and as a teacher of the visually impaired. Individual interviews were held with the teachers, while the teacher with visual impairment helped panel beat the focus group questions for students. This helped to expose the weaknesses of the two instruments and appropriate measures were taken to improve the questions.

3.4 THE POPULATION

The population for this study comprised all students with visual impairment in Masvingo province and the teachers teaching Mathematics. Best and Khan (2006) define a population as a group of individuals that have one or more characteristics in common that are of interest to the researcher. Similarly, Nachmias and Nachmias (1996: 179) regard a population as the "aggregate of all cases that conform to some designated set of specifications".

Schools A and B, where the sample was taken from, are the only boarding schools which enrol students with visual impairment in the province. Both operate in inclusive settings, that is, they enrol both sighted and visually impaired students. It was possible other schools could be enrolling day school students with visual impairment since the Ministry of Education advocated for inclusive education, but those statistics were not available from the provincial offices. Other schools that enrol students with visual impairment are located in different provinces, but these could not be included in the study in order to reduce the costs of travelling. The school enrolments were as shown in the tables below.

Table 1. School A Enrolment

	Form 1	Form 2	Form 3	Form 4	L 6th	U 6th	Total
Totally Blind	14	15	25	19	8	8	89
Partially sighted	6	8	12	14	4	4	48
Interviewed students	8	5					13
Students with multiple disabilities		All totally blind students					3

Table 2: School B Enrolment

	Form 1	Form 2	Form 3	Form 4	L6th	U 6th	Total
Totally blind	0	1	0	1	0	0	2
Partially sighted	0	0	0	0	0	1	1
Sighted	146	220	220*	220*	104*	96*	1016
Interviewed students	0	0	0	0	0	0	0

*Approximate figures were given

All students with visual impairment learn Mathematics from Form One, but when it comes to writing external examinations most of them drop out for different reasons. The study, therefore, tried to ascertain whether lack of opportunity to learn Mathematics could have been one reason for dropping out.

3.5 THE STUDY SAMPLE

Creswell (2012) propounds that the intention in qualitative research is not to generalise to a population, but to get an in-depth exploration of a central phenomenon. To best understand the phenomenon, the researcher purposefully or intentionally selects individuals and sites that can best help one to study the phenomenon. The sample for the study was made up of eight Form One and five Form Two learners learning at school A (Table 3), their two Mathematics teachers and two teachers from school B (the Resource teacher and one class teacher) as shown in Table 4 below. The sample was thus made up of thirteen students and four teachers. The classes comprised of both totally blind students and partially blind students who were below the age of 20, some of whom could read large print with the aid of glasses. But for the study only thirteen students who were totally blind took part in the focus group discussions. Since they learnt in the same classroom, the whole class were involved in the lessons that were observed. At School B no students took part in the study because there were no students with visual impairment in Form One or Form Two.

The researcher chose to work with junior secondary students because at that stage they would have settled in the secondary school and could decide what they wanted to do in regard to learning Mathematics. They would also have been introduced to the extra Braille used in

Mathematics and so could make a choice of whether to continue with Mathematics or not.

Table 3: Study sample; Student details

School	Class	Number of students	Age range
A	Form 1	5 (2 female, 3 Male)	16-17 years
A	Form 2	8 (2female, 5 male)	16-19 years
B	N/A	N/A	N/A

Four teachers also made part of the sample. The following table shows details of the teachers who took part in the study.

Table 4 Details of teachers

School	Teacher	Qualifications	Teaching Experience	Classes taught	Lessons observed
A	A1(male)	Certificate in Education + Bachelor of Education	16 years at school A	Form 2 & 4	3
A	A2 (male)	Diploma in Education	4 years at School A	Form 1 & 3	3
B	B1(female)	Certificate in Education + Bachelor of Education	19 years	Form 4	0
B	B2(female)	Diploma in Education + BSc Special Education	24 years	Resource teacher	0

As can be seen from the table, four teachers, two male and two female, took part in the study. All the teachers were professionally trained. Three teachers had more than fifteen years teaching experience which meant they would be in a better position to provide appropriate opportunities to learn Mathematics, all things being equal. The fourth teacher was still learning the trade.

3.6 SAMPLING PROCEDURES

Purposive sampling was adopted for this study. The two schools were chosen as they are the only ones enrolling learners with visual impairment in the province. Moreover, these schools were easily accessible, being located in the same province where the researcher works. The grade levels , form one and form two, were also purposefully chosen in line with the observation made by Nachmias and Nachmias (1996: 184), that purposive sampling depends on the subjective judgement of the researcher to come up with a sample that appears to be representative of the population. The exact number of students who took part in the focus group interviews were purposively selected by their teachers. In addition, Creswell (2012) propounds that the intent in qualitative research is not to generalise to a population, but to get an in-depth exploration of a central phenomenon. So, to best understand the phenomenon, the researcher purposefully or intentionally selected individuals and sites that could best help one to understand the phenomenon. The standard used in choosing participants and sites was whether they were "information rich" (Patton, 1990: 169). Sidhu (2002: 265) views purposive sampling as being "…within the control of the investigator and as such the researcher can include in his or her study such cases which in the researcher's considered judgement, will make the sample quite representative". In this study, the researcher preferred to work with form one and 2 students since the senior classes were busy with revision for the examination and could not be disturbed. Moreover, junior secondary classes are easier to convince given that the history of the school had it that at Form Three level that is when most students drop Mathematics.

3.7 DESCRIPTION OF SITES

In Masvingo Province of Zimbabwe there were only two schools that offered education to students with visual impairment under boarding conditions. There were similar schools in other provinces but these latter were difficult to access due to long distances, so two schools in Masvingo province were chosen for the study. These schools were chosen because they were easily accessible and they are the only ones in the Province that meet the criteria being studied. School A and School B were run by different Church organisations.

3.7.1 Site 1: School A

School A was the first school in Zimbabwe, (then Rhodesia), to offer education to students with visual impairment way back in 1927. School authorities observed that the school was opened by missionaries who responded to the plight of a blind boy whose parents were going to throw him into the river because they could not fend for him during drought years. Linder (1983) reports that parents of handicapped children pass through stages of grief similar to the stages of mourning that are associated with one's own dying or the death of a loved one. Linder notes that the parents are "mourning the loss of the expected normal child and the birth of a handicapped child" (Linder 1983:158). Linder adds that the parents pass through stages of denial and isolation, anger, bargaining, depression and finally acceptance. So, depending on the stage at which the parents are, some parents may not be in a position to raise a disabled child, let alone cooperate with school authorities to help the child. School A, under study, has since been relocated to another district and the Church has continued to administer it with assistance from the government.

Students at school A used to get financial support from Government through government grants and also from well wishers. After the economic meltdown which affected the country's economy from 2000 onwards, most well wishers withdrew their support and even government failed to meet its obligations on time. Currently, the students were supposed to pay whatever the parents could afford as school fees while waiting for the Government assistance, but even those with nothing are still admitted. The Church ran a primary and the secondary schools in the same premises and the schools shared some of the facilities. Of late, the schools started to admit partially sighted students, mostly albinos.

The community in which School A operates also accommodated non-sighted adults, some who work in the institution's workshops and also those that are retired and their families. So the community at school A is mostly comprised of adults and children with visual impairment. The few sighted people there are mostly teachers and otherchildren born of the blind parents. There was a mixture of blind and sighted teachers in the schools.

There was adequate classroom space to accommodate the students, but the classes were overcrowded. For students with visual impairment, the Ministry specified a teacher to pupil ratio of 1:10, but most of the classes had more than 15 students. All the equipment used by teachers and students, that is computers, Braille Perkins machines and embosser was donated. Some of the equipment has since become obsolete.

3.7.2 Site 2: School B

School B is run by a different church organisation which started offering education to students with visual impairment at primary level in 1987, and at secondary level in 1990. It was reported that the school started admitting students with visual impairment after the Responsible Authority recognised the plight of the blind children, some of whom had been brought by their parents with the hope that they might be healed through prayer. It was estimated that the majority of people who attended this church were poor and others came because they thought they were going to be healed. The legacy of poverty and disease persisted until the Responsible Authority opened up education facilities for children with visual impairment. The community caters for both the secondary and primary schools. The primary school admitted day scholars while at the secondary school the majority of students were boarders and their school fees were paid by their parents. There were only four students with visual impairment out of the one thousand and twenty students in the school, and none were eligible for the sample. It appears there were not many parents of non-sighted students who could afford to pay school fees for their children, there being no assistance from government. There was no mention of well wishers chipping in with assistance.

The school was well resourced, with a well stocked computer laboratory for students who learnt Computer Science. The classrooms and school grounds were well maintained and guarded. There was a staff compliment of over forty teachers, mostly graduates.

3.8 DESCRIPTION OF LEARNERS

School A used to cater for totally blind students only. Now they cater for both the totally blind and those with partial sight. The number of students who are totally blind was reported to be going down thanks to the immunisation programs run by the Ministry of Health and Child Welfare. School authorities explained that the major cause of blindness in children used to be measles but now the Health Ministry has managed to control the spread of the disease. It was reported that most partially sighted children who were learning at school A, lost their sight due to the HIV virus but it was difficult to ascertain how many.

The age range of the students who took part in the focus group discussions ranged from sixteen to nineteen years. It appeared the students started school much later than their sighted counterparts because the parents might not have information on where the children could be assisted. These non-sighted students lost sight at different stages of development, some as early as at birth and others as late as the previous term. All who took part in the discussions had passed their Grade Seven mathematics with grades that ranged from one to six, which means none had failed Mathematics at Grade seven.

At school A the totally blind students make up to about sixty four percent of the whole population, a few were partially sighted and used large print. A few had multiple disabilities which included physical impairment. One particular student in Form One could not handle the slate and stylus that he was supposed to use for writing.

At school B there were only three students with visual impairment, one in Form Two, one in Form Four and one in Upper Sixth. The form two student was not at school at the time of the visist and he was being taught by a student teacher. So, he could not be part of the sample. One who had just joined the schol and was put in reception class. The student in reception class had learnt at the school up to Form Four while sighted, but failed to write the 'O' level examinations when she fell ill. She was operated on and after that she could not see. Now she had to start afresh to learn the basic Braille. As for the other students, the U6th one was born blind but he was very good in Computers, the Form Two student lost sight at six years, while the Form Four student lost sight while at primary school. So these students had to learn Braille at different points in their lives. The good thing about the students was that they had all accepted their fate and were determined to go on with schooling. As mentioned earlier, there were fewer students with visual impairment at school B because parents had to fund their children's education.

3.9 DATA COLLECTION PROCEDURES

3.9.1 Negotiating access to data collection

For this study, written permission to conduct the study in the schools had been given by the Ministry of Primary and Secondary Education Head office (MoPSE) (Appendix 7).The letter issued by the Provincial Education Director (PED), the letter from MoPSE Head office and the letter from CEDU (Appendix 8) were shown to the Heads of the schools and the heads showed their willingness to cooperate. The school heads were approached one week before conducting the study.

3.9.2 Data collection from documents

The Mathematics syllabus document was analysed in order to see if there was any clause relating to students with visual impairment. The number of topics that involved use of diagrams were noted as these were cited by teachers as presenting problems when teaching students with visual impairment. In the researcher's view this could present a source of lost opportunity to learn when teachers avoided the topics with diagrams.

Samples of students' written work which had been marked by their teachers were collected for photocopying and scrutiny to check on how students were coping with the extra Braille, and how teachers marked and gave feedback to the students. The researcher enlisted the help of the Resource teacher at School B to assess the extent to which subject teachers were consistent in their marking of Braille material. Photographs of some of the work were taken as evidence (Appendix 5). Permission to use students written work had been requested from the parents though some did not return the consent forms.

3.9.3 Data collection from lesson observations

Two teachers at school A were observed while teaching four lessons each, one to Form One students and the other to Form twos. The lessons were audio recorded while the researcher used the check list (Appendix 2) to tick on the broad areas referred to earlier on. The researcher noted and wrote some comments on the behaviours not catered for by the checklist, such as whispers, laughs, change of tone of voice, or other actions.

3.9.4 Data collection from focus group interviews

The two groups of students were interviewed on the same day. Discussions were conducted in the library with the totally blind students who had been sampled by the teachers. During the focus group interviews the researcher assumed the role of moderator, taking heed of Descombe's (2010) recommendation, that the moderator should facilitate and not lead the discussion. Such an approach was meant to empower the students to speak out freely and voice their concerns as a group and not as individuals, as suggested by Cohen et al., (2011: 437). Questions posed to the students were taken from the interview guide mentioned earlier on.

After self introductions were made, the researcher explained to the students, the purpose of the interview, how the information was going to be used and that they were not forced to participate and could withdraw at any stage if they felt they no longer wanted to continue (Cohen et al. 2011: 78). The researcher also requested to audio record the interview. The group interview was meant to give the students the opportunity to voice out their opinions on how they felt about the way they were taught Mathematics, which gave a pointer to the kinds of opportunities to learn that they were accorded, and also to reiterate the challenges that they met in learning Mathematics. At the end the researcher thanked the participants.

3.9.5 Data collection from interviews with teachers

Individual interviews were held with the Mathematics teachers in the library at school A and in the resource room at school B, places that they themselves suggested. Each interview with the teachers lasted on average thirty minutes. The basic procedure used was the same for the two schools. The researcher introduced herself and then asked the interviewee to refer to the consent form and sign to show willingness to participate. The researcher had to build rapport and trust by giving verbal assurance that the information the interviewee was going to provide would be treated with utmost confidentiality. The interviews were audio recorded with concurrence of the interviewees.

The interviewees had a copy of the interview guide so they were free to start responding to any of the questions on the guide. The researcher gave the interviewee a chance to express oneself and only chipped in where further explaining was needed or in order to ask a probing question. Participants used English during the interview but would occasionally switch to their mother tongue to emphasise a point. At the end, the interviewee was given a chance to ask questions. The researcher finally thanked the interviewee for participating in the interview.

The Resource teacher had a different interview to those of the teachers. The researcher decided to interview the resource teacher after discovering that there were no students who qualified to be in the sample. Ideally, there should be a resource teacher at each school to cater for students with visual impairment, but most schools cannot accommodate these on the school establishment. The resource teacher was thus interviewed on her roles as this information was going to be a pointer on the kinds of opportunities to learn that should be afforded to students with visual impairment. This was one characteristic of qualitative research where more participants could be added to the sample if more information was to be gained for the study. The presence of the resource teacher was an advantage for teachers who were not literate in Braille as the resource teacher could do the transcriptions while the subject teacher concentrated on teaching.

3.10 DATA ANALYSIS PROCEDURES

Qualitative data analysis is usually based on an interpretive philosophy that is aimed at examining meaningful and symbolic content of qualitative data. That is to say, “it tries to establish how participants make meaning of a specific phenomenon by analysing their perceptions, attitudes, understanding, knowledge, feelings and experiences in an attempt to approximate their construction of the phenomenon” (Maree, 2012: 99). For Cohen et al. (2011: 537), data analysis is a rigorous process which involves “organising, accounting for, and explaining the data; in short, making sense of the data in terms of participants’ definitions of the situation, noting patterns, themes, categories and regularities”. For this research, the researcher employed an inductive analysis of the data where research findings were allowed to emerge from the data. Patton, (2002, in Marshall and Rossman, 2006: 159) describes the process of inductive analysis as “discovering patterns, themes and categories in one’s data”.

One characteristic of qualitative data analysis is that it is an ongoing iterative process, where a researcher continually notices things, collects things and thinks about (reflects) the things (Creswell, 2011, Siedel, 1998, in Maree, 2012: 100).

In analysing data for this study, the researcher used the narrative approach to inductive analysis. Sequences of events were tracked, collecting meanings in order to come up with themes that emerged from the data. Analysing qualitative data requires that the researcher understands how to make sense of the text and images so as to formulate answers to research questions. A description of how data from different instruments were analysed is given below.

3.10.1 Analysis of data from documents

The researcher read through the Mathematics syllabus document to check if there was any reference to what students with visual impairment should learn differently to that learnt by sighted candidates, any special clauses or addendums. Some excepts of students' written work were also examined to find out how students were coping with the extra Mathematics Braille, and to establish what constituted opportunity to learn Mathematics in the way teachers were dealing with students' work.

3.10.2 Analysis of data from Lesson observations

The researcher organised the data first by making a verbatim transcription and typing of the lessons that were observed and recorded, including the notes and comments that were hand written by the researcher during the lesson. The transcripts were then read several times

identifying any words, actions or phrases that could contribute towards answering the research questions. Identified words and actions were given codes which allowed the researcher to collect together all data that were associated with some thematic idea. The themes were then be combined into categories which were related to the research questions. Codes that might not fit into any category were not thrown away. Yin (2003: 61) advises that
"the researcher should be able to accommodate unexpected contradictions in the findings instead of sticking to substantiated preconceived positions".

Data from observation check lists were analysed in the same way as that from Likert scales, where total frequencies of occurrence for each attribute were calculated. A high score indicated the teacher was more inclined to provide opportunity to learn, while a low score meant otherwise.

3.10.3 Analysis of data from focus group interviews and teacher interviews

Data from focus group interviews was transcribed and typed as was done for individual interview data. Transcription of the data from audio tapes enabled the researcher to familiarise with the data at an early stage. In qualitative analysis, a major feature is coding, that is, to organise data so as to come up with themes and categories (Gray, 2009). HesseBiber and Leavy (2006: 160) view coding as the analysis strategy that many qualitative researchers employ in order to help them locate key themes, patterns, ideas and concepts that may occur within the data. Coding entailed identifying data related to opportunities to learn, the phenomenon under study. The researcher constantly referred to the research questions as a reminder on what one intended to explore. In the process of reading and re-reading the transcripts, the researcher wrote down memos on ideas that came to mind. Themes were identified and put into categories as in the case of lesson observations.

3.11 TRIANGULATION

The researcher was studying a unique and complex phenomenon where there could be many variables operating in the single case. To be able to catch the implications of these variables, the researcher used more than one tool to collect data. In this study, document analysis, lesson observations, personal interviews and focus group discussions were employed as data collection instruments (methodological triangulation). Data was also collected from many sources, that is, teachers, students, the syllabus document and pupils' written work (data triangulation). This approach enabled the researcher to describe and explain the phenomenon of opportunity to learn Mathematics by students with visual impairment which would aid other readers to understand the phenomenon.

Cohen et al. (2011: 195) define triangulation as the use of two or more methods of data collection in the study of some aspect of human behaviour. Guion, Diehl and Mcdonald (2002) view triangulation as a method used by qualitative researchers to check and establish validity in their studies by analysing a research question from multiple perspectives. Triangulation was meant to increase confidence in the results obtained as Gray (2009: 195) and Yin (2003: 89) argue that reliability could be improved through triangulation of data sources and data collection methods. Patton (2002), in Guion et al., (2002), however, cautions that it is a common misconception that the goal of triangulation is to arrive at consistency across data sources or approaches; in fact such inconsistencies may be likely, given the relative strengths of different approaches.

In Patton's view, these inconsistencies should not be seen as weakening the evidence, but should be viewed as an opportunity to uncover deeper meaning in the data.

3.12 QUALITY OF THE DATA

In qualitative research, reliability and validity are conceptualised as trustworthiness, rigor and quality, and terms such as credibility, transferability and trustworthiness are used (Golafshani, 2003). To understand how validity and reliability were achieved in the research, a discussion of trustworthiness, credibility and transferability is presented below.

3.12.1 Trustworthiness

Trustworthiness has to do with how much trust can be given to the research process and findings (Bless, Higson-Smith & Sithole, 2013). To enhance the rigour and quality of the study, the four concepts that are enshrined in trustworthiness, that is, credibility, transferability, dependability and confirmability, were employed.

3.12.2 Credibility

Credibility corresponds to internal validity. Lincoln and Guba (1985) argue that rigour in qualitative studies can be achieved through careful audit trails of evidence, by participant confirmation (also known as member checking), and through triangulation. Cohen et al., (2011) note that leaving an audit trail refers to all documents and records used in the study, including information concerning how instruments for data collection were developed. In order to increase credibility of this study, the researcher personally typed all the interview and observation data, and kept all the tapes and transcripts to enable assessors and other interested readers to view. Marshall and Rossman (2006: 5) emphasise that researchers need to examine how they represent the other, that is, participants, hence the researcher went back to the teachers to allow them to verify the accuracy of the records compiled. Triangulation of data sources and data method as explained above also helped to enhance credibility of the study.

3.12.3 Transferability

Transferability refers to the extent to which results apply to other similar situations, and is similar to external validity (Bless et al., 2013: 237; Lincoln and Guba, 1985). Gray (2009) argues for transferability to other situations rather than speaking of generalisability, depending on the similarities between the original situation and the current one to which it is transferred. To guarantee transferability of the research results, the researcher purposively selected the sample to ensure that participants were all well-versed in the phenomenon under study, that is, learning of Mathematics by students with visual impairment. IThe researcher also described in detail the population, sample and sampling procedures. The findings and conclusions were described in chapters 4 and 5. Such detailed descriptions should enable other researchers to make their decisions as regards transferability and for further study.

3.12.4 Dependability and Confirmability

Confirmability requires that other researchers be able to obtain similar findings by following a similar research process in a similar context (Bless et al., 2013:237). To that end, the researcher made a critical evaluation of the methodology that she used, trying to justify what was done and describing the context in detail. Different methods of data collection were used and results from observations were verified through the interview method. A pilot study was conducted so as to improve reliability. During data collection reliability was strengthened through verbatim transcriptions, detailed descriptions and quotes (Silverman, 2010). Bless et al, (2013) say confirmability makes it possible for new studies to repeat, elaborate, challenge and even defeat the old studies.

3.13 ETHICAL CONSIDERATIONS

Ethical issues have to do with protecting the rights of research participants. The study involved sharing confidential information with participants, the majority of whom were students with visual impairment, a vulnerable group. The principle of voluntary participation requires that people should not be coerced into taking part in a research. In this research, participants were fully informed about the procedures and risks involved in the study and they were asked to give their consent to participate (Trochim, 2006). Informed consent is a general principle on ethical behaviour in research, taken to mean that those who are researched on should have the right to know they are being researched and that they should give their consent by reading and signing a consent form to show their willingness to participate freely (Cohen et al 2011: 150). In the case of students with visual impairment, the consent form was read to them and they were asked to put a thump print on the form to show their willingness to take part in the study.

Ethical standards also require that participants are not put in situations where they might be at risk of harm as a result of participation. The researcher had applied to the UNISA Research Ethics Committee for Ethical Clearance which was granted in the form of a Clearence certificate with reference2016/06/15/04763866/15/MC. The researcher also sought permission from the Ministry of Primary and Secondary Education in Zimbabwe, which was granted in a letter dated 26 July 2016. The two letters are appended in the Appendix section.

Further, the researcher invited an official from the Schools Psychological Services in the Ministry of Education , Zimbabwe, who came and sat in the room where focus group discussions with the participants were held. In case some participants were going to experience discomfort, the officer would know how to deal with them.

3.14 SUMMARY

The chapter focused on the methodology used to conduct the study on opportunities to learn Mathematics by secondary scholstudents with visual impairment. The study employed a qualitative paradigm and the case study design. Document analysis, interviews, focus group discussions and observations were the instruments used to collect data for the research. The population comprised secondary schol students with visual impairment who learn Mathematics and their Mathematics teachers. The participants were expected to air their views on how they felt about the opportunities that students with visual impairment were accorded to learn mathematics. The next chapter will focus on data presentation, analysis and interpretation.

CHAPTER 4

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

The previous chapter described the methodology used to collect data for the study that investigated opportunities to learn Mathematics that are availed to secondary students with visual impairment. In this chapter the researcher presents and discusses results from documents analysed, lessons observed, individual interviews and focus group interviews. The data is presented and discussed according to the sub-research questions of the study. The study hopes to contribute to knowledge on the teaching and learning of Mathematics by secondary school students with visual impairment through answering these research questions.

The sub-research questions which guided the study were:

1. How are students with visual impairment exposed to Mathematics in the classroom?
2. How is time on task exploited by both teachers and students with visual impairment in the classroom?

3. What modifications, in terms of teaching strategies, do teachers make when teaching students with visual impairment?
4. What intervention strategies can be employed to maximise opportunities to learn Mathematics by students with visual impairment?

For each sub-question, data from lesson observations is presented first, then data from personal interviews, and finally, data from focus group interviews. In the discussion, reference is made to related literature so as to substantiate the findings and drawing on similarities between the findings and the literature. Quotations and excerpts are used sparingly so as to provide the reader with a feel of the original responses. However, only quotes representing related responses are used. Cohen et al. (2011:105) advises that categories can be found in the questions in terms of which the research originated or developed. The following are the categories (themes) drawn from the research questions:

- Exposure to Mathematics in the classroom
- Utilisation of time on task
- Modifications of teaching strategies
- Parallels drawn from literature
- Suggested intervention strategies

These categories enabled the researcher to get answers to the research questions. For each instrument used, there were sub-categories identified on the schedules used, which acted as pointers to the provision of opportunities to learn Mathematics.

4.2 PRESENTATION AND DISCUSSION OF DATA

4.2.1 Analysis of data from documents

The syllabus document was the official source which specified the intended Mathematics curriculum to be learnt. What was taught in class was the enacted curriculum, while the learners' observed performance in Mathematical activities defines the achieved curriculum.

An examination of the Mathematics syllabus document revealed that it was the only syllabus on offer for secondary school students, so all students were required to learn the same curriculum. There is no reference to anything extra that can be done for students with visual impairment. Out of the eleven sections which make up the O level syllabus, five involve diagrams and graphs which the students with visual impairment find difficult to deal with as reflected in their responses and those of their teachers. Even some algebraic formulae and expressions, such as the quadratic formula and algebraic fractions, as reported by one of the teachers, Mr Jira, present the same problems as graphs and diagrams. In developed countries, such as the United States, State Boards of Education have come up with Guiding Principles for Mathematics Curriculum and assessment (NCTM 2009) and Braille Mathematics Standards (2006), which specify what students with visual impairment should learn. Absence of such specific legislation in Zimbabwe has been confirmed in this study, constituting a case of lost opportunity for students with visual impairment.

Samples of students' written work were inspected to find out how students faired on the extra Braille Mathematics. The excerpts of written work are included as Appendix 5. A picture of a slate and stylus that students use has been included as Appendix 5a, to give the reader a general idea of how the students with visual impairment write. The slate is like a double page with the upper page having holes through which the stylus punches the dots. The Braille paper is placed between the pages of the slate and writing is done from the right to the left. To read what is written the student has to remove the paper from the slate and turn it over so that they read from the left to the right as sighted readers do with ordinary print. If a student makes an error while working a problem, there is no way of correcting the error except to start the problem afresh. There is no way that they can cancel like is done with ordinary print. If the students is disturbed and forgets the stage where he was, to continue writing, he would have to remove the paper, check (read using touch) what has been written and then return the paper to the slate. In so doing the student may fail to align the paper where it was before and there is a possibility of over-writing on previous work. The student might loose on time. This is one case of lost opportunity to learn for the student. In addition, the process of removing and then returning the paper into the slate takes time, the sighted students might have gained ground.

Marked written work was inspected in order to establish how the teacher marks the work and gives feedback to the student. The researcher asked one teacher to transcribe verbatim, the written work for the sake of comparing the Braille and the print equivalent, including the wrong spellings. One source of lost opportunity to learn could come through the teacher's lack of knowledge of Braille where the teacher would have to ask another visually impaired student to read for him, as was the case with the other teacher, Mr Kadya. The teacher has no way of checking whether what is being read to him by the student was the exact content that was written down which could result in the wrong feedback being given to the owner of the written work. It was also established that feedback was given to the learner verbally by the teacher, which might not be as clear as when the learners can 'see' their mistakes. If more students make errors and the teacher has to correct these verbally then a lot of time is needed, unless if the whole problem is re-worked in class. The teachers' lack of knowledge of Braille, therefore, becomes a source of loss of opportunity to learn for the students.

From the written work inspected, it was apparent that the teacher marks the work in the same way that work in ordinary print was marked, that is, an underline or ring where there is an error and a tick where there is the correct answer. There were very few comments made on the excerpts since the students was not going to read the comment. The students'work shows instances of wrong spellings,such as 'wenesday', 'circumf', but the marker made no effort to correct these. The lesson may not be on spellings, but the student should be taught the correct spellings of key terms in Mathematics. The written work also showed lots of extra dots that were not transcribed, which they call 'lost dots'. Mr Jira reported that these might have been punched in error. In some cases the transcriber used what they call 'contractions' or short cuts, and ignored the extra dots.When viewed by someone with no knowledge of Braille it gives the impression that some work was not marked.

4.2.2 Research question 1

How are students with visual impairment exposed to Mathematics in the classroom? The first sub-question related to how Mathematics was presented to students with visual impairment during the actual teaching and learning process. The researcher was interested in finding out how teachers actually presented the Mathematical concepts and skills since the students could not see and so could not rely on what was written on the white board or the ordinary print textbook. Furthermore, the students could not refer to any examples that the teacher worked on the board. The researcher was checking on the teaching strategies used by the teacher of students with visual impairment.

4.2.2.1 Data from lesson observations

For the lessons observed, data was gathered under the categories: organisation, presentation, interaction and content knowledge.

Observation of the whole communication process in the classroom was done, that is, how the teacher interacted with students with visual impairment, how the students interacted with the content and how partially sighted students interacted with non-sighted students. This approach was advocated by Brousseau (1997, cited in Kohanova 2006), who referred to the said interactions as the 'didactical situation'. The emphasis here was on interactions in the classroom which consequently brought out the opportunity to learn Mathematics.

In all the eight lessons that the researcher observed, it was noted that there was no particular order in which students were sitting. They sat on two-seater benches where most were not sharing the bench because of the small number of students. There was no interaction between the students. The totally blind students had their slates and stylus on the bench ready to work while some partially sighted students had copies of textbooks.

Data from observations was analysed under the sub-categories organisation, presentation, interaction and content knowledge, the sub-categories listed on the observation checklist.

Mr Jira's teaching

Mr Jira had seventeen years of teaching experience. He holds a Bachelor of Education degree but does not have specialist training to teach visually impaired students. Mr Jira was observed teaching form 2A1 and 2A2, two lessons for each class. The topic taught was on Number Bases, two lessons on addition then another two lessons on subtraction. There were thirteen students in 2A1 of whom six were non-sighted and ten in 2A2, five of whom were non-sighted.

The researcher chose to report on the lesson taught in 2A2 because the lesson covered all the sub-categories that were on the observation checklist. Below is an extract of the first lesson taught in 2A2. The same lesson was also taught in 2A1, so a few extracts will come from there. Below is an extract of the first lesson taught in 2A2.

Lesson 1. Class: Form 2A2. Topic: Number bases. Teacher: Mr Jira

The teacher got the class settled by greeting the pupils to ensure that they were paying attention, asked them to pick up paper from the floor, and then introduced the visitor. A review of the previous lesson was made culminating in some homework questions being repeated for the benefit of those who had not got the questions right.

Mr Jira: We read a number as a number in only base 10. It's a number that is in base 10 that can be written without a base. So some of you were writing their work and eh… leaving the answer without a base. That will be wrong. Your answer should have a base. So let's look at the first question. I think it was only the first question that was a problem. Some students got all the questions correct except for the other 2 books that came late. I don't know what happened. First question, let's look at the first question. Number 1. Someone to volunteer to work that out for us. As you will be working I correct the error.

Here, the teacher took time to remind students what they had learnt the previous day. As a pupil recited a step, the teacher would write on the whiteboard, a process which was only benefiting the partially sighted learners. Those without sight could be seen reading their own work with their fingers or writing using slate and stylus as the lesson progressed.

Leon 11011 base 2 + 1011base 2.

Mr Jira: *$11011_2 + 1011_2$* (repeating what the learner said step by step)

Leon *1011*

Mr Jira: *1011_2*

Leon *is equal to 100110_2*

Mr Jira: *We don't want the answer. How do you get to the answer, that's what is important. Because we don't want just to copy the answer. We want people to know how they get to the answer because in an exam you don't get the same question. So the most important thing is to know how you work out to the answer. May you please go step by step how you got that answer? Leon .* [Silence]

The teacher gave learners hints on how they were expected to answer the questions, availing an opportunity that would enable students to score marks. The lesson continued.

Mr Jira: *Leon.*

Silence.

Mr Jira: *You copied that answer.*

Leon: *Ah, kana (no I didn't)*

Mr Jira: *(laughs) So where is the problem?*

Leon Silence.

Mr Jira: *You don't know how you can work that question? So let's hear from Panashe.*

Panashe *We say 1 + 1 we get 2, 2 divided by 2 we get 1 remainder 0 then we, then we carry 1. We say 1 + 1 we get 2, + 1 which we carry, we get 1 remainder 1, we carry one from zero. We say 0 + 1 = 1. We now say 2 into 1, 0 remainder 1,* *then we say 1 + 1, 2, 2 divided by 2, 1 remainder 0. Then we say 1 + 1, 2 divided by 2. So our answer is 10010.*

Panashe and Leon are students with visual impairment, so when answering the question Panashe was reading from what he had written in his homework book. Some students could be seen just sitting and listening and, surprisingly, some could come up with correct answers working from memory. The lesson continued.

Mr Jira: *That's our answer, base 2. If you leave the base, that will be very wrong. Leon.*

Leon: *Sir.*

Mr Jira: *So how did you get the answer if you cannot even explain how you got the answer? Who was helping you? Wakaikonewaka (So you couldn't get it?)*

It was good that the teacher went back to Leon, but that was no guarantee that Leon could now work out the problem. If anything, Leon could have been embarrassed by being reminded of his failure to solve the problem. The teacher continued.

Mr Jira: *It's ok now. Then I also discovered that the last question was a problem, the last question most people were saying they write 1 then they forget to put a zero. Always remember when after adding you get a number that is what? That is below the base, you write it just as it is, because if you divide you still get zero and get that as the remainder. So there is no need for you to divide, just simply write the answer. If you get a number that is below the base you simply write it as it is. The last one, the last question because we want to get to today's work…the last question,…unless if there are other problems.*

Student: *71247_9*

Mr Jira: *I want the professor to work that one. These days the professor is very passive. You don't even have a book. You haven't even handed in your book. What happened?*

Silence.

The student they nicknamed 'professor' did not answer. It was not clear why he preferred to remain quiet. He could have been embarrassed to give a wrong answer. The teacher tried to probe him with no success. The use of a nickname could have been an effort to warm up to the student.

Mr Jira: *Zvii zviri kushupa? (Whats the problem?)* Inaudible whispers.

Mr Jira: *Um ok. Kumbulani, the last question.* (pause) *You can't even read the question? Someone has to work that question.*

Kumbulani *71247.*

Mr Jira: *71247.*

Kumbulani *Base 9 + 60350_9.*

Mr Jira: *Just make an attempt, following the example that we have worked, you start from the units adding, and then divide by the base and record the remainder.*[Giving students some encouragement]

Kumbulani *7 + 0.*

Mr Jira:

7 + 0. The last digit for the first number is 7 and the last digit for the second number is 8.

Kumbulani *Maybe I made a mistake* there.

Mr Jira: *Wakanyora zvisizvo.(You wrote the wrong thing)*

Kumbulani *My book indicates that there is a zero in the units.*

Mr Jira: *The first input is what, 71247. The next one it has also 5 digits. So you can't have a zero at the end. Both numbers are 5 digits. Unit to unit, 7 and 8,*

*Desire? (*pause, silence). *Um, Zakaria.*

Zakaria: *We say 7+8 we get 15 then we divide 9 into 15 we get 1 remainder 6. And we say 4+5 we get 9,+1 we carried, we get 10. Divide 9 into 10 we get 1 remainder 1and we say 2+3 we get 5, +1 we get 6, and we write as it is because its less than 9. And we say 1+0 = to 1 and we write as it is . And then we say 6+7 we get 13. And we divide 9 into 13 we get 1 remainder 4 and we say, 9, and we write 1 as it is because its less than 9. Our answer is 1416.*

The student meant he read 0 instead of 8. It was necessary for the teacher to listen carefully to what the student said, otherwise the student would get confused. Zakaria is also a student without sight. As with the previous student, he was reading from his book as well. It appears the teacher was making a deliberate effort to pick on more of those students completely without sight, maybe to give the researcher to see how the students fared in the lessons. If the student had got the question right he would listen all the way, or converse with the same learner, until the problem was completed. But for those who made errors he would quickly jump in to make the student correct the error before more harm had been done. Desire was completely ignored after she kept quiet instead of answering. It was her fault that she lost whatever opportunity to learn how to solve the problem.

Mr Jira: *The mistake that I noted, most people were writing they ended by writing just only 4, and the 1 they carried they didn't write it. That's the mistake that most people made on question 8 so check that whatever that you carry remember to write it, especially if it's the last digit, write it down because its adding with nothing so it remains as it is so you write it down. Don't forget to write it down. Any other problem?*(Pause*) Any other problem I know the people that I am asking. Any other problem , Precious.*

Most of the questions that the teacher asked were in the form of statements or phrases that the students had to complete using a word or phrase. The majority of the statements contained the word 'what' at the end, to which the students would chorus an answer. The teacher occasionally answered the question himself before the students could give the answer, after which the teacher would again repeat the students' response.

Precious *Hapachina (nothing)*

Mr Jira: *Um, hapachina? Hoo? So if we ask you to work another one are you able to do it? Uh?*

Precious *Ndinozama* (I will try)

Mr Jira: *Unozamaka? (*You will try?) *Fine. So that's how we carry put addition. So we want to go on to subtraction. We want to start with these numbers, write down the following numbers:*

Clattering sounds could be heard as students wrote on their slates.

Mr Jira:	*You must be organised.* $1000_{10} - 111_{10}$, *minus one hundred and 1, one hundred and eleven, that's the first number. The second number Evidence, unokota mumusoro handiti? ---- Chipo, what's wrong with you? (1000 – 111)* (3 times). [Pupils work on the --- slates]. *Are you working or you are thinking of something else? You are not even writing.*
Chipo	*I have a headache.*
Mr Jira:	*Chipo, can you make a try.* Silence…
Desire.	silence
Mr Jira:	*We want to start with things that you did at primary level. You can call someone from grade 7, he will be able to work this.*
Leo	*989.*
Mr Jira:	*How did you get the answer, you say the answer is what?*
Leo	*989.*
Mr Jira:	*Nine hundred and what? And eighty nine. How do you get the answer, may you go step by step.*
Leo	*1000 – 111.*
Mr Jira:	*Yes.*
Leo	*I say I an slow. 0 – 1, it can't and we borrow.*[Admitting his weakness]
Mr Jira:	(Pause). *What do we borrow.*
Leo	*1 from 1000.*
Mr Jira:	*1 from 1000, but there is a zero there, yes we borrow 1 from 1000, ---*

Leo *We say1, we say 10 – 9, equals ah, 10 -1 = 9.*

Mr Jira: *Someone who is quick to…., for the sake of time. Ok what we do is 0 minus what,-1, these are units not so? Whatever that we borrow, in this case if you borrow a 1 from the next digit it will be equal to what? To 10. Last time when we were adding, after, because we don't have any digit, the digits that we have in base 10 are 1 to, 0-9. So whatever we borrow is = 10, if a number is in base 10. So the one we that we borrow will be equal to 10. So we put a 10 there and subtract the 1 from the 10.So tava nechikwereti (we have a deficit). 10 – 9, minus 1 we get what?*

The teacher took over and solved the problem. He could have allowed the slow student to finish his solution. The student had accepted he had a weakness, and he needed that opportunity to make a contribution in class though he might not be able to cope with the fast speed of the teacher and the rest of the class. For him, this may have been a case of lost opportunity to learn. The conversation continued.

Student *9.*

Mr Jira: *We get 9, and here we are remaining with -1, we borrow from the next, again we borrow 1 from the 0, the 1 that we borrow is equal to 10 and we say 10 – 1 which was already there we get 9, -1. We pay first the credit handiti? If you get money the first thing you do is clear credits. So we pay, so 10 – 1 we get 9,*

- 1 we get 8. It's like you borrow something from someone, you borrow from Peter to pay John waiting probably for your parents to send you money handiti? That's what is there. So here we have -1 we borrow 1 now from the 1000 and

here we remain with zero because we had 1. The 1 that we borrow is equal to 10. So we say 10 – 1 we get what?10 – 1?

Here the teacher made reference to a real life experience, borrowing money and returning it. The topic was a bit abstract and finding a real life example was difficult.

Chorus *9.*

Mr Jira: *We get 9, -1 again we get what? Hah?*

Chorus *8.*

Teacher: *We get 8. So our answer becomes what?*

Student *889.*

Mr Jira: *889, it's not 989. It's 889. That's the correct answer that's in base what? In base 10. So whatever you borrow when it is subtraction, because you can't subtract what? A bigger number from a smaller number. So we had to borrow from the next units then you pay back. The next one I think this one is easy. 899 minus what? 647. This one is easy*

(Class Working on slates) *minus 6* ----

Mr Jira: *647. 889 – 647 what do we get?*

Inaudible whispers

Mr Jira: *Ok, give others chance. Tapiwa*

Tapiwa: *We say 9 – 7 we get 2.*

Mr Jira: *We get 2.*

Tapiwa *9 – 4 we get 5.* [Pause] *8 – 6 we get 2 again. Our answer is 252.*

Mr Jira: *252, we say 252 base what? base 10. So here it's not a problem because we are subtracting smaller numbers from what? From bigger numbers. It's when it comes to borrowing that is when there is the issue … Then the last one in base 10. 543 – 39*

Class working on slates, long pause.

It was good practice for non-sighted students to work on their slates while sighted students wrote in their books or rough papers, at least they could then follow what the others were seeing on the whiteboard and learn with the rest of the students. *Mr Jira: Just raise up your hand. (*pause) *Others you are still working.* (pause*)* Silence.

Siren rang to announce break time. The siren rang while the teacher was still busy, but he continued with the lesson. In fact he continued for another 6.24 minutes. Eating into break time may not be the best for the learners. It goes to show that time allocated for the lesson was not enough, or the teacher had planned too much work for the lesson. So he continued.

Mr Jira: *Ok it's break time. Let's hear from Leon. I think now he has corrected himself. We just want the answer. Tell us how you get to the answer. I think that is important.*

Leon Pause

Mr Jira: *Or maybe, ok it will be in the slate. That's why you just tell us the answer. How do you get to the answer?*

Leon *543 – 39, we say 3 – 9, we must borrow 1 from 4, we say 13, 13 – 9 we get 4, where we got 4 we say 3 – 3 we get 0. Its 3 because we borrowed 1 from 4*

Then we say 5 – 0 we get… its 5

Mr Jira: *That's the answer. The answer is what?*

Leon *504.*

Mr Jira: *5 what? 5 hundred and what? And 4. So the idea here we were working problems that are in base what? In base 10.*

This is an example of how the teacher was asking and answering his own questions. If the class had been a fast class there would have been lots of chorus answers. For Leon to give the answer that he had written using the slate and stylus, he had to remove the paper from the slate, read the answer and then return the paper into the slate. The problem would be how to align the paper so that he doesn't over-write on top of previously written work. This accounts for why the students were not able to correct wrong work they would have written.

Mr Jira: *So the boundary is 10 or whatever that we borrow is 10. Or if we are working with base 2, whatever we borrow is equal to 2, when it is in base 3*, *whatever we borrow is equal to 3, when it is in base 5*, *whatever we borrow = 5 and you add with the number that was there. So the last one before I give you something to do as homework, let's look at this question, from your textbooks. We have* $312_5 - 134_5$, *312, 312,* $312_5 - 134_5$. *Here whatever that we borrow if we are to borrow is equal to 5. because these numbers are in base 5.*

Mr Jira: *What do we do? We have 2 – 4, it can't so we borrow 1 from the next digit which is what? (chorus) Which is 1, so here we remain with what? With zero, and that 1 that we borrow equal to 5. 5 + 2 what do we get?*

Chorus *7.*

Mr Jira: *7 – 4.*

Chorus *3.*

Mr Jira: *Its 3 and then we are remaining here with 0. 0 – 3 it can't, we borrow from 3 and we remain here with 2 so whatever that we borrow is equal to*

Chorus *5.*

Mr Jira: *5. So 5 – 3 what do we get?*

Chorus *2.*

Mr Jira: *2, then we go to the next. We are remaining with 2 because we have borrowed our 1 from 3. So 2 – 1, we get 1. So our answer will be* 123_5*. This is one way of getting the answer. But if you have problems you go the long way because there are many ways of killing a cat. We are used to subtraction of numbers in base 1, we first have to convert* 312_5 *to base 10 and also convert* 134_5 *to base 10. When you convert a number in base 5 to base 10 what do we do?* (pause) *Yes.*

Steve *We expand.*

Mr Jira: *We use the method of what?*

Steve *Expansion*

Mr Jira: *Expansion and simplify, the answer we get will be in base what? Base 10. And* *then we carry out the subtraction. Then we convert back to base 5. How do we convert a number in base 10 to base 5? Eh Madzimure*

Steve *we divide.*

Mr Jira:

We use the method of what? Of division and we record the remainder. So you can do it the longer way. So you choose the method that is easy for you, but this is the shortest method. Because the answer you get you will be ***s****ubtracting numbers in base 5 and you get the answer in base 5.Its very simple. Is that clear?*

Class *Yes.*

Mr Jira: *Any questions before we leave? Silence.*

Mr Jira: *Let me give you the work to do as homework. You go and practice, number 1 c, f, g, i. tomorrow we will be looking at adding and subtracting numbers that are in different bases.*

At the end of the lesson students were assigned homework to write after school. From the focus group interviews, the pupils had indicated that they had adequate time to do homework in the evening, so there was no problem there. The teacher then assigned students work to do and to read ahead, but the non-sighted students had no textbooks. Those students would have to depend on the good will of their colleagues to read to them what is on the next exercise.

This, again, demonstrates a case of lost opportunity to learn because it is not everybody who would get someone to read to them.

Mr Jira repeated the procedure verbally for emphasis. Most of the time when he read out the question, he would repeat it several times so that the students with visual impairment could get it. Some of the partially sighted students had textbooks and could easily read from the book.

In 2A1, Mr Jira started by complaining that the pupils had not hand in their books for marking. It took him about three minutes trying to get an explanation on why the books were not brought to him but all in vain. One student tried to explain bit in an inaudible whisper.

Mr Jira: *So let's continue. I gave you work to do, 3 questions. What was the first question? It was 1000 minus what? Samson, what was the first question?*

Samson: *1000 – 111*

Mr Jira : *1000 -111*

Long pause. Students work on their slates.

Mr Jira: *Who can work that one for us? Or may you please show me where you wrote the work. The second one was 899 -647 and the third, 543 – 39. Let's attend to this one, 1000 – 111.*

The teacher went back to his complaint but it appeared the students had not got the instruction clearly.

Mr Jira: I think this is not the first time that you are encountering such a question. Ok? Remember the first step is to arrange the question so that the numbers that have the same value are in line. The first number has four digits and the second one, 3 digits. So you start from the units. So when you are subtracting you say 0 minus 1, what do you get?

So he wrote on the board

1000

- 111

But those students with visual impairment could only visualise the alignment in their minds because this is not how it appears in Braille. In Braille everything is written in a line [See Appendix 5].

The following excerpts show the teacher's repetition pattern.

Mr Jira: *You must be organised. Tapfuma, uku unomirira mumwe (you wait for someone). 1000 base 10 minus 111 base 10…. minus one hundred and one,(*repeated wrongly then corrected*) one hundred and eleven, that's the first number. The second number, Evidence, unokota mumusoro handiti?*(Do you do it in your head?) **…** *Chipo what's wrong with you***?** *1000 – 111…1000 – 111… 1000 - 111 (*repeated 3 times to enable those without sight to get the question right*).*

Another case of repetition;

Mr Jira: *So the last one before I give you something to do as homework, let's look at this question, from your textbooks. We have* $312_5 - 134_5$*,… 312,… 312,…* $312_5 - 134_5$*. Here whatever that we borrow, if we are to borrow is equal to 5, because these numbers are in base 5.*

Mr Jira had no problems with presentation of the lessons. He displayed adequate knowledge of the subject having taught for seventeen years and he used his teacher training knowledge to advantage. Occasionally, he switched to the mother tongue and accepted when students used the mother tongue as well. However, he should encourage students to use the official language and make an effort to assist them at that.

Lesson 2. Class: 1A1. Topic:Simultaneous equations. Teacher: Mr Kadya

Mr Kadya had taught for only four years at this school after leaving college. Like Mr Jira, he also had no specialist training. Mr Kadya was observed while teaching two lessons on simultaneous equations and another two on geometrical plane shapes to the Form Ones. In this presentation, reference will be made to all four lessons. The lesson on simultaneous equations and another on geometry are going to be discussed in detail and comments and excerpts will also be taken from the other lessons observed.

In 1A1 there were 10 students, 5 of whom were totally without sight and were using slate and stylus to write. Most students sat singly on two-seater desks so there was no chance of any interaction between the students. In 1A2, two out of the 12 students were non-sighted.

The class was 1A1, the topic simultaneous equations. A few of the sighted students had print copies of the textbook, *Mathematics Today*, which the school got as a donation. The official textbook is *New General Mathematics*, but as shall be explained under interviews, there were no available copies. Two students had ‘talking’ adding machines which were donated and one had a scientific calculator bought him by his parents.

The lesson proceeded as follows; the teacher asked students to introduce themselves to the visitor, so self-introductions were made, each saying out their names, home area, and favourable subject, probably to set the tone for the lesson. From the introductions it was apparent that students came from all over the country, which was an indication that the school was well known. The ages of the students ranged from fifteen tosixteen years and the favourite subjects included Mathematics (7), English (3), Science (2) and Geography (1). Some named more than one favourite subject. The lesson then proceeded as follows:

Mr Kadya: *Let us introduce ourselves for the benefit of the visitor. Let's start with you Edward.*

Edward: *My name is Edward. I come from Zaka. I am 15 years old. My favourite subjects are Maths and English.*

Leon: *My name is Leon. I am 16 years old. I come from Chivhu. My favourite subjects are Maths, English and Science.*

Joy: *My name is Joy. I am 16 years old. I come from Chitungwiza. My favourite subjects are Maths and Geography.*

The introductions continued until all had introduced themselves.

Mr Kadya: *Thank you very much. Let us look at what we did on Tuesday. You said you encountered problems on number 2.*

Class *Yes. (chorus)*

Mr Kadya: *Number 2: The first equation is* $4m - 2n = 16$ *and the second equation is* $2m + 3n = 0$ [said slowly and repeated twice for students to get the correct equations, while writing on the board].

[Clattering sounds as students write on their slates].

Mr Kadya: *So we want to eliminate one of the unknowns. It's either we eliminate m or we eliminate, what? n* [Pause]. *Edward, unoda kueliminator ani? [which one do you want to eliminate?]*

Edward: *n.*

Mr Kadya: *n, so we want to eliminate n. So we multiply first equation with what ?*

Edward: *1*

Mr Kadya: *and second equation?*

Edward *2.*

Teacher:

So the first equation by 1 and the second equation by 2. The first equation will remain 4m – 2n = 16. Second equation 4m… 3n times 2,

chorus *6n.*

Mr Kadya: *6n, is equal to, 0 times 2*

Chorus *0.*
Mr Kadya r: *0, then here what are we going to do? Mada Mada:*

We are going to, to, to subtract.

Mr Kadya: *Yes.*

Mada *Subtract the upper* --- -*[*inaudible*] the second.*

Mr Kadya:

*Yes we are going to subtract the second number from the second equation handiti (*isn't it*)? We subtract the second equation from the first equation. So we say 4m – 4m what do we get?*

Chorus *0.*

Mr Kadya: *0, (-2n - -6n) [said* twice*]. Yes Maseko*

Chorus *-8.*

Teacher: *-8? Edward*

Edward: *-4.*

Teacher: *-4? Minus followed by minus is what? Yes Mugabe*

Mugabe *It's plus.*

Mr Kadya: *So it's -2n - -6n. Yes Mugabe*

Mugabe *8.*

Mr Kadya: *8? Edward*

Edward *It's 4.*

Mr Kadya: *It's 4. Which is 4 what?*

Edward *4n.*

Mr Kadya: *4n handiti? 4n =, 16 – 0.*

Chorus *16.*

Teacher: *We have 4n = 16. So what are we going to do? Olina, we have 4n = 16.*[silence, pause]. *Yes Lizzie*

Lizzie *We divide both sides by 4.*

Mr Kadya: *We divide both sides by 4. 4 into 4n.*

Chorus *n.*

Mr Kadya: *n. 4 into 16.*

Chorus *4.*

Teacher:

4. Here we have n = 4, n = 4 and we want to find m, what are going to do? We have n = 4, we now have the value of n. What are we going to do? Yes Joy.

Joy: *We choose the equation.*

Most of the time the teacher would repeat the answer given by a pupil before asking the next question, as can be seen in the previous conversation. The way he asked and answered his own questions encouraged all students to answer in chorus. Meanwhile the sighted students would also be working out problems in their exercise books. The lesson continued.

Mr Kadya: *Which one? Here we now have 4 equations, which one do we choose?*

Joy *The original.*

Mr Kadya: *Yes we go back to the original equations. Then we choose one of the equations, which one is your favourite, the first one or the second?*

Joy *Second one.*

Mr Kadya: *So we substitute the value of what? Of n in the second what? Equation, and second equation is 2m – 3, instead of writing n we are going to write what? 4, = 0. Then 2m -, -3 times 4 what do we get?* (Answering his own questions)

Joy *-12.*

Mr Kadya: *-12, = 0. Then we have 2m – 12 = 0. What do we do? 2m – 12 = 0, Thomas.*

Thomas:

Shift -12 to the RHS and then change sign. It becomes +. So 0 + 12 we get 12, we divide both sides by 2 we get 6.

Mr Kadya:

Here we are going to shift -12 to the right hand side handiti? Change side change sign rule will apply. Which means -12 becomes what?

Tom *+12.*

Mr Kadya: *+12. So we have 2m = 0 + 12. 0 + 12 gives us what?*

Tom *12*

Mr Kadya: *So now 2m = 12. We want to find m. What are we going to do? Nonthabiso? 2m = 12.*

Nonthabiso: *Divide by 4.*

Teacher: *By 4? Divide by 4? Yes John.*

John *Divide by 2.*

Mr Kadya: *We divide both sides by 2 handiti? 2 into 2m.*

Chorus *m.*

Mr Kadya: *m. 2 into 12.*
Chorus *6.*

Mr Kadya: *6. m = 6. Now we have m = 6, n = 4 then we write them clearly as m = 6, n = 4 so that the examiner won't have problems locating your answer Handiti?. We don't leave them mixed up. We have to write them clearly. Then we put our values of m and n together. That is number, that is number 2.*

The first equation took 7,52 minutes to solve with the class, and this was a revision of work done the previous day which served as the introduction to the lesson. In a normal class of sighted students, the introduction normally takes about 5 minutes. So this could be a pointer to the fact that the non-sighted students need more time to learn Mathematics as compared to their sighted counterparts. The chorus answers were echoed by the whole class. However, when it came to picking a student to give an answer, the teacher would deliberately pick on a visually impaired student. The lesson continued.

Mr Kadya: *Any other number? Yes Edward*

Ed: *Number 4.*

Mr Kadya:

*Number 4. Number 4 is: 3x – 6y = 15 and 5x – 2y = 14 (*twice*). What are we going to do here?*

Edward *We eliminate x.* [clattering sounds of the slates]

Mr Kadya: *We want to eliminate x.*

Ed: *We multiply first equation by 5.*

Mr Kadya: *Multiply first equation by 5.*

Ed: *And second equation by 3.*

Mr Kadya: *And second by 3. So that we can eliminate what? X. So let's multiply the first equation by 5. 3x times 5.*

Class *15x.*

Mr Kadya: *15x. -6y times 5.*

Class *-30.*

Mr Kadya: *30. – 6y times 5.*

Class *30y.*

Mr Kadya: *30y. Yes it's -30y not -30. Is = 15 times 5.*

Class *75.*

Mr Kadya: *Seventy? 75. Then we go the second equation. 5x times 3.*

Class *15x.*

Teacher: *15x. -2y times 3.*

Class *-6y.*

Mr Kadya: *-6y, is equal to, 14 times 3.*

Class *42.*

Mr Kadya:
=42. Here what are we going to do? We have 15x – 30y = 75, second one 15x – 6y = 42. Lizzie.

Lizzie *We subtract the second number from the first one.*
Mr Kadya: *We subtract the second equation from the first equation handiti? So that we get rid of what? Of x. 15x – 15x.*

Class *0.*

Mr Kadya: *It's 0. -30y - -6y* (twice)*. Yes Busisa*

Busisa *34y.*

Mr Kadya: *It's what? Yes Mugabe.*

Mugabe: *-24y.*

Mr Kadya: *It's -24y. 15 = to 25 – 42* (twice)

Class *33.*

Mr Kadya: *33. We have -24y = 33. What are we going to do? Mugabe.*

Mugabe: *We divide both sides by 24.*

Mr Kadya: *We divide both sides by what? By 24. -24,-24 into -24y.*

Class *Y.*

Mr Kadya: *Is equal to, -24 into 33.*

Mugabe *1 $\frac{3}{8}$.*

Mr Kadya: *What? -24 into 33.*

Mugabe *- 1$\frac{3}{8}$*

Mr Kadya: *It's -1 $\frac{3}{8}$. That is our value of what? Y. What are we going to do now with our value of y? Remember we want to find the value of x, what are we going to do?*

Pause

Mr Kadya: *What are we going to do here? We have y = -1$\frac{3}{8}$, we want to find the value of x. What are we going to do? Toita sei? Yes Mada*

Mada *We go back to our original equation.*

Mr Kadya:

Yes we go back to our original equations. So we are going to substitute the value of y into one of our original what? Equations. So which one do you favour?

Mada *First one.*

Mr Kadya: *First one. First one is 3x – 6, then we say 8 times 1.*

Class *8.*

Mr Kadya: *+3.*

Class *11.*

Mr Kadya:

*So it's -6, open bracket -11/8, close bracket, = 15. 3x – 6(11/8) = 15. Let us remove the bracket (*twice*). -6 multiplied by- 11/8 = what?*

Mada *-66/8.*

Mr Kadya: *Very good. So, we have 3x + 66/8 is equal to what? 15 (*twice*). What are we going to do? Toita sei? Yes Mada*

Mada *We remove the fraction.*

Mr Kadya:

*Yes, whenever we have an equation with a fraction the first thing to do is to remove what? To remove the fraction. How do we remove the fraction? (*twice*) Ndiani anoziva kuti toremover fraction pa equation sei (who knows how we remove a fraction from an equation? Thabiso … watokanganwa (have you forgotten?. Yes Thomas.*

Thomas: *We find the LCM.*

Mr Kadya:

We find the lowest common multiple of our denominators handiti, and our common denominator here is what?

Thomas *8.*

Mr Kadya:

It's 8, We have got the LCM, 8. What are we going to do ? Ye…s Busisa

(jovially, like he wanted to motivate Busisa)

Busisa (Inaudible)

Mr Kadya: *Our common denominator here is 8 what are we going to do? Yes John.*

John: *We multiply each term by 8.*

Mr Kadya:

Yes we multiply each term here in the equation by what? Here by 8, here by 8, here by 8. 3x times 8.

Class *24x.*

Mr Kadya: *+ 68/8 times 8.*

Class *66.*

Mr Kadya: *Yes 66 because 8 and 8 they cancel each other because you are multiplying. So you remain with what ? 66, = 15 times 8.What does the Calculator say, Thomas?*

Thomas: *120.*

Mr Kadya: *24x + 66 = 120. So what are going to do? Edward*

Edward: *We shift +66 to the right hand side and +66 becomes …*

Mr Kadya:

Yes we shift +66 to the right hand side and the change side change sign rule will apply so +66 becomes -66. So it's 24x = 120 – 66. 120 – 66 what do we get?

Class *54.*

Mr Kadya: *Is it 54? So it's 24x = 54. Then from here what do we do, Busisa?*

Busisa: *We divide both sides by 24.*

Mr Kadya: *We divide by?*

Busisa *By 24.*

Mr Kadya: *We divide both sides by what?*

Busisa *24.*

Mr Kadya: *By 24 handiti? 24 into 24x.*

Class *X.*

Mr Kadya: *X is =, 24 into 54?*

Mada *2 ¼.*
Mr Kadya: *2 and? Is it ¼? Yes it's 2 ¼, it's 2 ¼. Now we have our value of what? Our value of x and our value of y. So we have to write them together clearly so that the examiner won't have problems looking for the answer. Y = -1 3/8.*

The second question took about 11 minutes to solve and still it was revision. New work was only started after almost 20 minutes into the lesson. At this rate there was no way the visually impaired students could cover the same amount of work as sighted students. So the lesson continued.

Mr Kadya: *So today's work we are going to compare the 2 methods, ie substitution and what? Substitution and elimination. So let us look at the following example. Here we have: y = 3x – 2, this is our first equation. Second equation 4x – 2y = 0. We want to use the substitution method first. The first one is y = 3x – 2 and the second one is 4x – 2y = 0. What are we going to do? Toita sei?(What do we do?)*

Clatter of Slates.

This question was done twice, first by substitution and then by elimination. The approach was slightly different for this problem since he wanted to assist the students to be able to choose the shorter method. He did more talking than before. Below are some extracts to show the way he talked more.

Mr Kadya: *We arrange? We want to use the substitution method here* (twice) *first then we go to elimination method. Already we have the value of what? Y in the first equation handiti? Because y = 3x – 2. So we are going to substitute the value of y in the second what? In the second equation. So we are going to substitute* (twice)*. So this one will be 4x – 2, where there is y we don't write y we put 3x – what? 2 , =to what? To 0. (*Writes on the board: 4x – 2(3x-2) = 0)*. So from here we remove what? Brackets. So let us remove brackets. 4x, we get 4x -2 times 3x.*

He went on to solve the equation on the board while the visually impaired students worked on their slates. Most of the time they would have to depend on their memory. After getting the value of one unknown, he then said:

At th end of the question he gave a lengthy explanation as follows:

Mr Kadya: *So y = 4. Now we can write them clearly ,x = 2, y = 4. That is the substitution method. Now let us use the elimination method on the same equations. The first equation y =, y = 3x - 2, second equation is 4x – 2y = to what? To zero handiti?* (2 times)*. What are we going to do? We want to use the elimination method. We used this method before, let's just revise. What do we do in order to use the elimination method, we want to compare to see which one is better substitution or elimination. We were told substitution is best when it's like this, do we still remember? We were also told that elimination is best when it's like this. Where one of the coefficients is 1, substitution is the best, where our variables have* *coefficients which are above 1 then elimination is the best handiti? So in this case we want to use elimination. What are we going to do?*

Y = 3x – 2, 4x – 2y = 0. Toita sei (What do we do)? Yes …

He went on to explain the procedure as follows:

Mr Kadya: Ok it's not first equation. It's second equation we want the first equation. What do we do? Here we can shift y to the right, it's either we can shift y to the right then -2 to the left handiti, and we can start by writing 3x – y =, since

we shift -2 to the other side it changes what? Sign, so it becomes what, 2. Then our second equation remains the same 4x – 2y = 0. Then we now have 3x – y = 2, we shifted y to the RHS and we shifted -2 to the LHS. We now have 3x – y = 2 and 4x – 2y = 0. We want to eliminate one of the unknowns there. What do we do? Molina

His conclusion to the lesson was as follows:

*Mr Kadya: 2 = x, which is the same as x = 2 and y = 4. So in the exam you will not be told which method to use. They just say solve the simultaneous equations. You choose the best method whish does not take a lot of time. So today I want you to do number, on practice **G3.** You are going to use whichever method you like here, whether substitution or elimination. On practice **G3** you are going to do number 1-6. Any questions? We are winding up on equations. Equations are the building blocks of mathematics[ndiwo akabata mathematics]. Its equations from now up to university.*

All the time when he was giving lengthy explanations, the students with visual impairment sat there listening. The partially sighted students could follow what was written on the board.

It was difficult to tell whether even those with good memory could follow the explanations.

Mr Kadya gave students adequate time to think of a response before answering. He used the 'question, pause, name individual' principle which effectively encourages all students to prepare to answer. However, most of the questions were asked in the vernacular language and some students would also respond in the vernacular without any discouragement from the teacher.

There were only two occasions in this lesson when the teacher linked current work to previously learnt concepts. The conversation went as follows;

Madanire: *We move 4 to the right side and it becomes 0 + 4.*

Mr Kadya: *Is it 0 + 4? We have 2x + 4 = 0.*

Madanire *0 – 4.*

Mr Kadya: *It's 0 – 4, so 0 – 4 gives us what?*

Madanire *Zero .*

Teacher:

0 – 4? [dragging] *Is that what we agreed on when we did directed numbers, huh?*

Madanire *-4.*

The examples revised in class took up half of the lesson time and the new problems the other half. There was no time for what we normally refer to as class work. In other words, no time was reserved for individual work in class during the lesson. It was all question and answer.

The homework assigned was meant to be done after normal lessons.

Lesson 3. Cass: 1A1. Topic: Plane shapes. Teacher: Mr Kadya

The lesson taught to 1A1 is presented here with some excerpts taken from the lesson taught to 1A2. There were two non-sighted students in 1A2 so more information could be got from 1A1 where 5 students were non-sighted.

The teacher greeted the students and introduced the visitor. The lesson proceeded as described below, with most of the conversation done in the vernacular language. The conversations were translated for the benefit of the assessors.

Mr Kadya: *Today we are starting a new topic and this topic is called Mensuration in plane shapes. Can you name any plane shape that you know, Thomas*

Thomas: *Square.*

Mr Kadya: *How many sides has a square?*

Thomas *4 sides.*

Mr Kadya: *4 sides. Eh, Busisa.*

Busisa: *Triangle.*

Mr Kadya: *Triangle how many sides?*

Busisa *3.*

Mr Kadya: *3. Ehe Edward.*

Edward *Octagon*

Mr Kadya: *how many sides?*

Edward *8.*
Another student *Heptagon.*

Mr Kadya: *Heptagon, how many sides?*

Student *7.*

Teacher: *7. Yes Mugabe*

Mugabe *Pentagon.*

Mr Kadya: *Pentagon how many sides?*

Mugabe *5.*

Student *Quadrilateral*

Mr Kadya *Quadrilateral? (3 times), That is a combination of shapes isn't it?. Busisa.*

Busisa: *Decagon.*

Mr Kadya: *Decagon how many sides?*

Busisa *10.*

Mr Kadya: *10 sides.*

Student *Rectangle .*

Mr Kadya: *Rectangle how many sides?*

Student *4 sides.*

Mr Kadya: *4. So quadrilaterals, (these are 4 sided what? 4 sided Shapes)[twice]. We have a quadrilateral, Lizzie, what shape do you know?*

Lizzie: *Square.*

Mr Kadya: *Square and what else?*

Student *Rectangle.*

Mr Kadya: *Rectangle. This one, what shape is this? Keep holding it. Have you seen it before?*

The teacher handed over different plane shapes made from cardboard, to students. On getting a shape, the visualy impaired students could be seen feeling the shapes with their hands, moving their hands along the sides of the shapes.

Teacher: *Madanhire, what shape is this?*

[Long Pause, no response]

Teacher: *Lizzie, what shape is this?*

Lizzie: *Triangle.*

Teacher: *It's a triangle. What about this one?* [inaudible] *It's a what?*

Lizzie *Square.*

Teacher:

It's a square? No, this one is not a square. It's a parallelogram. What about this one? [Silence]

Teacher: *Madanire**,** what shape is that one?*

Madanire: *It's a triangle.*

Teacher: *Triangle, what about this one?*

Madanire *rectangle*

Teacher: *It's a what?*

Student *Rectangle.*

Teacher: *That one is a trapezium. So today we want to… mensuration simply means finding the missing what? Dimensions, on a what? The missing dimensions on plane shapes. That means mensuration, finding the missing dimensions, on plane what? Plane shapes. Let me just read this for you. 'Mensuration deals* *with finding missing dimensions on plane shapes'. Plane shapes are 2dimensional, measurements are in 2 dimensions. When they say 2 dimensions it means they are flat. You can find them pasted on the board or on paper, they are flat, these are the 2 dimensional, flat shapes, they can be drawn in a book. Then when we go to rectangular prism, then to cylinders, they are 3 what? They are 3 dimensional. They are things that can be handled, like those blocks, they have 3 dimensions. So all plane shapes they are 2 what? 2 dimensional. Mensuration of plane shapes deals with finding missing dimensions. The use of standard notational units, these standard notational units, the units that we use, like distance cm, m, mm, but these ones are used globally, the world over. You go to USA if you say km everybody knows them?*

But if you say 'nhanho mbiri', in USA they won't know what you are talking about. So they are called standard notational units, the units that we use everywhere in the world, like for measuring distance, like km, m and cm. So let us find perimeter and area of basic plane shapes. What is perimeter? What is perimeter? Nomtandazo what is perimeter?

After explaining what mensuration is, the teacher could have proceeded to also define 'dimension'. Instead, he took it for granted that students knew it. In his exposition, the teacher made several repetitions and on many occasions, answered his own questions.

Nomtandazo: Perimeter is the distance right round a shape.

Teacher:

Yes perimeter is the distance right round the shape. Perimeter is a measure of distance right round an object. Area is a measure of how large the surface is, let's say in this class we want to find out how many square metres in this class. When I say m^2 it means we are given a metre length then a metre width, that makes a square metre. We want to find out how many m^2 are in this class, so if we lay the m^2, let's say this class has length 6m and the width is 4m. (What is the area?)[twice]. Yes Jones

Jones *24m.*

Teacher: *Is it 24m? Yes Edward.*

Eward: *$12m^2$.*

Teacher: *$12cm^2$? 6 length then 4 width? Yes Madanire.*

Madanire *$24m^2$.*

Teacher: *It's $24m^2$, which means we can lay about $24m^2$, 24 boxes of length metre by metre, so if we lay them here they should be 24. That is area. So the Table 12.1 gives formulae for calculating both the area and the perimeter of some plane shapes . For us to find the area of a rectangle area of a rectangle, What do we do?*

The teacher referred students to Table 12.1 which was in the textbook, yet none of the students with visual impairment had textbooks to refer to. So these students were supposed to depend on their memory.

Student *Length times width.*

Teacher: *Its Length times width. What about the perimeter? Thomas.*

Thomas: *Length + width times 2.*

Teacher: *It's Length + width times 2, Did you hear him? What he knows is that on a rectangle we have how many lengths? We have 2, and 2 what? 2 widths, so we just say length + width times what? Times 2. That's the perimeter of a rectangle. Then we move on to a parallelogram. The formula to (find the area of a parallelogram)[twice]. Don't we know the formula? This is a parallelogram.* [showing a student close to him]. *The area to find…... This one is a parallelogram.* [Moves from pupil to pupil]. *The formula to find the area of a parallelogram is… yes Madanire.*

Mr Kadya had done well to prepare teaching aids using cardboard. The students could handle the different shapes and get a general idea of the shapes. However, the teacher had to spend time moving around trying to show each of the students with visual impairment how to figure out the dimensions of the different shapes. This process took time. Time on task was used to the maximum, but not much work could be covered during one lesson. The lesson continued.

Student *Side times side.*

Teacher:

Side times side? No, not side times side. Its base times what? Times height.

*The area to find… is base times height. Let's say we have our base, (*showing a student), *(this is our base, then our height is from here, straight)[twice]. So its base times height. That is the area of a parallelogram. Then we move on the area of a square, Thomas.*

Thomas: *Side times side.*

Teacher: *Its side times side or side squared. What about the perimeter of a square?*

Thomas: *Length times 4.*

its length times 4 or 4l, it will have 4 sides equal, so we say 4 times length.

Then we come to a triangle, how many sides?

Class *3 sides.*

Teacher:

Teacher: *And the formula to find the area of a triangle?*

Student: *½ base times height,* (the partially sighted read from the textbook)

Teacher:

It's (½ base times height) [twice]. Do we know where this ½ base times height came from? Let's say this is a rectangle. This is our rectangle. The length is 12 then the width is 3cm. What is the area of this rectangle, Mugabe?

Mugabe: *30cm.*

Teacher: *30cm? area? Yes Filda*

Filda: *36cm*^{2}.

Teacher:

It's 36cm^2*. So let us cut this rectangle diagonally, if we cut this rectangle diagonally, how many triangles do we get?*

Class: *2.*

Teacher:

2. So each triangle has what area? Isn't it we got 36? So we cut the rectangle in half to get 2 triangles, so each triangle has what area?

Class: *18.*

Teacher:

Its 18. 18 being the half of what? Half of 36, that's where the ½ came from [repeated]. *So its half base times height. Trapezium. Sorry, what about the perimeter of a triangle? How do we get the perimeter of a triangle?*

Student: *We add all the 3 sides.*

Teacher:

(We simply add all the 3 sides)[repeated]. *a+b+c and we get perimeter of a triangle. a and b and c they are sides. If we add the 3 of them we get the perimeter of what? The perimeter of a triangle. Then trapezium, trapezium, the formula to find area of a trapezium. Do we know it? The formula to find the area of a trapezium.* [showing a student] *This is the trapezium. These are the parallel sides, this and this, this side is parallel to this one. From this corner and we draw straight down to the other parallel line, that's what we call the height. This is the height of what? Of the trapezium, can you see it? So this side is parallel to this side. What did I say about parallel lines?*

Student *Lines which do not meet.*

Teacher: *Lines which will never what? So we have this one and this one. Then height, we want the height from here down to the other parallel line, straight, perpendicular down to this parallel line. Busisa (3times)*

Busisa had been fast asleep in the previous 10 or so minutes, but the teacher had let him be.

At 15 years he was the youngest student in Form One.

Teacher: *Busisa. What's wrong? (Are you not well)*[twice].

Busisa *[yawning]*

Teacher:

[Showing Busisa]. So this one is a trapezium. This line here, here, is parallel to this one. Then we also have to know the height of this parallelogram, from here going down up to here, that is the height of the trapezium. Can you see it? We have this one here, here, this line is parallel to this one. Do you see?

Busiso: *Yes.*

So the height goes down to here. So for the area of a trapezium, it's half the sum of, what does sum mean? Yes Munoda.

This is the sort of individual attention that each student with visual impairment would have to get. There is no way the teacher can cover the same amount of work for sighted and nonsighted students.

Munoda *Addition.*

Teacher:
Teacher:

It's addition, so it's half the sum of parallel lines times what? Times height. So in the book they write it as half, open bracket, a + b, close bracket. a and b are parallel lines of a trapezium, times height. So if we have the 2 parallel lines and the height we can calculate the area of a what? Of a trapezium. Right, I want to see if there is anyone who can calculate. We have parallel lines one with 8 and the other 6, the height is 4. Find the area of the trapezium)[repeated] . Lizzie, have you finished calculating? Yes what's the answer?

Lizzie *28cm^2.*

Teacher:

She says its 28cm^2. Lets see if that is true. I said 8 and 6, if we say 8 + 6 what do we get?.

Chorus *14.*

Teacher: *14 times 4.*

Chorus *56.*

Teacher: *56 divide by what? By 2.*

Lizzie: *28.*

Well done Lizzie. Right lets go to the parallelogram, the base is 10 and the height is 3, what is the area of a parallelogram, the area of the parallelogram? I want those who have been listening. Yes John.

John: *10 multiplied by 3.*

Teacher:

10 multiplied by 3, 10 is the base and 3 is the height. The area of a parallelogram is base times what?

Teacher:	
John	*Times height.*
Teacher:	
	Base times height. Calculate the perimeter of a rectangle with a length 7cm and the width 4cm. The perimeter of a rectangle, what is it? Ye..s Busisa, you are awake now.
Busisa	*7 times 4.*
Teacher:	*7 times 4?*
Busisa	*Ah, 7+4 equals to 11, times 2, equals 22.*
Teacher:	*22, 22 what?*
Busisa	*cm.*
Teacher:	*cm handiti? On perimeter there is no* cm^2.
	Calculate the (area of a square with a length 8cm)[twice] Mugabe.
Mugabe:	*8 times 8* [inaudible interjection] *62, it's 64.*
Teacher:	*64 what?*
Mugabe	cm^2. *Right we were given (the area of a rectangle is 30* cm^2*, then length is 6 ,find the width* [twice] *, Yes Busisa, the area is what? 30*cm^2*, the length is 6. Find the width.*
Busisa	*5.*
Teacher:	*Busisa says 5*
Busisa;	*Yes 5.*

Teacher:

Teacher: *5, How did you get 5?*

Busisa *I said 30cm^2 divided by 6.*

Teacher:

Yes 30cm^2 divided by what? By 6, because to get the area of a rectangle we say length times width equals to what? To 30, so we are given the length and the area, so we simply say, length into the what? Length into the area for us to find the width. Same applies if we are asked to find the length if we are given the area and the width. Not so? Right. (What are the characteristics of a rectangle?) [twice] Yes.

Student *It has 2 parallel lines.*

Teacher:

He said it has 2 parallel lines, is it correct? Rectangle, characteristics of a rectangle, it has 2 parallel lines is that correct? Rectangle. Yes eh Lizzie. This is a rectangle [showing her].

Lizzie: *It has 4 sides.*

Teacher: *Yes it has 4 sides, good.*

Lizzie *2 sides equal.*
2 sides equal. Is it just 2 sides which are equal? Yes Nontandazo.

Nontandazo: It has 4 sides, each side are equal to each other.

Teacher: *Each side is equal to each other, Yes Busisa*

Busisa *It has 4 sides, 2 sides are equal and the other 2 sides are equal.*

Teacher:
Teacher:

Yes (opposite sides are what? Equal and parallel)[twice]. *Those are the characteristics of a rectangle. What about a square (characteristics of a square*)[twice]. *Yes Chikuku, you are quiet, give us the characteristics of a square.*

Chikuku *It has 4 sides and all sides are equal.*

Teacher:

(4 sides and all sides are equal)[twice]. *Right* [pause]. *Can you give me the (3 types of triangles*)[three times] [pause] *Do you know the types of triangles and their characteristics? Yes Molina.*

Molina: *Quadrilateral.*

Teacher: *What?*

Molina *Equilateral triangle.*

Teacher:

Equilateral triangle, can you give me the characteristics of equilateral triangles, one or two characteristics. Eh Lizzie.

Lizzie: *All sides are equal.*

Teacher:

All sides are equal in an equilateral triangle. Another type of triangle. Yes Nicholas.

Nicholas: *Scalene triangle.*
Yes scalene triangle, what are the characteristics?

All sides are not equal.

Teacher: *Scalene triangle, all sides are not equal, very good. Eh another type of a triangle. Busisa.*

Teacher:

Busiso: *Isosceles triangle.*

Teacher: *Isosceles triangle, what are the characteristics of isosceles triangle?*

Busisa *2 sides are equal.*

Teacher: *2 sides are equal and base angles are also what? Equal. Today boys and girls I want you to do practice12 A, practice12 A, numbers 3, 4 and 5,, numbers 3, 4 and 5, and tomorrow we will be looking at (circle, circumference and area)*[twice]. *Do you know the formula to find the formula to find the area of a circle?*

The lesson on plane shapes was more on the practical side and students were handling physical materials. Each student was availed a chance to handle particular shapes and with the help of the teacher, culd learn the concepts and calculate quantities. This , however, took time as the teacher had to atend to each student individually. As with the lessons on simultaneous equations, the whole lesson was spent discussing with students and there was no time left for class work. Normaly, work that is written in class, with the teacher supervising is meant to consolidate what would have been leant in class. But for students with visual impairment such time could not be availed. The homework would have to be done during evening study.

4.2.2.2 Data from personal teacher interviews

Interviews were held with four teachers separately in a bid to have them explain their experiences in teaching students with visual impairment, the problems they encountered, and to recommend on what can be done to improve on opportunity to learn Mathematics for students. Only data relating to the first research question was presented here and excerpts of responses were compared.

The first question on the interview sheet required the teachers to explain their experiences in teaching students with visual impairment and how these students learn Mathematics. For Mr Kadya, his first experience of teaching students with visual impairment was a nightmare. On deployment, the staffing officer had not told him he was going to a school for the blind. He saw it on the sign post when he got to the bus stop. He was only told that the school had a 0% pass rate in Mathematics, "*so are you going to manage*?" was all the staffing officer had said. He was welcomed at the school by a Form Thre student who was non-sighted, who told him they had stopped doing Mathematics a long time before. His first impression was clouded with uncertainty. Below is part of the conversation he had with the boy.

Student: *Sir, what subject do you teach?*

Mr Kadya *: Mathematics*

Student: *Ah! So you came to teach Mathematics, we have stopped doing Maths. Do you think this place is for maths? We stopped doing Maths a long time ago, we don't do maths here.*

This student was in the class that Mr Kadya was assigned to teach. He later dropped Mathematics after eight months in Form Three. Mr Kadya was comparing his teaching experience at a school where he had taught while on Teaching Practice during training with his experience at the current station. He said he had noted that the visually sighted students did not come to ask questions, he had to look for them, whereas at the other school the students would follow him to the staffroom with questions. He also noted that during the lesson some visually impaired students would not write anything even if the teacher gave them paper to write on. You would think they had not heard anything. He said he had one totally blind student who was good in Maths and this is how the teacher described the student.

Mr Kadya: He would sit quietly. The problem with those who are totally blind, they don't write during the lesson, you would think they have not heard anything. I try to give then papers to write on while I am talking. They write after you have left. That one was very good, but his problem was he would never raise his hand in class. But if you call him you have nothing to correct. He surprised me once when he requested for a chance to explain some concept, he did it so well.

With that, together with what he had been told the first day when he got to the school, Mr Kadya came to the conclusion that the non-sighted students had no interest in Mathematics. However, during lesson observations, what the researcher noted was that it was true that the students did not raise their hands to answer a question, but all the groups observed were working out solutions using their slates and styluses.

Mr Jira, had taught at School A for seventeen years and seemed reluctant to leave. He revealed that when he first came to the school he had got the impression that students with visual impairment were not able to pass Mathematics since none had passed before. He said it was as if the students had accepted that label and so were not making an effort to excel in mathematics. It was only after some of the students got Ds and Es that they started changing their attitude. During the first two years at the school, he experienced a lot of dropouts from the Form Three, but there was one totally blind student who was determined to be the first one to pass Mathematics. He figured that the major challenge that students faced was the unavailability of Braille textbooks. He had this to say about the student:

Mr Jira: *Him being totally blind, it was really a challenge because of the problem of books. We had no Braille textbooks. I tried by all means to improvise and help him individually. At one time I gave him a talking calculator, it's really an adding machine, it was stolen. And when I gave him some print book, because he would ask someone to read to him, the book was stolen. So they were trying by all means to discourage him. They were saying if you concentrate on Mathematics you will fail other subjects, it will take all your time. But he remained resolute and in the end passed with a B. That was the first student to pass Mathematics.*

He was exceptionally good. Its only that when he wrote he didn't finish one of the papers, he would have got an A. This was my first student and up to now no one has performed better than him.

In trying to explain his commitment to the school, he disclosed that he now had a challenge with his eyes.

Mr Jira : The other thing is that I have a challenge with my eyes. I am now not used to the board because with the visually impaired students you mostly work with them individually. When you are dealing with work that does not involve diagrams there is no problem, you can *just lecture. But if the work involves diagrams, for one to understand a diagram it can take a full lesson to attend to one person for him to grasp the concept, because you have to be pressing and trying to show the person. First one has to understand, that diagram has to be in the mind, especially those who did not eh… those who were born blind.*

Researcher : Thats one thing I always wonder about, what sort of mental image they have.

Mr Jira: It's really a challenge. So that's why they have to feel, you have to show them and try to create something in the mind, unlike someone who once saw and with time lost his sight.

Researcher: Maybe those who get blind at 16 or 17 would be able to remember.

Mr Jira: That's the problem. So it's a real challenge when it comes to things that need to be… to have a picture.

Researcher: Yah, it's a challenge.

Mr Jira: It would be better probably if we had models, but even with models, one has to feel it and probably create something in the mind, so its really a challenge.

Researcher: Maybe you still need models at secondary school.

Mr Jira: Really?

Researcher: Then you would need a good carpenter to make those.

Mr Jira: That would be…but the problem is when it comes to the exams, they will be working with papers. That's why we have to draw and try to …

Reseacher: But can't they transfer that knowledge when the have handled models?

Mr Jira: SBut when its on the diagram it appears different.

What Mr Jira was trying to show was that the teacher has to make adjustments in the methods they use to teach students with visual impairment. The teacher needs a lot of time to be able to attend to each individual student when teaching concepts involving diagrams. This was witnessed by the researcher in the Form One classes when they were learning shapes. The teacher had to move from student to student, making them feel the model plane shapes that he had given them

In addition to the shortage of textbooks, the teacher revealed that they were not able to provide students with diagrams. The school has a department that is supposed to print Braille material for students. They have a machine called an embosser, but they cannot get the appropriate braillon paper for drawing diagrams. The school used to get braillon paper through donations which have since ceased. So the non-sighted students face challenges when they learn topics that involve diagrams. Moreover, the Braille books are voluminous; one textbook can have up to 15 volumes in Braille. The students cannot carry these volumes to go and do homework or to revise during the holiday, culminating in another loss of opportunity to learn mMathematics.

At School B the researcher held interviews with one teacher and the resource teacher. The teacher, Mrs Mvura was an experienced teacher with nineteen years in the field, which means she should have been well versed with what went on in the classroom. At the time the school was visited, Mrs Mvura was not teaching any students with visual impairment, but she had taught them before. She was thus asked to relate her experience which is captured in the conversation below.

Researcher: *Do you teach these students with visual impairment?*

Mrs Mvura: *This time I am not teaching them but I taught them before.*

Researcher: *What were your experiences in teaching them?*

Mrs Mvura: *It was a bit difficult sometimes. I was not used to teaching them together with the sighted students.*

Researcher: *How many children with visual impairment were in each class?*

Mrs Mvura: *I had three in a class of 45. Sometimes, when I wanted to do a demonstration on the board, then I forgot that there were blind students who can't see what I am doing. When I then remembered I had to go back to assist them. Sometimes I would ignore and say I will see them later. So most of the time they would be left behind.*

Researcher: *Was that when you failed to find time to see them?*

Mrs Mvura: *Yes. And then for topics that have diagrams I found it difficult to incorporate them in the learning experiences.*

Researcher: *Ok*

Mrs Mvura: *Like with sets, the curly brackets are like this* [demonstrating with her hands]. *I would just assume they knew what brackets are. These are the issues that I encountered but in the end I talked to the resource teacher when we were doing sets and most of the time I would come and ask her. These children ended up not writing the Maths.*

Researcher: *What form were you teaching them?*

Mrs Mvura: *Form 3.*

Researcher: *Did they have textbooks?*

Mrs Mvura: *Their textbooks had not come.*

Researcher: *How then did they do their homework?*

Mrs Mvura: *They had to get help from their friends. The friends would dictate to them the questions. For tests I would come and have the resource teacher braille the questions if I remembered in time. But if I forgot the child had to start by writing down the questions while I dictated to him, then he would write the test later.*

Researcher: *Are you conversant with Braille?*

Mrs Mvura: *No I am not.*

Researcher: *So it was like whatever they wrote you would bring to the resource teacher?*

Mrs Mvura: *Yes I would bring to the resource teacher so that she would transcribe.*

Researcher: *Would you then explain to the child where he would have gone wrong?*

Mrs Mvura: *No I wouldn't. The time...*[laughs]*… I would mark their work much later when I remembered I had given them work. This side there were problems; Braille paper may not be available, transcribing, and then the work was sent back to me.Sometimes I would get the books three days later after I had corrected for the sighted students. So when the books came I would be far ahead. It was a challenge.*

Researcher: *So there was a problem?*
Mrs Mvura: [Laughs]*… No, but now I think people are used to them so they now know.*

Mrs Mvura: *I came in 2008. The resource unit eh.. was it there I can't remember.*

Researcher: *But the resource teacher came in 2009*

Mrs Mvura: *Yes, but I can't remember if there was a resource unit, but these children I taught them in form 3.*

Researcher: *Ok*

Mrs Mvura: *So now it's better because people know that we have such children in class.*

From Mrs Mvura's comments, the researcher noted that the teacher had problems teaching non-sighted students. Besides not being conversant with Braille, she admitted 'forgetting' that there were students with visual impairment in her class she and would only go to assist them as an afterthought, even when working on the board. At one time when the researcher visited school A as a school inspector, she noticed boards had been removed from the classrooms. On inquiring she was told the totally blind students, who were in the majority at the time, had demanded the boards be removed because teachers would work on the board with the partially sighted students and forget the visually impaired could not follow what was going on. The exposition by this teacher points to a loss of opportunity to learn for the students with visual impairment.

Mrs Mvura also talked about the lack of textbooks at the time. Even currently, the resource teacher reported that there were no textbooks for Form Three. They only had copies for Form One and Two, so the students could not access information as easily as the sighted were doing.

On the question about the problems she had in teaching the Nemeth code, Mrs Mvura professed ignorance of what the Nemeth code is. She asked; *What is the Nemeth code?* It appears she had not heard of the word. So whatever the students wrote would be taken to the resource teacher to transcribe. The teacher would mark and return them to the resource teacher who would then explain to the students individually, where they had gone wrong wrong. It was quite a process and obviously these students could never catch up with the rest of the class.

The researcher also interviewed the resource teacher, Mrs Madzore, at school B, after discovering that there were no students who fitted in the sample. The Mrs Madzore had more information on the experiences of students with visual impairment. First, she was asked to explain her general duties as resource teacher before zeroing in on Mathematics. The duties of the resource teacher included reading students' work, transcription (form ordinary print to Braille and vice versa), and training non-sighted students in mobility and daily living skills. She had to know each one's background because she had to teach Braille to those who got blind along the way.

Mrs Madzore explained that they had copies of *New General Mathematics Books 1 and 2*, but none for the upper classes. Part of the conversation the researcher had with Mrs Madzore is captured below. The conversation was conducted in Shona as she had indicated she was comfortable speaking in Shona. The researcher then translated the script.

Researcher: *So these are the students that you assist with Braille?*

Mrs Madzore:

To teach Braille yes, some of them come here already conversant in Braille, but there are other contractions which are more advanced which are used at secondary level which they do not know. That is what we teach them here.

This had been confirmed by Mr Jira when he pointed out that for every topic that you teach, you have to start by teaching the Braille specific to that topic.

Researcher: So what do the children use for writing?

Mrs Madzore: The juniors use slate and stylus.

Researcher: Do you mean the Form Ones?

Mrs Madzore: Yes the Form Ones, but we are training them to use computers.

Researcher: Okay.

Mrs Madzore: Yes, they are at the preliminary stage, they are not fast yet. It's only the Upper sixth student who uses the computer.

Researcher: Do they still use the Perkins machine?

Mrs Madzore: They use the Perkins but currently we have none working.

Researcher: Ok so they use computers?

Mrs Madzore: Yes we encourage them to use computers.

Researcher: How do they manage in maths?

Mrs Madzore: In Maths we have our Braille textbooks.

Mrs Madzore:
Researcher: Did you transcribe them here?

Yes, NGM are the ones we use [some came from Dorothy Duncan library]. *The teacher brings work for a chapter, I Braille it including the examples the teacher will use in class so that the student can also try and follow what will be done.*

Researcher: So that when others are working on the board the students can follow?

Mrs Madzore: They will be able to follow but there are challenges. You will see what happens during lessons. It's better if you see for yourself.

Researcher: So what do you use for brailling?

Mrs Madzore: The Slate and Stylus. Plus we have a computer which has Duxbury software.

Researcher: Okay.

Mrs Madzore: So I type directly and it converts to print.

Researcher: So it then prints Braille?

Mrs Madzore: Yes, we translate.. It's only that the equipment is at administration, we were using it at the prize giving day.

Mrs Madzore: These ones and those with low vision, and to train them. I also give remedial in other subjects because teachers don't have enough time with these kids

Researcher: Time?

Mrs Madzore: Our classes, they are too big.

Researcher: You mean for them to give individual help?

Mrs Madzore:

Yes to give individual help. And it's a challenge to the specialist teacher since you can't know all subjects. [But she attends to all subjects that are learnt by non-sighted students]

Researcher: Yes you are right.

Researcher: Did you do Special Education?

Mrs Madzore: Yes I did Special Education at Zimbabwe Open University (ZOU).

Researcher: So you have BEd?

Mrs Madzore: I have a BSc.

Researcher: BSc Special Education.

Mrs Madzore: Yes, plus I am on the Masters program.

Researcher: Did you start as a teacher?

Mrs Madzore: Yes I started as a teacher; I have a Diploma in Education but under primary.

Researcher: Okay.

The discussion with Mrs Madzore confirmed what the other teachers had pointed out, that the subject specialists had no knowledge of braille, the non-availability of Mathematics textbooks and the lack of adequate time to assist students with visual impairment. Unlike the other teachers, Mrs Madzore had specialised in Special Needs Education so she had more knowledge of how students with visual impairment could be assisted.

Mrs Madzore:

4.2.2.3 Data from focus group interviews

Focus group interviews were held with a group of Form Ones and then a group of Form Twos. During the introductions, each one talked about their age, home area, when they lost sight and the subjects they liked at school. It emerged the they lost sight at different ages, ranging from birth to as late as six months ago. This information was required since the researcher wanted to assess how students managed with Braille.

With regard to research question one, the students were asked to say how they viewed their learning of Mathematics now as compared to how they learnt it at primary school. Part of the conversation with the researcher is given below.

Researcher: Is there any difference in the way you learn Maths now and how you learnt at primary school?

Chorus *Yes there is.*

Researcher: *What's the difference?*

Student 1: *At primary we were doing maths using models, cubes with numbers. We were using cube baring board.*

Researcher: *And what is that?*

Student 1: *Where you put the board. You would put a number on the board.*

It sounded like the cube was some sort of abacus.

Researcher: So at primary it was easy for you to work your Maths using the cube?

Student 2: *At secondary we have no cube baring board… we should use calculators and here we require scientific calculators.*

Researcher *Are you given talking calculators?*

Student 2:

Yes they are available. If you request you are given but they just add and subtract [these were adding machines]

Researcher: *So how do you write?*

Student 3:

For shapes we have no Braille textbooks so we do not understand shapes. It requires one to have one's own book so that you can feel for yourself.

Researcher: *How were you learning the shapes at primary school?*

Student 5: *At primary the books were available.*

From the discussion with students, it appeared there were more learning facilities at primary than at secondary school. Textbooks were available at primary whereas at secondary school they had to be transcribed, a facility that was giving teachers challenges, and hence culminating in lost opportunity to learn.

From the individual interviews and focus group discussions, what emerged was that from theway lessons were presented in, there were lots of lost opportunities to learn mathematics and so students with visual impairment could not perform as well as their sighted peers.

First, the teachers had no specialist training so they were teaching using trial and error. Then there were no materials to enable students with visual impairment to practise doing Mathematics, so the time spent doing mathematics may not be comparable with that for sighted students. It also emerged that the negative attitude of students made it difficult for them to concentrate on learning Mathematics. All this translates to lost opportunity to learn Mathematics.

The ICEM (2005: 21), notes that in the regular classroom,

> " most of the teaching of Mathematics is done through blackboard work supplemented by oral instruction. So sighted students grasp the idea of 'organising' and

'sequencing' mostly by the manner in which the matter is presented on the board".

In other words, the way teachers frame classroom activities significantly impacts on the way the students are likely to engage tasks (Gresalfi et al. 2011). But due to limitations caused by visual impairment, the non-sighted students miss this important information on learning. Hence, children with visual impairment face difficulties in the rest of the process of arrival at the results and interpretation. Teachers of the visually impaired should, therefore, bear this in mind when planning strategies in teaching Mathematics.

4.2.2.4 Discussion of findings

Exposure to Mathematics

The findings from eight lessons observations, four teacher interviews andtwo focus group interviews revealed that teachers presented lessons to visually impaired students in more or less the same way as they do with sighted students, particularly in terms of organisation, presentation, interaction and content knowledge.

Organisation

It emerged from the study that content was presented in logical sequence as demonstrated by Mr Kadya and Mr Jira. Lessons started with a recapitulation of previous work before new work was introduced, and finally, the teacher would conclude the lesson. However, a lot of time was spent on revision of the previous day's homework, sometimes taking up more than half of the lesson. This meant that very little time was left for new work. For instance, Mr Kadya, in the 1A1 class, took eleven minutes to solve the question on simultaneous equations, while Mr Jira took almost eight minutes on the question on number bases. The teachers had to repeat their statements, sometimes more than twice to make sure students grasped it. A possible explanation for such protracted revision could be that students could not see what the teacher was writing on the board. The teacher had, therefore, to repeat whatever he said for the non-sighted students to internalise the concepts being dealt with. The repetition could also be taken as a way of ensuring mastery learning of concepts. Through mastery learning the teacher could monitor student progress so as to "certify competent learners…diagnose individual learning difficulties…and prescribe specific remedial problems" (Wood, 1998: 315). However, in this study, the classes were large and individualising instruction for learners with disabilities presents its own problems for the teacher.

All the students worked out the problems dictated by the teacher, but then the teacher never checked on what the non-sighted students were writing on their slates as can be seen from all the lessons observed. The students could not refer to any examples that the teacher worked on the board since they could not see. This is one instance where the researcher noticed a difference with the way sighted students are taught where the teacher goes round checking and correcting what the students are writing. This finding concurs with what was noted by the ICEM (2005: 21) that

> "most of the teaching in mathematics is done through blackboard work supplemented by oral instruction. So sighted students grasp the idea of 'organising' and 'sequencing mostly by the manner in which the matter is presented on the board".

Gressalfi et al., (2011) add that the way teachers frame classroom activities significantly impacts on the way students are likely to engage on the tasks. In other words, Gresalfi et al. are saying is that what students can do is fundamentally an issue of what is made possible for them to do. In that regard, the researcher feels there is loss of opportunity to learn for nonsighted students.

Presentation

Questions were broken down into short precise questions which gave more students a chance to answer. Questions play an important role in the teaching and learning of Mathematics since teachers used exposition most of the time. It, therefore, becomes essential to consider how questions are formulated, to who they are addressed and the sort of knowledge required in answering the question. In this study, questions mostly followed the recommended ‘question, pause and name individual’ format. This was done in order to invite students to think and to invite silent agreement or begin the organisation of a response (Ged Gast Creativity Consultant, 2017). In a way, it forced all students to prepare for a response since they would not know who would be called next. This finding is in support of Posamentier and Jaye (1999), who recommend that the teacher should select a student to answer a question rather than rely on volunteers. In cases where the teachers relied on volunteers it was noted that the whole class would chorus an answer, with no guarantee that every student had got the right response. The teacher would the repeat the answer given by a student before asking the next question. The repetition was an indication that the response was correct, but in some cases even the wrong answers were repeated in the form of a question. This was evident from lessons reported previously in 1A2 and 2A2 .

The results of the study further revealed that the questions asked were mostly ‘how’ and very rarely ‘why’ questions. ‘Why’ questions prompt learners to explain and justify their thinking, giving them the opportunity to understand what they are doing. Most questions asked dealt with ‘what’, for instance ‘what are we going to do?’ which prompted students to mention the next step of the solution. The drawback of procedural oriented questions is that emphasis is on doing rather than understanding. Learners cause rules and procedures without understanding why they work. They may focus on computational procedures rather than the concept. It also emerged that more often than not, the teacher would ask and answer his own questions. This was equivalent to lecturing. In the view of the researcher there was no way the teacher could ascertain students' understanding or lack of it, culminating in loss of opportunity to learn Mathematics.

It emerged from the study that conclusions to lessons were not drawn from the class. At the end of the lesson the teacher would give a summary of the steps to follow in a solution or the main points. The lesson conclusion, traditionally, should be a way of testing whether objectives have been achieved or not, by asking students short precise questions on the concepts taught and learnt. In the current study this was not done by both teachers who were observed, so this was another case of loss of opportunity to learn.

The study revealed that teachers made and used teaching aids where appropriate. For the geometry lessons the teacher had made plane shapes using cardboard boxes, although these were not durable, which he issued to the class. Each student had to be issued with a set of plane shapes that they were going to learn that day, a triangle, a rectangle, a parallelogram and a trapezium. The teacher had gone through the difficult task of making aids for each of the visually impaired students since these were to be handled at the same time. Each student, therefore, had the opportunity to handle and manipulate the different plane shapes that were issued out. Mariotti (1995) stresses the relationship between a geometrical figure and a geometrical concept and argues that geometry is a field in which it is necessary for images and concepts to interact. Visually impaired students thus have to handle geometrical figures in order to develop a mental picture of the object. But it was a tough task for the teacher who had to move from one student to another trying to make them identify the different dimensions. It took a lot of time such that not much could be covered in a single lesson. In the meantime, those partially sighted students who could read were using diagrams from the textbook.

Interaction

On interaction, the findings showed that the teachers were speaking clearly and loud enough to be heard from the back of the class. The teachers occasionally switched to the mother tongue in order to explain fully for the benefit of those students who might not be fluent in English language. In particular Mr Kadya spoke in the mother tongue most of the time even though the language policy specifies that students at secondary level should be taught in English. He claimed some visually impaired students in the B class, and this was confirmed by the researcher during observations, students would just listen and not write anything in class and not raise their hands to give a response. This was confirmedby the researcher during observations. Mr Kadya explained the behaviour by saying "those who are better are in the A class, for those in the B class we just have to push. They were streamed using Grade Seven results". He gave the impression that students in the B class could be having problems understanding the English language and he used the mother-tongue to make them understand clearly. However, this was contrary to what Channa (2012: 762) stated that teachers should strive to let learners practice English language in order for them to comprehend mathematics language vividly".

Both teachers tried to create rapport with students. They knew students by their names and also their backgrounds. Occasionally, they reached out to some in order to get them feel wanted and identify with the teacher. In the lessons that were observed, both Mr Kadya and Mr Jira tried their best to call students by their name and occasionally reached out to some students to try and encourage them to answer questions. For instance, whenever Mr Kadya wanted Busisa to answer a question he would approach him jovially and give the impression that he would know the answer: '*Ye-s , Busisa'*. Mr Kadya spoke feelinglyly about the student who dropped Mathematics and kept repeating how it pained him. Mr Jira also demonstrated that he was on friendly terms with the students. He had nicknamed one student '*Professor'*, to show that he believed in him. He also talked of one student whom he tried to assist because he could see the student had potential.

Students with visual impairment need support from the teachers and other stakeholders so as to gain on opportunities to learn Mathematics. Tindell (2006) notes that the most important low-tech item a parent can offer a child with visual impairmentis encouragement. He argues that in the end, it will not be the tools or the technology that will make a difference, but the attitude and beliefs about blindness which we convey to our children throughout life that will matter most. If teachers have high hopes for the students and keep encouraging them, the students will be motivated to learn the Mathematics.

It emerged from the study that teachers tried their best to communicate with the visually impaired students during lessons. Giving feedback to students on their homework assignments, however, left a lot to be desired. Mr Jira disclosed that he marked his students' assignments even though he admitted having problems with his sight because he read the dots instead of feeling them. He was however literate in Braille and could show students where they went wrong in their written work. On the other hand, Mr Kadya and Mrs Mvura admitted being illiterate when it came to reading Braille, yet they were supposed to teach the students the extra Braille symbols that had to be introduced for each topic. Mr Kadya confessed thst hr used other students or other teachers to mark his students' work because he could not read Braille. He also read the dots as did Mr Jira and had also developed eye problems.

One wonders how a teacher can trust a student to mark another student's work. There was no way the teacher could check whether what was being read to him was the exact content that was written down, possibly resulting in wrong feedback being given to the student who had written the work. Moreover feedback was given verbally which is different from the case with sighted students where they actually see the error. Mrs Mvura also confessed that she was not literate in Braille. She disclosed that she would take all the written work to the Resource teacher for her to transcribe. When asked if she then used the transcribed work to explain to the students where they had gone wrong she admitted that she referred the students to the resource teacher. The way responsibilities were shared between Mrs Mvura and Mrs Madzore depicted the way in which co-teaching is practised even though this was more by coincidence rather than being planned for. The two ended up sharing the responsibilities for planning, delivering and evaluating instructional practices (Sileo & Garderen, 2010). The approach also supports what was suggested by the ICEVI (2005: 24) where the learner will be able to consult the regular teacher on matters to do with content and consult the resource teacher with regard to format and presentation of reading materials.

Mrs Madzore, the Resource teacher, confirmed what Mrs Mvura had said, especially that Mrs Mvura took her work to the Resource teacher for transcription. Mrs Mvura would then mark the work and return the marked work to the resource teacher who would then explain the errors to the student. In the process, the visually impaired students found it difficult to catch up with their peers,culminating in loss of opportunity to learn. Samples of transcribed, marked work is shown in Appendix 5b where instances of wrong spellings, e.g. 'wenesday' and 'circumf', were not even corrected. Though the lesson may not be on spellings, students need to be taught the correct spellings.

Mrs Madzore disclosed how some teachers were failing to communicate with their students. She claimed that at one time she asked the students with visual impairment what they wanted to be adjusted in the classroom to enable them to learn well and they mentioned the board. They preferred the board to be removed because they said the board "*separates them from the others*". They said "*the teacher may simply write an assignment on the board and we don't know it*". However the teachers did not communicate much with the students on errors that they made, the resource teacher did that, in spite of the fact that she was not a specialist in Mathematics. So there are chances that students are losing opportunities to learn the appropriate concepts. The discussion with Mrs Madzore confirmed what the other teachers had pointed out. The other teachers hadnoted that the subject specialists had no knowledge of Braille, there was non-availability of textbooks and there was no adequate time to assist students with visual impairment.

In addition to being ignorant in Braille, Mrs Mvura admitted that she sometimes forgot that there were visually impaired students in her class and that she would only attend to them as an afterthought. The teacher would work out problems on the board with the sighted students, oblivious of the non-sighted students present in the inclusive setting. The teacher was being irresponsible and for students this constitutes a clear case of lack of opportunity to learn Mathematics.

Mr Jira and Mr Kadya would write on the board and not bother to check what the visually impaired students were writing since the students could not copy what was written on the board. This finding was in line with what Jackson (2002:1249) reported about a blind Mathematician, Emmanuel Giroux, who said "But also I'm extremely frustrated because other mathematicians don't explain what they are doing at the board and what they write". At the end of the lesson, the teachers would give students homework to be done during study time. The question numbers were dictated, and yet the visually impaired students had no textbooks to refer to. They would have to depend on the good will of their peers who would read to them the questions on the exercise which the researcher saw as loss of opportunity to learn.

Content knowledge

The results of the study therefore confirmed that all four teachers had received appropriate professional training, and had no problems with the subject content to be taught. Three of the teachers had at least a Bachelor of Education in Mathematics and experience of more than seventeen years, while Mr Kadya had a Diploma in Education and only four years experience. Both Mr Kadya and Mr Jira used teaching methods that they used with sighted students, occasionally making adjustments such as preparing teaching aids and engaging in individualised instruction. However, their efforts were hampered by their lack of knowledge of Braille (especially Mr Kadya), continued use of the board at the expense of non-sighted students and the shortage of textbooks for students with visual impairment. This was contrary to what the California State Board of Education (2006: vi) stated in their Braille Mathematics Standards, that it is critical to have a qualified teacher who understands the non-visual approach necessary for teaching functionally blind students. So, again, we se a case of lost opportunity to learn.

4.2.3 Research question 2

How is time on task exploited by both teachers and the students with visual impairment in the classroom?

The second question dealt with how the teacher and the students utilised the time set aside as the Mathematics period. For sighted students, the procedure is normally that the teacher introduces the lesson in a specified time, then new concepts are introduced with examples being worked on the board by both the teacher and the students, with the use of teaching aids where appropriate. Then students are given time to practise individually or in groups, actually answering some questions, with the teacher going round checking and assisting. The teacher will then conclude the lesson by a quick check on what knowledge and skills students will have acquired, in about five minutes, which is basically a check on the extent of achievement of the lesson objectives. The same should be practised with non-sighted students, but the extent to which this is done is what the researcher wanted to ascertain during the lesson observations and interviews.

4.2.3.1 Data from lesson observations

During lesson observations, the researcher noted that it took a lot of time for the class to work through a problem. In the lessons taught to the Form Ones on simultaneous equations, only three problems were done with the class during the lesson and there was no individual class work. The lesson on shapes also took a lot of time. The students were engaged in the learning but this is where the teacher had to go from one student to another, showing the students the models and helping them identify the length, width, and other characteristics, a sort of individual education activity. Depending on the number of visually impaired students in a class, this can take a very long time.

For the Form Two lessons on number bases, four short questions were done. In all cases, the first two would be revision of problems given as homework as can be seen from the following excerpts.(The full lesson was reported before)

Mr Kadya: *Let us look at what we did on Tuesday. You said you encountered problems on number 2.*

Class: *Yes.*

Mr Kadya: *Ok. Number 2, first equation $4m - 2n = 16$ and second equation $2m - 3n = 0$*

The revision of number 2 took about 8 minutes.

Mr Kadya: *That is number…that is number 2. Any other number? Yes Edward.*

Edward : *number 4*

It took eleven minutes to go through number 4. One of the problems was done twice, using substitution and then using elimination, that was all, no class work. To be able to learn Mathematics effectively, the students need a lot of practice in solving problems. For sighted students the practice is started in class when students are given questions to answer individually in class, and the teacher checks on how the students are doing. This was not the case with students with visual impairment, which the researcher saw as a case of lost opportunity to learn.

Mr Jira used the same strategy in presenting his lessons. The lessons taught were on number bases and all the students did was answer oral questions and occasionally work on their slates and stylus.

4.2.3.2 Data from personal teacher interviews

Both Mr Jira and Mr Kadya seemed to agree that time was inadequate for students with visual impairment to learn Mathematics effectively. Below is an excerpt from the interview with Mr Jira.

Mr Jira: *"When you are dealing with work that does not involve diagrams it's not a problem, you can just lecture. But if the work involves diagrams, for one to understand a diagram, it takes a full lesson to attend to one person because you will be trying to show the person. First of all, one has to understand, that diagram has to be in the mind, especially those who did not, eh… those who were born blind".*

"It's a challenge. So that's why they have to feel, you have to show them and try to create something in the mind, unlike someone who once saw and with time lost sight. That person will be having pictures in the mind".

Part of the conversation with Mr Jira is given below.

Mr Jira : *So this topic I am doing on equations, it is clear that the children are behind. I have said I will not rush.*

Researcher: *If you compare the time that you spend teaching, like at the normal school as compared to here, how much time would you spend teaching simultaneous equations at a normal school?*

Mr Jira: *A week, but if you teach both linear and simultaneous equationsyou would* *take….2 weeks.*

Researcher: So how long does it take?

Mr Jira: Ah, like now I have gone for three weeks… but there is a challenge that if they write something today, we have to repeat the work especially with the B class. They were streamed using grade 7 results.

Researcher: Ok.

Mr Jira: So the majority they can't even write.

Researcher: So those in the A class are they better?

Mr Jira: The A class is better, the B class we just have to push them…There is just Lameck but he was put in the B class because in all other subjects he had 9's. He just had a 0ne in maths. He is good in most topics, but this one, did you see his hands? To write he has to exercise patience.

Researcher: Yes I noticed quite a number have multiple disabilities.

Mr Jira: So there is a challenge that if you administer a test, you should not think too much about time. But since our events are timetabled there is a challenge. If you noticed, I gave them 6 questions, I don't expect to get the books early, maybe in the evening, because they take their time.

Mr Jira confirmed time was not adequate especially when dealing with diagrams where one has to make every blind child feel the object.

Mr Jira: It's really a challenge. That's why they have to feel, you have to show them and try to create something in the mind, unlike somebody who once saw and with time lost their sight. That person will be having pictures of things in the mind. So they have a challenge.

Researcher: But they forget. I was talking to one girl…

Mr Jira: Oh ! Is that so?

Researcher: She said she had gone blind at 5 or 6 years somewhere there. She is now 16. I was saying to her "Do you still remember anything?' and she said "Ah, I can't".

Mr Jira: That's why! That's the challenge.

It therefore goes without saying, that the students with visual impairment need more time on tasks to effectively learn Mathematics.

Still on time, the researcher inquired about the time during which the students with visual impairment write their examination.

Researcher: So are you still giving them an extra 30 minutes during the examination?

Mr Jira: They say it has to be 25% of the time so its 25% of 2 and a half hours. They write for three hours and some few minutes. But still you find those who have challenges of reading will not be able to finish. Form 1 and 2 they will be performing very well, they will not have many problems. But when it comes to form 3, probably it will be the increase in work load as a result they are saying they don't have a future.

Researcher: It's a pity.

Mr Jira: And they were saying 'we can be accepted in any institution without maths',(because of the affirmative action that is sometimes practised).

When the researcher talked to Mr Kadya, he revealed that a few students started liking Maths after some of their friends failed to secure temporary employment as teachers after the staffing officer told them they only employ those with Maths at O level.

4.2.3.3 Data from focus group interviews

From the group interviews, the students also had something to say concerning time.

We need more time.

On when they do homework they disclosed that they do homework during study time and they thought that time was enough.

During study time.

Ye we are able to finish.

On what they do if they make an error while brailling their work they responded;

It depends on the error. If it's just the answer and you have written it at the end of the line, and there are other things above and below you just have to tear the paper and start afresh.

Some slates have pins so if you pin the paper, it remains with holes you can put back the paper into the pin holes.

Ma problems atosangana nawo pakudzidza Maths ndeekuti tinogona kupiwa sokuti Maths tonyora pasi muslate,kuti tizobudisa muslate iya iya tichiworker maths, iya zvinoita sokutora time zvinoita sokunetsa. Munhu weprint anenge achitonyora pa rough achitoona achitonyorera pamusoro achitoenda.Manje isu tikambonyora , tombobudisa, todzosera futi hatizogoni kunanganisa.(The problem we meet is that when given a problem to work we write in the slate so it takes time. The print person will be writing on top in rough and proceeding. We have to write then remove the paper from the slate and when we put it back we sometimes fail to align).

Both teachers and students were agreed that the time given to visually impaired students to learn Mathematics was not adequate. Students spent a lot of time if they had to make corrections while writing with the slate and stylus. Teachers also spent a lot of time assisting each student individually when teaching geometry. As a result, they would not manage to complete the syllabus in the stipulated time, culminating in lost opportunity to learn.

Stols (2013:2) echoes what has been explained by Gillies and Quijada (2008), that learning depends to some degree on time and effort. He warns that without adequate time on task no learning is possible. In the lessons observed, students were seen to be engaged in learning activities when they answered questions asked by the teacher and when they worked problems on their slates. The question to ask here is whether there was effective use of time. It appeared the questions asked by the teachers in most of the problems worked by the students, were emphasising more on procedural fluency. There was no evidence of understanding, adaptative reasoning or strategic competency. The questions set as homework seemed to test the same concepts, which were at the same level of cognitive demand. The time spent repeating the problems took up most of the day's lesson. Learners need to engage in exercises in a range of levels of cognitive demand in order to improve learner performance (Stols 2013). This evidence corroborates what Ngoepe and Treagust (2003) found in a study done in South Africa, where teachers wasted time writing down solutions on the board for students to copy and wrote all the class work on the board instead of referring learners to the textbook. So the inefficient use of time constituted another opportunity to learn.

4.2.3.4 Discussion

It emerged from the study that visually impaired students spent a lot of time on a task yet they still needed more time to learn Mathematics than their sighted peers. Their teachers started the lesson with a revision or recapitulation of the previous day's work. An introduction to a lesson normally takes about five minutes, but in their case the revision would take more than half of the lesson. In other words, new work was only introduced after twenty minutes into the lesson. At this rate, there is no way the visually impaired students can cover the same amount of work as the sighted students. Although the students spent a lot of time on the task, not much ground was covered, which is a pointer that they need a lot more time than the sighted students.

There was no time for individual work where the teacher would check on what students were writing. In fact, the teachers did not even look at what the students were writing while answering questions in class. A lot of time was, therefore, spent 'doing' Mathematics, but with no evidence of what the students could actually do. This finding confirms Stols's (2013: 2) argument, that learning depends, to some extent, on the degree of time and effort. Stols (2013) also warns that without adequate time on task, no learning is possible. Stols adds that learners need to engage in exercises in a range of levels of cognitive demand in order to improve performance. This evidence corroborates what Ngoepe and Treagust (2003) found in a study done in South Africa, where teachers were found to be wasting time writing solutionson the board for students to copy and writing the class work on the board instead of referring learners to the textbook. So the ineficient use of time constituted another oportunity to learn lost.

It also emerged from the lessons on geometry that a lot of time was needed for students with visual impairment to learn geometry effectively. When students were given different models of plane shapes, they had to be assisted to identify the dimensions of the shapes. The teacher had to move from one student to another showing each one how to figure out the dimensions. This took a long time since it was like an individualised learning activity. A lot of time was spent on a task, but not much ground was covered in terms of concept acquisition. This finding was in line with the expectations of the California State Board of Education (2006: vii) who explained that the blind child cannot take in his or her surroundings at a glance, hence touching is essential, which means “the blind child will need additional learning time in order to have the opportunity for tactile exploration of shapes, objects or graphics”.

On the lessons involving simultaneous equations taught by Mr Kadya, Mr Kadya spentthe whole lesson discussing with students and there was no time left for class work. This was unfortunate because work that is normally written in class, with the teacher supervising is meant to consolidate what students would have learnt in class. But such time could not be availed for students with visual impairment. The homework would have to be done during evening study as confirmed by the students. So, by the end of the lesson a teacher may not be absolutely sure of what exactly each student had mastered from the lesson since nothing would have been written down to prove it, which is again a lost opportunity to learn.

Data from the study revealed that the time availed to students with visual impairment was not enough. For instance, Mr Kadya indicated that the time he would take to cover the topic on simultaneous equations was almost three times the amount of time he required when teaching sighted students. He admitted he should not rush because he realised they took their time and some could not even write. This finding confirms what the ICEVI (2005) said about visually impaired students, that their pace of learning is comparatively ‘slower’ than that of sighted students because of the visually impaired child’s limitations in organising ideas, methods and devices used for solving Mathematical problems. The California State Board of Education (2006) also accepted that a blind child will need additional learning since he or she should be given the opportunity for tactile exploration of shapes, objects and graphics. Mr Kadya had opted thus to teach them extra lessons in the evening.

Evidence from the study pointed to lack of management of time on the part of the other teacher. Mr Jira taught for an extra seven minutes after the siren had gone to indicate the start of break time. His concern was to finish what he had planned to teach, which showed that either lesson time was too short or he had planned too much for one lesson. This meant the students were going to delay coming back from break and that would inconvenience the next teacher. All this goes to show that although students spend a lot of time on tasks, the work that is covered does not match the effort put into the work.

4.2.4 Research question 3

What modifications, in terms of teaching strategies, do teachers make when teaching Mathematics to students with visual impairment?

The third question dealt with teaching strategies employed by the teacher when teaching Mathematics to students with VI. Strategies for teaching students with VI are bound to be different from those used with sighted students. The fact that non-sighted students cannot read print means that the teacher has to employ other strategies to impart Mathematical knowledge and skills to them. The researcher observed how students were writing, how the teacher made use of his voice, the resources teachers employed to assist students to learn, and how the students coped in class.

Students with visual impairment were observed using slates and stylus to write in Braille. The slate and stylus can be seen in Appendix 5a and 5b. The students could be seen working very fast on the slate and stylus and some were able to give correct answers. However, the teacher could not check on the Braille paper whether the wrong answer given was due to computation error or lack of concept as this would involve removing the paper from the slate. Instead of using the slate and stylus, the students could have use the Perkins brailler. In both schools, however, the Perkins machines were reported to be out of use due to nonavailability of repair facilities. The schools had computers which students should have used to type their work though. At school A, computers were available but they were only used when teaching new students Braille. At school B the non-sighted students only use computers available for typing work in content subjects where they use the basic Braille.

Mathematics is one subject where very little can be done on the computer because the Mathematics symbols come as a separate program which even the experienced typists find very slow to use. So for Mathematics it was back to slate and stylus and there was no loss of opportunity to learn.

During the lessons, both teachers were using their voices to advantage. Both spoke very loudly for all students to hear and they would repeat their questions or comments to make sure all students got the message correct. This is what Mr Jira had to say, during the interview, about the way the students learn:

Mr Jira: *Yes maths is a challenge even to those who are sighted, what more for those who are blind? ……Because one thing that I discovered with the visually impaired is that their hearing is very sharp.*

Researcher: *Yeah?*

Mr Jira: *So they learn more by hearing and feeling.*

Researcher: *Even their memory appears to be much better than ours.*

Mr Jira: *That's why they are good at content subjects.*

The teachers had, therefore, to speak loudly and repeat whatever they said for the benefit of the visually impaired. In addition the teachers had to switch to the mother tongue to explain fully to those who may not be articulate in English. The policy on language is that at secondary school level students should be taught in English, but for this group, most students start school later in life and may not grasp the language as early as is expected.

Some students were reported to be having problems with the feeling the dots during reading. Mr Jira explained the problem that one of his students encounters.

Mr Jira: *The other challenge we are having is of those that are blind, especially these days it seems most people are getting blind, its related to HIV so its really a challenge.*

Researcher: *Is that so?*

Mr Jira: *Those with HIV have feeling problems because it's only the forefinger that is used for reading. So when it comes to reading it's really a challenge. I have one student in form 4 who is good, when you ask him things he can answer you, but when it comes to reading he is very slow.*

It could not be ascertained during the visit, whether the slow reading speed was due to the effect of HIV or something else. All the teacher knew was that the students who had that problem had feeling problems.

Another modification noted on teaching strategy was the way the teacher had to assist every non-sighted student in handling models and diagrams. The ideal practice for these students would be to give each one an individual education programme so that the teacher could have adequate time with each student and ensure the student has grasped the concept. In a way, that was what the teacher was doing, but in a class of five or more non-sighted students, one period may not be enough to attend to each student individually. Maguvhe (2015:3) avers that "most learners do not take mathematics and science subjects mostly because their teachers give them the impression that these subjects are inaccessible to learners with sight problems". And yet the problem could be that the teachers themselves do not have adequate direct experience with teaching no-sighted learners. To illustrate the importance of teaching learners different methods of doing things, Osterhaus (2002) successfully taught Braille users to master scientific and mathematics concepts. Osterhaus suggested how to set up a technology corner, explaining methods of teaching graphs to blind and partially sighted learners. She advocated for the use of Perkins Braillewriter so that all the steps could be shown in Nemeth code. In developed countries such as the USA, varieties of technologies are now available to allow for the participation of visually impaired students in learning Mathematics. Fraser and Maguvhe (2008) illustrated how to use a combination of three dimensional models to capture the meaning of two dimensional drawings. These examples show that with necessary adjustments in teaching methods, students with visual impairment are in a better position to access mathematics concepts just like their sighted peers. Unfortunately for students in Zimbabwe, the current level of the economy does not support the acquisition of the said technologies, and students lose opportunities to learn Mathematics that way.

The teachers observed were explaining whatever they were writing on the board in order for both groups to benefit from the instruction. When they repeated the question or the answer given by a student, it was all in an effort to make sure all students grasped that part of the proceedings.

The use of the talking calculator is one strategy that the teacher could use to enable the nonsighted students to perform calculations on their own. Unfortunately, the schools could not afford to buy the talking calculators for students because the calculators are expensive. What were available were the donated ‘talking’ adding machines which could do the four basic four operations only. So the students could not do complicated calculations on the adding machine.

The revision of the problems done the previous day, which some may see as a waste of time, could be taken as a way of ensuring mastery learning of the concepts learnt. In mastery learning learners have to work on a concept until they show some degree of mastery before proceeding to the next section. Through mastery learning the teacher could monitor student progress so as to “certify competent learners…diagnose individual learning difficulties… and prescribe specific remediation procedures” (Wood, 1998: 315). However in the current situation, the classes were to large and individualising instruction for children with disabilities presented its own problems for the teacher.

4.2.4.1 Discussion

The major modification that was made in the teaching of Mathematics to visually impaired students was the use of the Nemeth code for Braille Mathematics and Science notation, a tool which gave students with visual impairment access to Mathematics work. The study revealed that students used a slate and stylus to write in Braille. Previously, students were using the Perkins Braille writer which was more user-friendly than the slate and stylus. Pictures of the slate and stylus can be viewed in Appendix 5a. With the Perkins writer, it was possible to read what one has written by moving the paper up, while with the slate and stylus, to read what has been written, the student would have to remove the paper from the slate, turn the paper over and read using the forefingers and then return the paper into the slate. On returning the paper, there is the danger of misaligning the paper so that the student could leave a wide gap in between, or worse still, over-write on top of a previously written line. This was confirmed by the students who complained that, in addition to the misalignment, it wasted time as well. Currently, there were no functional Perkins writers in the schools as these had outlived their working lives and there were no technicians to repair them.

It emerged from the study that there was a critical shortage of Braille textbooks. Both the teachers and the students lamented this shortage of textbooks. Donated books were in print so they would need to be transcribed for the visually impaired students to access them. However, there were problems with transcription. Where there was a Braille Press, there were no qualified personnel to operate the thermoform which produces diagrams. Where the books had been sourced, they had been produced without the accompanying diagrams. Furthermore, the school could not import braillon paper that is used on the thermoform due to financial constraints. The implication is that students would learn a concept but the associated diagram would not be there to reinforce the concept, resulting in lost opportunity to learn. This finding is against the philosophy of the Braille Standards which stipulates that the teaching and learning of Mathematics in a tactile mode is as essential for a blind child as the teaching and learning of print Mathematics is for a sighted child.

The bottom line was that visually impaired students were operating without textbooks and depended on the good will of partially sighted students to read to them. During the school holiday, these students could not be exposed to Mathematics. Where books are available, such the books were so voluminous that the students would not be able to carry them home, which is a big loss of opportunity to learn.

Results from the study revealed that the teachers verbally repeated the answer given by a student for emphasis. Most of the questions were also repeated several times to make sure that the visually impaired students got them since they were working from memory. The repetition was probably meant to allow the non-sighted students to visualise exactly what the questions required since they could not read the work written on the board.

Findings from the study also showed that efforts had been made to increase the time for visually impaired students during examinations. The policy stipulated that they be given an extra 25% of the time, but although this is appreciated, the students still faied to finish their examination, especially in Mathematics.

4.2.5 Research question 4

What intervention strategies can be employed to maximise opportunity to learn Mathematics by students with visual impairment?

The last question focused on intervention strategies that could be employed to maximise opportunities to learn Mathematics by students with visual impairment. The teachers were asked to suggest what they thought could be done to improve the learning of Mathematics by students with visual impairment. The teachers made a number of suggestions on what the school and other stakeholders could do to improve the opportunities of students with visual impairment to learn Mathematics. The suggestions shall be discussed in relation to the challenges that were being faced by both teachers and students in their classroom interactions and also the researcher's own ideas.

One suggestion by teachers was to provide a different syllabus for students with visual impairment, one that did not involve a lot of diagrams. The excerpt below explains how the teacher felt about the syllabus.

Researcher: *Do you want to add anything or ask anything:*

Teacher:

The other thing that I had left concerns the syllabus, because there are other things that are not of help to the visually impaired.

Researcher: *Yes, like what?*

Teacher:

I think its important that we have an arithmetic paper for Maths, something that makes them have an interest in Maths than to concentrate on things that are not of any importance or any value in their lives.

Researcher: *But the new syllabus that came out again did not accommodate that.*

Teacher:

That's the problem because they are a minority group. If it was like what is done in South Africa, [not sure if this is authentic] *they have arithmetic and also maths. They would write both of them but at least we would not be having that challenge.*

Researcher:

So that those who want arithmetic would write arithmetic and those who want Maths would they write their Maths?

Yes: *Yes, I think that would be better.*

The teacher felt that since students with visual impairment were good at arithmetic, if a separate arithmetic paper was set for them, a number of students would be able to come out with a certificate in some aspect of Mathematics. It appears, though, that the curriculum planners in different parts of the world are convinced that students with visual impairment can learn the same curriculum as their sighted counterparts. Brawand and Johnson (2016) say that schools in America put an emphasis on instruction in Mathematics and students who are visually impaired should not be left out of this national effort. Tindell (2006) points out that children who are visually impaired should learn Mathematical skills at the same level as their sighted peers. Tindell (2006:1) goes further to say "not only do blind children require the same skills, they are capable of learning the same information and performing the same tasks as sighted children." The same sentiment is echoed by Maguvhe (2015) on the South African situation and Simalalo (2006) reporting on the Zambia situation, that children with visual impairment learn the same curriculum as the sighted students. So we cannot be an exception. What is needed is to make suitable adjustments in strategies for students with visual impairment to access the same information as their sighted peers.

Most teachers at secondary school level did not get specialist training on teaching Mathematics to students with visual impairment. That has a bearing on how they teach and how they supervise these students. Of the four teachers interviewed, three were secondary school trained and had no specialist training, while only one who was primary trained had gone through some specialist training. The secondary teachers apparently shun specialist training in Zimbabwe because it is offered at primary teachers'training colleges. The universities in this country have, however, introduced a degree in Special Needs Education (SNE), but again the degree is offered to primary school teachers. Secondary school teachers need to learn Braille so as to be able to mark students' work effectively. As the situation was at School A, Mr Kadya was using students to read the homework written by other students.

The conversation I had with the teacher is captured below:

Mr Kadya: *The other challenge is with the Braille, up to now I have not mastered Braille, it's a problem to me…..*

Researcher: *So do you have time to learn Braille?*

Mr Kadya: *I don't have the time, I just learn it as we go.*

Researcher: *Just learning from what you see in the books?*

Mr Kadya: *Yes just seeing what's in the books. I thought I should be attending lessons on Braille, but then there is no time. I should be having lessons with the teacher with a set programme, but I have no time. I have a problem in that I look at the dots and I now have eye problems. I am told I should not read the dots, as it is now I can't see the dots, my eyes become watery. They say we should not read the dots, we should feel the dots.*

Researcher: *You are supposed to feel the dots.*

Teacher: *But a person who has sight is more prone to seeing than feeling the dots.*

Researcher:

Yes, we always feel we have an advantage because we can see the dots, but the dots are not good for our eyes in the same way that computers are also not good for our sight.

Teacher: *So that's where I have a problem. Now I just look offside.*

Researcher: *So how do you mark?*

Mr Kadya:

I make use of some students and some teachers when they are free. The problem I have with some teachers is that they don't know or have forgotten some of the maths signs. So I use students mostly.

Researcher:

Did you ever consider going for Special Needs Education or maybe it depends on your ambitions? Do you see yourself staying here or would you like to move on?

Mr Kadya: *Before I came here I wasn't thinking about it. But when I joined the school I realised those things were needed here, they make the job easier and there are certain things that we need to do to lighten the burden of others. We were just brought her without knowledge of what to do with the students……My first three weeks here were difficult for me.*

For as long as the secondary teacher training colleges and the universities continue to leave out special needs education from their in-service and pre-service programmes for secondary school teachers, students with visual impairment will continue to suffer. Besides, it does not sound morally right to employ a student to do the teacher's task. Rowe (2013: 11) supports the idea of providing specialist training for teachers when she observes that neither studies conducted in Kenya nor Zambia showed any example of good practice. She further identified a considerable lack of suitable teacher training experiences in the field of Mathematics. She also highlighted concern that the trainee teachers raised, that teachers were not being exposed sufficient training on how to use specialist resources they were provided with. Mereku et al. (2005) recommend that there be an urgent increase in school-based in-service education activities to support teachers of students with visual impairment. In addition, Maguvhe (2015) suggests that Mathematics and Science teachers need to attend regular staff development courses that cover selected topics in Mathematics and Science,that also accommodate students with visual impairment.

Students with visual impairment should be provided with appropriate Mathematicstextbooks and other learning resources for them to master the concepts (Mereku et al, 2005; Rowe, 2013). Data gathered from School A indicated that the school had no basic Mathematics textbooks at secondary school level. The basic Mathematics text used at secondary level was the *New General Mathematics* (NGM) series, but these were not available at the school. Mr Jira, who has been in the school for a long time, bemoaned the lack of Mathematics textbooks and the lack of facilities to print Braille material. Below is the part of the conversation the researcher had with him.

Mr Jira: *And the other challenge that we have is of Braille textbooks. So they don't have eh… they are not exposed to ….*

Researcher: *They don't have extra material to refer to?*

Mr Jira r: *Yes. So they depend on the print.*

Researcher: *That one will remain a challenge. I don't know, about this embosser that you have?*

Mr Jira r: *The problem with the embosser, no diagrams and with Maths when it comes to…*

Researcher: *So diagrams you have to do on their own?*

Mr Jira: *Yah.*

Researcher: *That lady was talking about, you can use strings and then go to the embosser.*

Mr Jira: *The problem is we no longer have* braillon.

Researcher: *What's this braillon?*

Mr Jira: [Takes a sample] *this is the braillon paper that we put on the thermoform.*

Researcher: *Okay. Where were you getting these from?*

Mr Jira: *From Germany. We used to be provided by CBN but nowadays they no longer supply. They have since stopped.*

Researcher: *There is a problem, because even if you want to do the diagrams they become too many.*
Yah, it's voluminous. For one book for Maths book 3 you will be having more than 15 volumes. So that's very voluminous, they can only …The other challenge is with these print versions, these print people, they can take the book

Mr Jira:

home. But those who use Braille they can only use the books here because you can't carry them.

Researcher: *They are too many.*

Mr Jira: *So during the holidays they are not exposed to Maths.*

Mr Kadya also confirmed the issue concerning shortage of Mathematics textbooks. Here is what he said

Researcher: *Are there any teachers at the primary school who did SNE?*

Mr Jira:

Yes … quite a number and some of them tried to help me write some signs that I didn't understand. SNE is essential, but the problem is that there are not enough resources,….

Researcher: *Um, Braille books?*

Mr Jira:

Here we have a problem with Braille books. If you noticed, in that class, I am using a print book and I give the pupils print books. That one is a big problem.

Researcher: *Is it because the majority are partially sighted?*

Mr Jira:

Yah they are partially sighted but I have nothing to give the blind. The child is supposed to touch and follow through when I, for instance, go over an example in the textbook.

Researcher: *Do you still have a Braille Press here?*

The Braille Press is there but the books that they say they were using I never saw them, the NGM. I think I got 2 or 3. I am using Maths Today and those at Dorothy Duncan had promised to transcribe these but up to now nothing. One parent went there and collected for his child in form 3, 12 volumes, and the child has improved greatly ever since he got the books.

Mr Jira:

Mr Jira: *I don't know how they operate. This parent has even bought a talking calculator, very expensive, for her child. She was saying she bought from Dorothy Duncan, but when I got here the teachers were saying Dorothy Duncan loans out their books but the problem again is that there are no diagrams, it has very few. It's just explanations.*

Researcher: *So does it mean they have no expert on diagrams?*

Mr Jira: *Maybe. And the challenge we face now with ZIMSEC is that they put too many diagrams. One of my good students ended up passing with a C, I was expecting a B. Coming out of the exam he said "Sir, I left out all diagrams".*

Textbooks contain explanations on new concepts, worked examples and exercises that the teacher can use to assign class work and homework. Students can also solve problems on their own. Students with visual impairment, therefore, are at a disadvantage since they cannot access material for learning on their own. They cannot read the explanations on new concepts nor can they follow the worked examples in the textbook. They have to depend on sighted peers to read to them the problems assigned for homework. For them these are lost opportunities to learn Mathematics. It takes a student with a positive attitude towards Mathematics and very good memory to be able to follow up on work done in class. The International Council for Education of People with Visual Impairment (ICEVI)(2005) also identified provision of correct Mathematics text material as one of the factors which contribute to the child's success in Mathematics. In addition, the USAID Working Paper (2008: 11) reiterates that textbooks are recognised as a critical component of instruction: textbooks support the curriculum and relate directly to the syllabus of the course. So there is need for every student to have a Mathematics textbook.

On the issue of support for students, Mr Jira talked of one student whom he had tried to assist because he could realise that the student had potential. His comments are captured below.

Teacher: *The stream that I started with in Form One that's the stream I tried to educate and encourage and I had one student who promised in Form One. He said it was possible that the visually impaired can pass Maths so I want to be the first to pass. I encouraged him and we worked together…Him being totally blind it was a challenge because we had no Braille textbooks. I tried all means to improvise and help him individually. At one time when I gave him a talking calculator, its actually an adding machine, it was stolen.[laughs].And when I gave him some print books , because he would ask someone to read for him, the books were stolen. So they were trying by all means to discourage him….But he remained resolute and passed with a B. That was the first student to pass Maths here.*

Researcher: *Oh! That was good.*

Teacher: *He was really exceptionally good. Its only that when he wrote he didn't finish one of the papers, he would have got an A. That was my first student and up to now there is no one who is totally blind who performed better than him.*

Researcher: Are there others who passed with C's?

Teacher: *So far those who passed with C's who are totally, I think I have about 4….*

Researcher: *By the way how long have you been teaching here?*

Teacher: *This is my 17th year.*

Researcher: *Seventeen? So you are stuck here, you don't want to move away?*

Teacher:

Ah…I am now enjoying it [laughs]. *Because working with few people as compared to when you go to other schools you work with large numbers* [laughs again]

Researcher: *Maybe the other thing is commitment as well!*

Teacher: *Yes I am really committed. The other thing is that I have a challenge with my eyes. I am now not used to using the board because with the visually impaired students you mostly work with them individually those who are totally.*

Mr Jira appeared committed to assisting the students with visual impairment judging from the length of time he has been at the school. Teaching small classes could be an attraction, but if he had no commitment he could have left. His other colleagues have moved up the ladder, getting promoted to deputy head, but he does not seem worried. He also confirmed what was said by Mr Kadya concerning damage to the eyes. It all goes to reinforce the need for training in Braille so that the teacher can also read with the fingers instead of reading the dots.

Mr Jira bemourned the need for a teacher of the visually impaired to learn Braille as the following excerpt shows. Mr Dew (not his real name) was a teacher at school A before he was engaged by ZIMSEC as the specialist for Braille.

Researcher: *Has there been any change since Mr Dew went to Zimsec?*

Mr Jira: Yes there has been a change but the problem is, he was working in the primary section so some of the things… Because when they are coming from primary, with Maths you have to introduce more signs. So there is more new work with Braille to *learn than with other subjects where they use the same Braille they were using from primary level. With Maths every topic has new signs and that's another challenge for the kids.*

Researcher: *So the teacher has to know those signs in order to teach them?*

Mr Jira: *Yes, so it's a real challenge.*

He felt Mr Dew was not doing enough to assist secondary school students on Braille issues since he was primary trained.

The ICEM (2005) stresses the importance of mastery of Mathematics Braille code by both the teacher and the students. For the teacher, "the real challenge is in teaching the Braille code to the child effectively" (ICEVI, 2005:12). At School A, where the Braille teacher just teaches the literary code, the mathematics teacher needs to be conversant with the Mathematics Braille code. The child should know how to discriminate the Mathematical Braille code from the literary code while reading.

4.2.5.1 Discussion

It emerged from the study that knowledge of Braille is crucial for both teachers and students. Teachers have to teach the Nemeth code when introducing each new topic because different concepts have different symbols. Symbols needed for learners to master the concept brackets, for instance, is different when they are taught in matrices or in sets. The teachers of the visually impaired should, thus, be literate in Braille in order that they can prepare and mark students' work and give feedback to students after marking. In a country where the economy cannot sustain the employment of a resource teacher in every institution where visually impaired students learn, then it is incumbent upon the general teacher to be conversant with Braille. This finding is in agreement with sentiments by Brawand and Johnson (2016: 2) who state that "teachers of the visually impaired should ensure that the student is presented with flawless Braille and adhere to all of the mathematical code's rules". Teachers need to feel confident in the ability to teach both the general Braille cod and the Nemeth code.

It was apparent from the study that teachers were not well trained to teach the visually impaired. Teachers lacked the necessary innovation where resources for teaching are limited. This was apparent from the experiences of one teacher who was deployed straight from college to go and teach visually impaired students. The secondary teachers' training college itself does not equip student teachers to teach visually impaired students at secondary level, so Mr Kadya was thrown at the deep end. It appeared the secondary teachers were not interested in getting in-service training from primary teachers colleges. Such teachers lack specialist training to teach the visually impaired. They do not know what to do to improve the learning conditions of their learners. This finding concurs with that of Sahim and Yorek (2009) who found that teachers do not have direct experience in teaching blind and partially sighted learners.

The study established that teachers need to attend regular staff development workshopsthat cover selected topics in Mathematics so that they may share ideas on how to accommodate the visually impaired learner. The idea coming out of this is that workshops should be organised for those teachers teaching the visually impaired students. One teacher even suggested bringing in visually impaired professionals who have an interest in Mathematics so that they can provide first hand information. More often than not, representatives from top management are invited to the workshops and conferences when they do not have direct experience with visually impaired learners. Apparently those officials cannot articulate issues to do with the teaching of visually impaired students and the reports they bring back may not be very helpful to the teachers on the ground. This finding was in line with Maguvhe's (2015: 8) who suggested that Mathematics and Science teachers need to attend regular staff development workshops covering selected topics in Mathematics, Science and the accommodation suitable for blind and partially sighted students. The California State Board of Education, the need for teachers of children who are blind to access ongoing in-service training among their Braille Mathematics Standards, so that they enhance and refresh their university preparation activities.

It emerged from the study that there is lack of relevant materials for use by students with visual impairment in the schools. Students are still using slates and stylus to write despite the problems encountered where corrections have to be made, when it would have been ideal for them to use the Perkins Braille machine or even the computer. Schools have been experiencing shortage of qualified technicians to service and repair machines, so the nonfunctional gadgets are more or less treated as junk. The shortage of materials includes textbooks which the schools are even failing to source. At school A they have employed braillists. But since these people are not mathematically literate, they are not able to produce Mathematics materials. One institution, the Dorothy Duncan centre, which used to provide support for the schools has been facing problems since it also depends on donations. The withdrawal of donor support because of political interference has left schools in a quandary, unable to provide even the basic Braille textbooks. Material for the blind is not available locally and is said to be very expensive. In such a scenario, it is the visually impaired students who suffer from lack of opportunities to learn. The finding is consistent with that of Rowe (2013) whose study demonstrated that there was a considerable paucity of appropriate didactical materials. The majority of schools did not provide adequate or suitable learning and teaching materials to pupils with visual impairment. Mereku et al., (2005) suggested that materials needed to be assessed in terms of whether they were available and adequate, or available and inadequate, or not available at all.

The study revealed that there was need to have a Braille Authority in Zimbabwe so that all institutions teach the same codes. It was revealed that at one institution the teachers were using the Nemeth code while the other school was using codes downloaded through Dexbury. One teacher was not even aware of what the Nemeth code was all about. The teachers noted that there were differences in some signs and these were going to confuse students. The problem is compounded when the children have to learn topics such as algebraic fractions or the quadratic formula where, in the print version, the one long division line will suffice while in the Braille version one will need two or more sets of brackets. The suggestions made by teachers were in line with what is happening in Slovakia where Kohanova (2006) reported thatthey had adopted the Lambda editor, a linear notation.

The results from the study also revealed that the students themselves had developed a negative attitude to Mathematics. Some claimed that there were teachers and peers who discouraged them, arguing that Mathematics would take all their time such that they would fail in other subjects. The finding was in line with what Maguvhe (2015) established that the blind and partially sighted learners themselves had no volition to improve their circumstances because their total learning environments had failed to assist them optimally.

4.2.6 Summary

The rationale behind opportunity to learn is that learners cannot be held responsible for underperforming if they have not had the chance to learn that which they are tested. Gresalfi et al., (2011) posit that learning is a function of what people can do given what they have opportunities to do. They note further that "failure and success must be taken apart in terms of interrelations between the 'affordances' of the designed learning environment and the individual intentions, and 'affectivities' that impact on whether those affordances are acted upon" Gresalfi et al., (2011: 250). The purpose of this study however to examine the opportunities to learn Mathematics that are availed to students with visual impairment.

The study revealed that students with visual impairment find it difficult to pursue Mathematics studies because the resources are limited, teachers are not adequately trained to deal with the situation confronting them in a classroom of learners with visual impairment, and some non-sighted students themselves have no volition to improve their circumstances. The study, also revealed that students with visual impairment need additional learning time in order to have the opportunity for tactile exploration of shapes, objects and graphics. This isalso confirmed by the Braille Maths Standards by the California State Board of education where they observe that one-on-one time is needed with an adult for a child with visual impairment to learn the names of objects, understand terms of movement and acquire other labels for the world that sighted students might acquire incidentally. So all in all, students with visual impairment experience a lot of missed opportunities to learn Mathematics.

One of the theoretical implications of the findings of this study is that if resources were to be made available to visually impaired students, in the form of clear policies, material resources such as braille textbooks, writing materials, adaptable electronic aids; and specially trained teachers, these students would perfom as well as their sighted counterparts. With the positive signs of the country's economic development witnessed of late, the education sector appears set improve.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The focus of this study was to examine the opportunities to learn mathematics that are accorded to visually impaired secondary school students in Zimbabwe. In chapter 4 the findings of the study were discussed. The purpose of this chapter is to present a summary of findings of the study, conclusions drawn from the study and recommendations given as suggestions for improvement on the teaching of mathematics to visually impaired students.

The chapter ends with suggestions for future studies.

The study was conceived out of the realisation that very few students with visual impairment rarely performed well in mathematics at Ordinary level and none had been witnessed taking mathematics beyond Ordinary level. In history though, we read about a whole world of blind mathematicians from other countries (Jackson 2002). In order to understand the opportunities to learn mathematics accorded to visually impaired students, the study considered the following research questions:

1. How are students with visual impairment exposed to mathematics in the classroom?
2. How is time on task exploited by both teachers and students with visual impairment in the classroom?
3. What modifications, in terms of teaching strategies, do teachers make when teaching students with visual impairment?
4. What intervention strategies can be employed to maximise opportunities to learn mathematics by students with visual impairment?

5.2 SUMMARY OF FINDINGS

The findings of the study are presented under the four sub-research questions. For each research question, results are presented under the categories that were used during data collection.

5.2.1 Research question 1:

How are students with VI exposed to mathematics in the classroom?

Data for research question 1 was collected and analysed under the categories organisation, presentation, interaction and content knowledge.

5.2.1.1 Organisation of the teaching and learning

Curriculum

The study established that visually impaired students are taught in the same way sighted students are taught. They learn the same curriculum as the sighted, in the same four years of secondary education as was seen from the syllabus document and they wrote the same examination. The fact that the students fail to complete the syllabus due to different reasons as compared to their sighted counterparts may be taken as a limitation on affordances which culminates in a loss of opportunity to learn mathematics. The ICEVI (2005) stated that in providing learning experiences to children with visual impairment, it is advisable to keep the expected outcomes on par with sighted children and adapt or substitute learning experiences to derive maximum understanding of concepts. Teaching mathematics to students who are visually impaired is essential for the same reasons that it is essential for sighted students (Sileo and Garderen, 2010).

Class size and Teacher-pupil ratio

Policy stipulates that the teacher pupil ratio for visually impaired students should be one teacher to ten students (1:10). It was observed that three of the classes observed had ten students each while one had thirteen, which meant the school met policy expectations. Class size is one factor that determines the amount of interaction between teacher and students.

Evidence from related studies suggests that class size has an important influence on student achievement, particularly for minority or disadvantaged students (US Aid, 2008, Moses, 2005). There is also evidence to show that lower student to teacher ratio improves teacher performance and satisfaction (Mosteller, 1995). In this research the class sizes were closer to figuresstipulated in the policy recommendations.

5.2.1.2 Lesson Presentation

Chalkboard work

The study revealed that teachers wrote solutions on the board despite the fact that the visually impaired students would not see what is written. Mrs Mvura admitted she would work on the board and forget she had non-sighted student in class (see interview excerpt 4.2.2.2). The teachers never looked at what was being written by the visually impaired students in class during class discussions. This prompted the students to request that boards be removed from the classroom, which was not effected since most students in the school are partially sighted and can read from the board. The non-sighted student regarded this as a loss of opportunity as the teacher could illustrate solutions on the board for the sighted when the non-sighted could not see.

Questioning

It was observed that the teachers tried to make up to the students by breaking their questions into short questions in order to reach out to more students. Teachers also repeated the questions and answers to allow the visually impaired students to internalise the bits of concepts. Henningsen and Stein (1997) document that the teacher's practices, such as the kinds of questions they ask, the ways they organise students' work and how they frame activities, shape the ways that tasks are implemented and therefore, students' ultimate engagement. For students to engage deeply with mathematics content, they must be given tasks that create opportunities for engagement. Thus, teacher's framing of activities
significantly impacts the ways students are likely to engage tasks.

5.2.1.3 Classroom Interactions

Teacher-pupil interaction

It was noted from the study, that there was a lot of interaction between the teachers and the students. It was observed that both Mr Jira and Mr Kadya made lots of repetition of questions to ensure the students heard them and could assimilate the ideas and commit them to memory (see 4.2.2.1 lesson excerpts). That way the visually impaired students would get adequate time to think of a response. During the lessons on geometry, Mr Kadya went through oneon-one encounters with each visually impaired student to make sure the students learnt the names of objects and "acquire the labels for the world that sighted students might acquire incidentally through vision" (California State Board, 2006) (see 4.2.2.1 lesson on plane shapes). Although the one-to-one encounters ensured adequate teacher-pupil interaction, it presented limitations on the number of students that could be attended to by the teacher during any particular lesson. Hence, there was need to further limit the number of students in each class. The teacher should thus ensure that the child does not encounter any difficulty in understanding the concept. Gresalfi et al. (2011), emphasise the interrelationship between learners and contexts and posit that learning is a function of what people do given what they have opportunities to do. What this means is that what students can do is fundamentally an issue of what is made possible for them to do.

Rapport with students

Teachers tried their best to create rapport with the students. Some students had been given nicknames (for instance one was called 'professor'), and the teachers used these to probe where they thought the student was left behind. Occasionally the teacher would teach using the mother tongue to get students to master the concepts.

5.2.1.4 Teachers' knowledge of mathematics content

Teacher training and experience

All teachers involved in this study were trained and experienced, which meant it could be assumed they had adequate content knowledge for the level they were teaching. Mereku et al., (2005) aver that one indicator of opportunity to learn standards is teachers' preparedness to implement the curriculum content, measured through the teachers' knowledge of the subject matter content and pedagogy. Teachers' knowledge of subject content and pedagogy often vary according to teachers' qualifications and experience.

Specialist Training

The only problem noted among the teachers was that three out of the four involved in the study lacked specialist training in Braille, which meant their pedagogy for visually impaired students could be faulty. They experienced difficulties in teaching visually impaired students, the difficulties being worsened by their lack of knowledge of Braille. In addition, Osterhaus (2015) avers that the mathematics teachers need to realise that it is their job to teach the mathematicsl concepts to their students, it is not the job of the resource teacher. The resorce teacher should only make sure the materials arein proper Nemeth code and that all graphics are of good quality.

5.2.2 Research question 2:

How is time on task exploited by both teachers and students with VI in the classroom?

Teaching and learning time

Both teachers and students were convinced that visually impaired students needed more time than the sighted students, to learn the complete mathematics syllabus. Mr Kadya disclosed that he needed three times the stipulated time to complete the topic ‘simultaneous equations’ with the visually impaired students. When it comes to geometry lessons where the students with visual impairment had to practice tactile tolerance, the teacher needs to give each student some individual help to manipulate the learning aids. In the sudy, teachers failed to manage time because it was difficult to assist every student individually in class. The students revealed that it took them time to correct, where they would have made an error when writing using the slate and stylus. Meanwhile the sighted student would be correcting on top of their work and proceeding.

Attitudes of students

The study also established that visually impaired students had a negative attitude towards mathematics. Mr Jira reported that some students who wanted to drop mathematics disclosed that some people, even some teachers, had advised them to drop mathematics because they said “if you concentrate on mathematics you will fail other subject, it will take all your time”.
Another student disclosed he had been told that “maths will make you fail other subjects” (see 4.2.2.1 interview excerpt). The teacher further explained that the students rush to drop mathematics because they believe “*maths hadzisi dzevanhu vasingagoni* (maths is not for the less able)”. With such attitudes one cannot see these students spending time doing mathematics, especially during their spare time. The finding concurs with Kutz et al. (2012: 47) who posit that for many students with disabilities, the curriculum of the general student population may be viewed as boring, irrelevant or unfair, such that students may choose to expend little time and effort despite having the knowledge and skills to be successful. Mehan (2008) also stated:

"Students' unwillingness to participate comes from their assessment of the costs and benefits of playing the game. It is not that schooling will not propel them up the ladder of success, it is that the chances are too slim to warrant the attempt".

Seifert (2004) adds that low achieving students will adopt learned helplessness behaviours which are characterised by an unwillingness to engage in tasks because the student believes the effort is meaningless and failure is pre-determined. Seifert explains that students with disabilities are at risk of developing learned helplessness because their disability may affect their decision making skills or privilege adult choices over student choices. Visually impaired students in Zimbabwe have no role models to emulate; they see no reason for learning mathematics.

5.2.3 Research question 3:

What modifications, in terms of teaching strategies, do teachers make when teaching students with visual impairment?

Braille code

The study revealed that the major modification effected for visually impaired students was the use of the basic Braille code for reading and writing. In addition to the basic Braille, mathematics students have to learn extra Braille, called the Nemeth code, which consists of extra mathematical symbols associated with each topic. Basic Braille is taught by the resource teacher, but the real challenge for classroom teachers lay in teaching the Nemeth code to the students effectively. Oral instruction makes sense to children with visual impairment only when the matter is presented either through visual or tactile information (ICEVI, 2005). Visually impaired students are supposed to be provided with correct text material especially textbooks, after the necessary editing of content and format. However in the study it was revealed that at school A, there were no Braille textbooks for use by the students. Efforts to have print texts transcribed to Braille had been hampered by the nonavailability of braillon paper which the school could not afford to import. At school B, textbooks for form one and two were available but with no diagrams; there were none for the O level classes. The students thus had no reference material to use on their own.

*Mathematics diagram*s

Diagrams were normally made on a machine called a thermoform. It was established that schools found it difficult to get braillon paper that is used on the thermoform since it was not available locally and it was reported to be very expensive. Children with visual impairment experience the world through their ears and their fingers; hence, tactile attraction at every stage is very important. The learning of the extra Braille for each topic and diagram would require more time. Osterhaus (2012) emphasises that blind students should not be excused from learning a mathematics concept because they are blind. Teachers are often heard saying ‘’blind students cannot graph” or blind students cannot do geometric constructions. The fact is they can do it if the correct tools are provided.

5.2.4 Research question 4:

What intervention strategies can be employed to maximise opportunities to learn mathematics by students with visual impairment?

Alternative syllabus

The study showed that the mathematics curriculum was accessible to students with visual impairment. However, one suggestion given by the teachers was that visually impaired students should be given a different syllabus from that given to sighted students, something with few diagrams, which can allow them to be operational in life. The teacher felt that giving the students the same menu was a waste of time since some topics end up not being taught anyway due to lack of resources. However other researchers have shown that visually impaired students are capable of learning the same material as sighted students; the material just needed to be presented in tactile form (Kumar, 2001; Sahin and Yorek, 2009.

In-service workshops

One suggestion made was that teachers of visually impaired students be given opportunity to hold workshops where they meet and share ideas on how to assist each other and the students. The current position was that decisions were made at the top and handed down without any contribution from the grassroots. People on the ground are in a better position to articulate problems encountered by both the teachers and the visually impaired students. Maguvhe (2015:7) supports the idea of teachers holding in-service workshops so that they "keep abreast of curriculum demands, new developments in their subject area and emerging technologies for accommodating the educational and wellness needs of their learners".

Pre-service training

Teachers suggested that all secondary teacher trainees should enrol for a course on Special Needs Education so that they learn the basic skills to teach mathematics to visually impaired students. Teachers felt there was need to learn Braille so that they can effectively supervise written assignments from students with visual impairment. The teachers also said they required training in the efficient use of material resources where they are available. In addition, teachers need to be made aware of all teaching methods available so that they are able to tailor these to an individual child's needs.

Learning materials for students

Students disclosed that they should be provided with relevant learning resources. Tactile materials such as Braille textbooks, embossed graphs and charts, raised diagrams, Perkins Braille machines, writing frames and styluses, ordinary typewriters and thermoform material for creating tactile shapes were not available in schools and yet these are the basic requirements for students with visual impairment to learn effectively. Absence of appropriate didactic materials for these students may prohibit access to a range of other subjects, which will severely limit their career opportunities. This finding is supported by Maguvhe (2012) who recommends that proper support be provided and reasonable accommodation measures be implemented to ensure effective mathematics and sience teaching and learning.

5.3 CONCLUSIONS

On the basis of the findings of this study, it can be concluded that secondary visually impaired students in Zimbabwe are not getting adequate opportunities to learn mathematics.

Teachers lacked basic training for them to effectively teach visually impaired students. At workshops, teachers were also not given opportunity to articulate the challenges met by both teachers and learners as they interact in the classroom.

Schools did not have adequate teaching and learning materials to enable students with visual impairment to practice tactile tolerance.

The fact that very little new work was taught meant the students would not be able to complete the syllabus at the same time as sighted students.

The government seems to have abdicated its responsibility to provide quality education to visually impaired students, this having been left to private organisations like the Churches.

There were no Braille standards on which to base the quality of learning of visually impaired students and there was no Braille authority to standardise the Braille codes used in schools. This had serious implications on the criterion used for assessing the visually impaired students.

5.4 RECOMMENDATIONS

The researcher made the following recommendations, basing on the findings of the study and the literature reviewed.

Recommendation to Ministry of education

5.4.1 It is recommended that the Ministry of Primary and Secondary Education produce guidelines on the mathematics content to be taught to students with visual impairment. At the moment teachers were quietly leaving out topics that they thought were difficult to teach to students with visual impairment.

Deployment of trained teachers

5.4.2 Deployment of teachers should be done systematically so that schools with visually impaired students are staffed with properly qualified teachers. It was learnt that teachers with no specialist training were deployed to special schools while others who had specialised were deployed anywhere.

Recommendation to colleges and universities

5.4.3 Universities and colleges which train secondary teachers should include Special Needs Education on their mathematics curricula so as to familiarise every teacher with the basics of Braille and sign language. A lot was being done to orient primary teachers in special needs education, but nothing was being done for secondary teacher trainees.

In-service training of teachers

5.4.4 In-service workshops should be organised for teachers already teaching students with visual impairment at district, provincial and national levels to give teachers a chance to articulate problems which will guide policy makers.

Procurement of materials for the visually impaired

5.4.5 The study recommends that Government assists the schools for visually impaired students to procure relevant teaching and learning materials at subsidised costs, and provide grants to these schools. This sentiment is echoed by Disability Rights (2015, cited in Maguvhe, 2015)) which argues that proper teaching and learning would take place if duty bearers take responsibility for exclusion, marginalisation and discrimination in education and are held responsible, They further argue that it is not the responsibility of the parents of visually impaired children to go up and down seeking a door that will open, spending the family's food budget moving from one school to the next. It shold be the responsibility of government officials to ensure that visually impaired learners access education.

5.4.6 Lastly, the study recommends that teachers engage in co-teaching which may be blended with selected research based mathematics instructional practices that are apptopriate for students who struggle with or have a disability in mathematics (Sileo,& van Garderen, 2010).

5.5 RECOMMENDATIONS FOR FURTHER STUDIES

Large scale research on teaching and learning of mathematics by visually impaired students

5.5.1 The study used small samples due to constraints of time and transport. Other researchers can investigate perceptions of working adults with visual impairment on the learning and teaching of mathematics at secondary level.

5.5.2 Other large scale studies should be made to find out the views of street blind beggars on the kind of mathematics that they need in order to survive.

5.5.3 Other studies could also investigate whwther mathematics and science would be prefered options for learners with visual impairment.

5.6 LIMITATIONS OF THE STUDY

The study was conducted in Masvingo province of Zimbabwe. Zimbabwe has ten provinces so the findings of the study may be difficult to generalise. The province however caters for more visually impaired students than any other province so the findings have potential to inform other researchers who may want to extend the study. There being scanty information on teaching and learning of mathematics at secondary level in Zimbabwe, the findings of this study can be used as a starting point in research work on teaching and learning of mathematics.

5.7 CONCLUSION OF THE THESIS

The study sought to examine the opportunities to learn mathematics accorded to secondary school students in Zimbabwe. The study was organised in 5 chapters as enunciated below.

5.7.1The problem and its setting

Chapter one puts the problem into context by reviewing the problem setting. The chapter described the motivation for embarking on the study. Research questions which guided the study were formulated. The study then explored the concept of visual impairment before stating the significance of the study, delimitations and limitations of the study, ending with a summary.

5.7.2 Review of related literature and theoretical framework

Chapter 2 the reviewed literature related to the study. The study explored the concept of visual impairment using ideas from Mangal (2007), Hergarty (19930, Baraga (1983 and Turn bull et al. (1995). The concept of opportunity to learn was explored basing on ideas from Posamantier and Jaye (2006), Mereku et al. (2005), Kurz 2012, Scherff and Piazza (2005) and Cooper and Lou (2007). The theoretical framework was taken from the works of Gresalfi, Barnes and Cross

(2011) and Gibson (1988) who specifically posits that learning is a function of what people do given what they have opportunities to do. The chapter also describes educational provisions for students with visual impairment in Zimbabwe as reported by Chimedza and Peters (2001).

5.7.3 Methodology

Chapter 3 describes the methodology adopted for the study. The study used a case study approach under the qualitative paradigm with special reference to Stake's version of a case study. Data gathering instruments employed were document analysis, lesson observations, personal interviews with teachers and focus group discussions with form 1 and form 2 students. The chapter explained the sample used and the sampling procedure and explained why the sample had to be boosted. Purposive sampling was used for sampling the schools, teachers and students included in the sample. The population consisted of form 1 and form 2 visually impaired students learning at two boarding schools in Masvingo province in Zimbabwe.

The chapter ended with a description of quality of data trustworthiness, credibility, transferability, dependability and confirmability. Ethical considerations were also discussed.

5.7.4 Findings and discussion

The chapter presented the findings of the study obtained from the different instruments used. A discussion of findings was presented after each research question.

5.7.5 Summary of key findings

The study established that teachers of visually impaired students at secondary level were not trained to teach students with visual impairment. As a result they were not using appropriate strategies for teaching these students. The majority of teachers were not conversant with Braille, which is the language used by visually impaired students. Schools were not well resourced with materials and equipment for use by students with visual impairment due to the high cost of equipment. This meant that visually impaired students could not access mathematical knowledge to the same extent that their sighted counterparts did. The time allocated for learning mathematics was found to be inadequate for visually impaired students.

The study recommends that teachers be trained to teach students with visual impairment at diploma and undergraduate level, that workshops be organised for teachers in service, and that the government tries to assist schools for the visually impaired in financing and sourcing materials.

5.8 CONCLUSION

The study has shown that students with visual impairment are not accorded adequate opportunities to learn mathematics at secondary school level. Students with visual impairment are a minority population and it's easy to overlook their requirements for learning, especially learning of mathematics. One needs to associate with them in order to understand their plight. The study has opened up more questions which other researchers can tackle in order to enlighten both the policy makers and the public in general, on the educational needs of the visually impaired students. These students need mathematics as much as anyone else.

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APPENDICES

APPENDIX 1
FOCUS GROUP INTERVIEW SCHEDULE

1. Can you tell me the subjects that you like most and why.
2. What was your grade in mathematics at grade 7?

3. Some people say mathematics is a difficult subject, what do you think?

4. Is there any difference between the way you learnt mathematics at primary level and how you learn it now?

5. What are the problems that you meet in learning mathematics?

6. How does your teacher assist you to overcome the problems?

7. Are you given time to write any mathematics problems during the lesson?

8. When do you do your mathematics homework and who assists you?

9. How does your teacher assist you to learn the Braille that you use in mathematics?

10. Would you like to continue learning mathematics after O level? Explain.

APPENDIX 2

CLASSROOM OBSERVATION CHECKLIST

Teacher…………………… Class……………..

Date…………………………………..

Topic……………………………………………………………………

Listed below are characteristics of effective teaching. The observer should **circle** the appropriate number using the scale below. Not all characteristics may be observable in one classroom situation.

1 = Not observed   2 = Needs improvement   3 = Accomplished very well

Organisation

Got the class settled	1	2	3
Introduced visitor	1	2	3
Reviewed previous lesson	1	2	3
Introduced the day's topic	1	2	3
Paced lesson appropriately	1	2	3
Presented concepts in logical sequence	1	2	3
Linked today's lesson to previous lesson	1	2	3
Summarised major points of the lesson	1	2	3

Presentation

Defined key concepts clearly	1	2	3
Used appropriate examples to clarify points	1	2	3
Showed all steps in solution to problems	1	2	3
Varied explanations for different material	1	2	3
Integrated examples from real life experiences	1	2	3
Used appropriate teaching aids	1	2	3

Interaction

Asked clear questions	1	2	3
Repeated questions where necessary	1	2	3
Switched to mother tongue for clarity	1	2	3
Encouraged students to ask questions	1	2	3
Listened carefully to student questions	1	2	3
Responded appropriately to students' responses	1	2	3

Gave students enough time to answer questions	1	2	3
Allowed students to discuss in groups	1	2	3
Knew his/her students by name	1	2	3
Content knowledge			
Presented material at an appropriate level	1	2	3
Presented material at correct level of course	1	2	3
Used appropriate level of language	1	2	3
Demonstrated a command of the subject	1	2	3
Times activities appropriately	1	2	3

Summary comments

- What were the teacher's major strengths?

- If this was a repeat observation, what progress did you discern in the teacher's skills?

- How does the teacher ensure key concepts are captured by students?

- What suggestions can be given for improving the teacher's skills or methodology?

Observer's signature……………………………………..
Date…………………………..

APPENDIX 3

INTERVIEW GUIDE FOR TEACHERS

1. Tell me about your experience as a mathematics teacher of students with visual impairment.
2. What challenges do you meet in your teaching and how do you deal with the challenges?
3. Do you have problems teaching the students the Nemeth code? Explain your answer.
4. What extra efforts do you make to enable the students to master what you teach them?

5. What can you tell me about the students with visual impairment and how they learn mathematics?

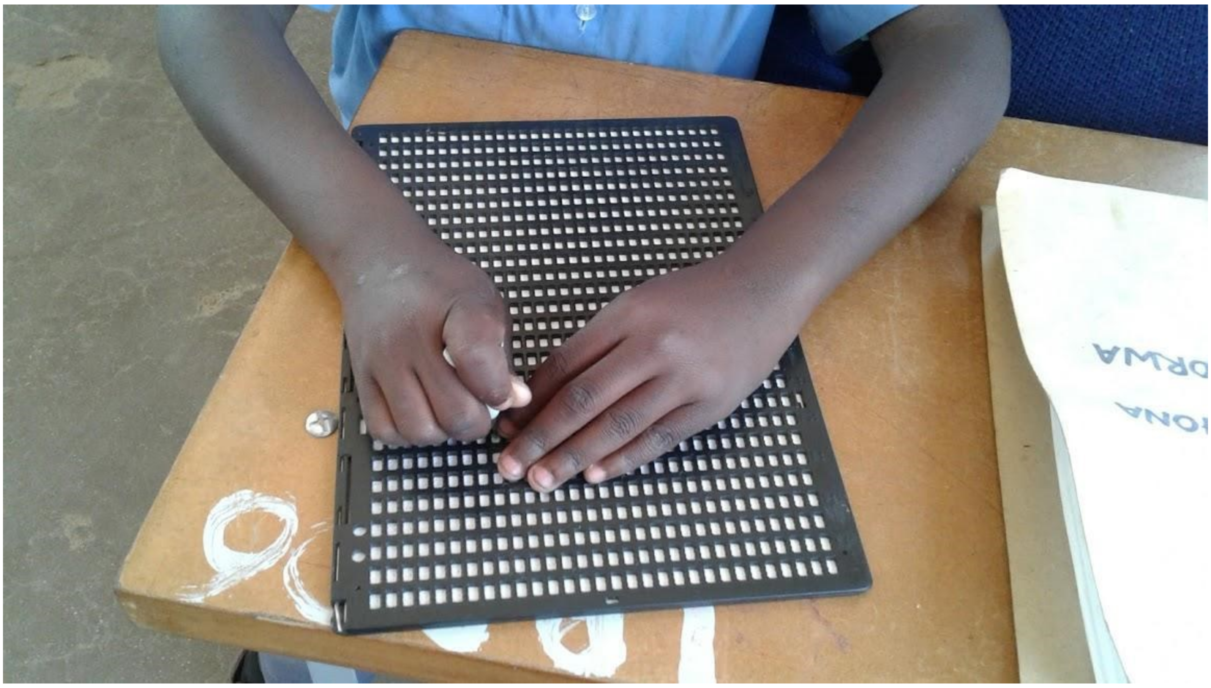
6. In your opinion, what problems do these students meet in trying to learn mathematics at secondary level?

7. Can you suggest what can be done by the school authorities, or by the Ministry of Education, or by ZIMSEC, to make the learning of mathematics more accessible to students with visual impairment?

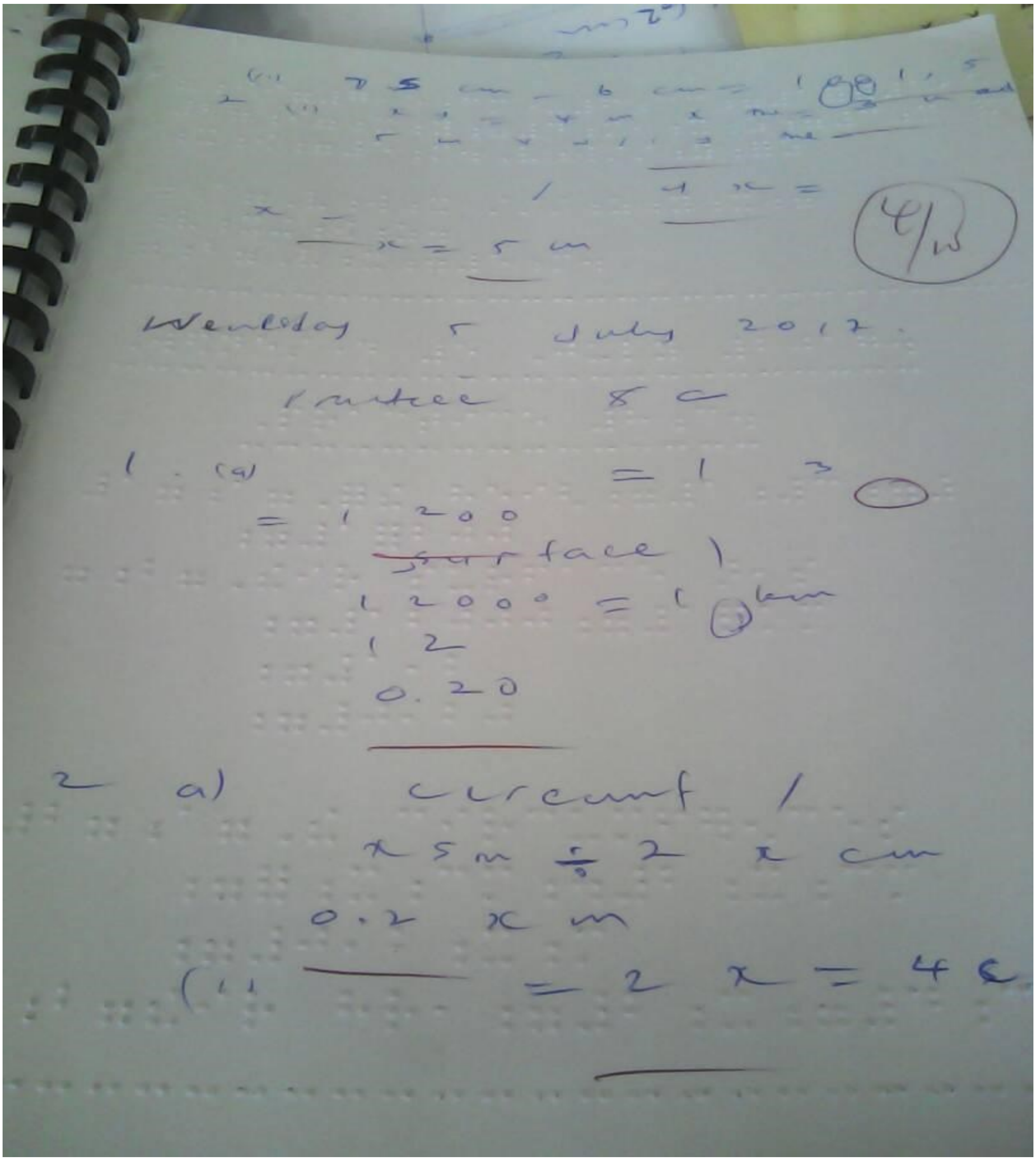
APPENDIX 5

STUDENTS' WRITTEN WORK

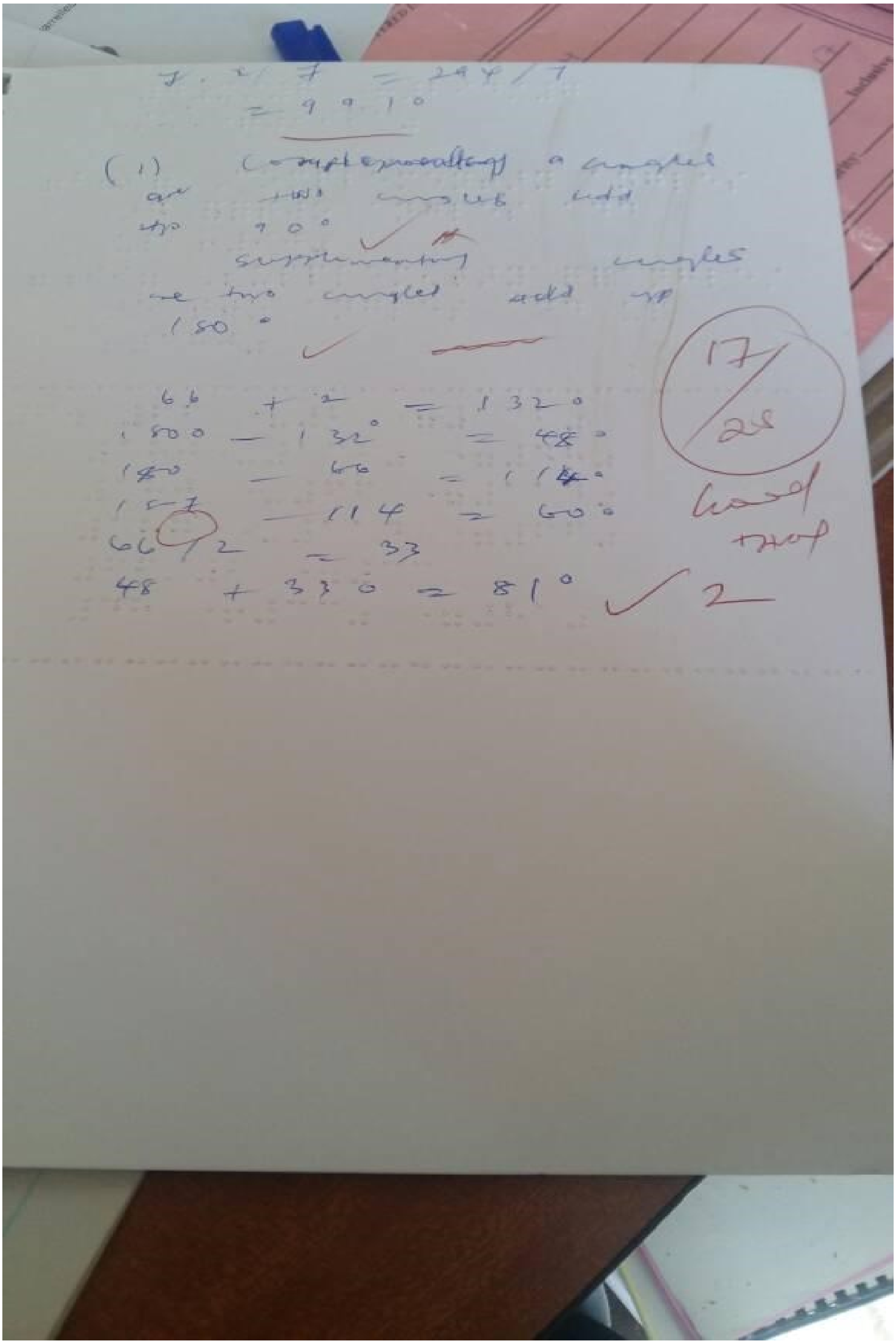
5a: Student writing with Slate and stylus



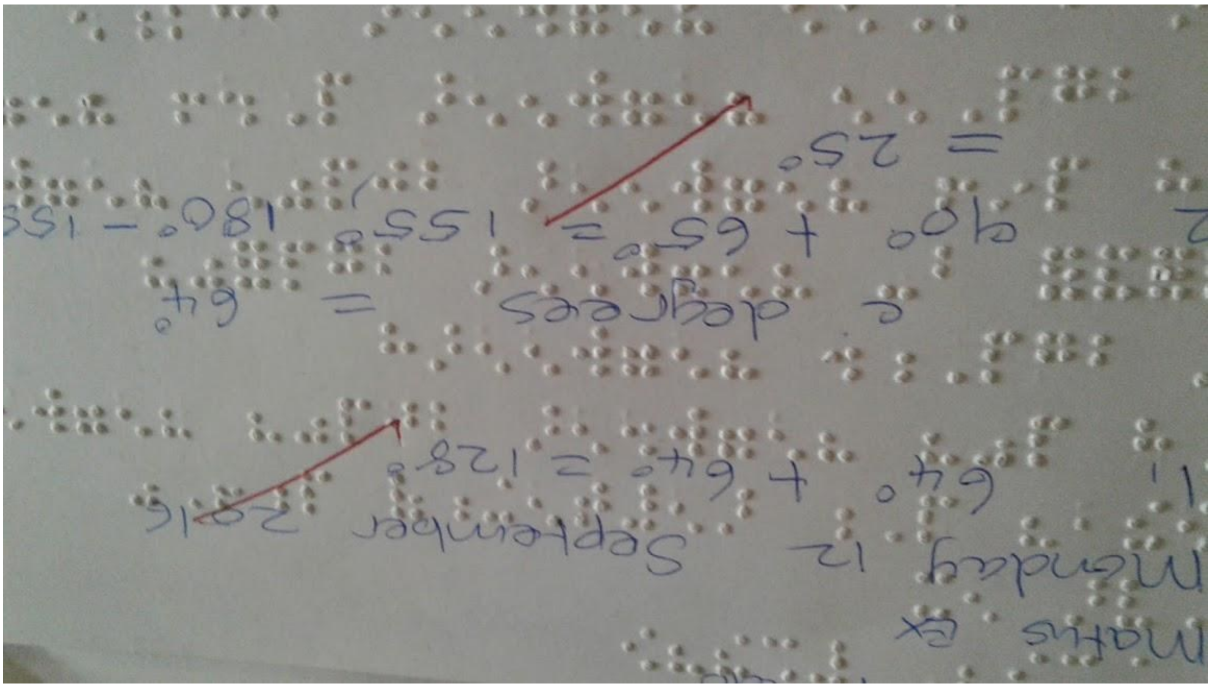
5b: Marked exercises



5c. Marked exercises



5d. Marked exercises



APPENDIX 6

INFORMED CONSENT

Great Zimbabwe University

P. O. box 1235

Masvingo

Title: OPPORTUNITY TO LEARN MATHEMATICS: THE CASE OF SECONDARY STUDENTS WITH VISUAL IMPAIRMENT IN ZIMBABWE

Dear Prospective Participant

My name is Louise S. Madungwe and I am doing research with Prof M. Ngoepe a senior lecturer in the Department of Mathematics Education towards a Doctor of Education degree at the University of South Africa. We are inviting you to participate in a study entitled 'Opportunities to learn mathematics: the case of students with visual impairment in Zimbabwe'.

Purpose of the study: This study is expected to collect important information that could assist you as a teacher in your teaching of mathematics so that you get improved performance from students with visual impairment. It is envisaged the Ministry of Education and Culture and the Zimbabwe School Examinations Council will be challenged to provide an appropriate mathematics curriculum and an appropriate examination respectively, for students with visual impairment.

Why you are invited: I am aware from my association with the School Head that you teach mathematics and that is the reason why I chose you to participate. I am inviting the two mathematics teachers and I would like to observe lessons being taught to form two students.

Nature of participation: The study involves audio recording of interviews with you and your colleague, audio recording of lessons being observed and audio recording of focus group discussion conducted with students. I would like to find out your views on the teaching of mathematics to this special group of students, the challenges that you meet in your teaching and your suggestions on what can be done to make your task easier. I intend to have an interview with the teachers together at the beginning and at the end of the encounter and conduct a focus group discussion with your form two students (two groups) on their learning. I also intend to observe the two teachers teaching form two for a week or as long as a topic lasts. I anticipate that an interview will last for an hour while a focus group discussion could last for an hour at most.

Withdrawal: Participation in this study is voluntary and you are under no obligation to consent to participation. If you decide to take part, you will be given this information she keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

Potential benefits: There will be no benefits in monetary terms for those who take part in the study. Some participants may derive satisfaction from taking part in educational research that seeks to provide an understanding of how the visually impaired learn mathematics for the benefit of both society and Government agencies.

Any negative consequences from participating: I do not foresee any negative consequences for you if you participate in the study. The only source of inconvenience could come from being observed for a whole week, but the prime purpose of the observation is to see how students learn, and not to judge the teacher.

Confidentiality: You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher, will know about your involvement in the research. Your answers will be given a code or pseudonym and you will be referred to in this way in the data, any publications or other research reporting methods such as conference proceedings.

Security of data: Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet in my office at Great Zimbabwe University for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. If necessary, information will be destroyed by shredding hard copies and electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software programme.

Payment or any incentives for participating: The researcher will not give any incentive to the participants.

Has the study received ethics approval: This study is yet to receive written approval from the Research Ethics Review Committee of the College of Education Research Ethics Review committee, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

How will i be informed of the findings/results of the research?

If you would like to be informed of the final research findings, please contact Ms L. S. Madungwe on 0772 237 823 or email : ldsmadungwe@gmail.com.

Should you have concerns about the way in which the research has been conducted, you may contact Prof. M. Ngoepe on ngoepmg@unisa.ac.za or +2712 429 8375 Alternatively, contact the research ethics chairperson of the College of Education Research Ethics Committee, Dr M Classens, on email mcdtc@netactive.co.za

Thank you for taking time to read this information sheet and for participating in this study. Thank you.

L. S. Madungwe

APPENDIX 7

LETTER FROM MINISTRY OF PRIMARY AND SEODARY EDUCATION

All communications should be addressed to "The Secretary for Primary and Secondary Education"
Telephone: 799914 and 705153
Telegraphic address : "EDUCATION"
Fax: 791923

ZIMBABWE

Reference: C/426/3 Masvingo
Ministry of Primary and Secondary Education
P.O Box CY 121
Causeway
Harare

26 July 2016

Louise S Madungwe
Greatv Zimbabwe University
P.O.Box 1235
Masvingo

RE: PERMISSION TO CARRY OUT RESEARCH IN MASVINGO PROVINCE: MASVINGO DISTRICT: M.HUGO AND MUTENDI HIGH SCHOOLS.

Reference is made to your application to carry out a research at the above mentioned schools in Masvingo Province on the research title:

"OPPORTUNITY TO LEARN MATHEMATICS:THE CASE OF SECONDARY STUDENTS WITH VISUAL IMPAIRMENT IN ZIMBABWE."

Permission is hereby granted. However, you are required to liaise with the Provincial Education Director Masvingo, who is responsible for the schools which you want to involve in your research. You should ensure that your research work does not disrupt the normal operations of the school. You are required to seek consent of the parents/guardians of all learners who will be involved in the research.

You are required to provide a copy of your presentation and a report of what transpired to the Secretary for Primary and Secondary Education by December 2016.

M. T. Madzinga (Mrs)
Acting Director: Policy Planning, Research and Development
For: **SECRETARY FOR PRIMARY AND SECONDARY EDUCATION**
cc: PED – Masvingo Province

MIN OF PRY & SEC EDUCATION
27 JUL 2016
P.O. BOX
ZIMBABWE

R/AATM16

APPENDIX 8 ETHICAL CLEARANCE

UNISA university of south africa

COLLEGE OF EDUCATION RESEARCH ETHICS REVIEW COMMITTEE

15 June 2016

Ref : **2016/06/15/04763866/15/MC**
Student : Ms LS Madungwe
Student Number : 04763866

Dear Ms Madungwe

Decision: Ethics Approval

Researcher: Ms LS Madungwe
Tel: +263 39 253350
Email: ldsmadungwe@gmail.com

Supervisor: Prof. M Ngoepe
College of Education
Department of Mathematics Education
Tel: +2782 963 3706
Email: ngoepe@unisa.ac.za

Proposal: Opportunity to learn Mathematics: The case of Secondary students with visual impairment in Zimbabwe

Qualification: D Ed in Curriculum Studies

Thank you for the application for research ethics clearance by the College of Education Research Ethics Review Committee for the above mentioned research. Final approval is granted for the duration of the research.

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the College of Education Research Ethics Review Committee on 15 June 2016.

The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*
2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the College of Education Ethics Review Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for*

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
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www.unisa.ac.za

the research participants.

3) The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.

Note:

The reference number **2016/06/15/04763866/15/MC** *should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the College of Education RERC.*

Kind regards,

Dr M Claassens
CHAIRPERSON: CEDU RERC
mcdtc@netactive.co.za

Prof VI McKay
EXECUTIVE DEAN

Approval template 2014

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