FACTORS CONTRIBUTING TO LOW ACHIEVEMENT LEVELS IN MATHEMATICS AMONG HEARING IMPAIRED LEARNERS: A CASE OF SELECTED SCHOOLS OF LUSAKA, ZAMBIA.

BY

MANCHISHI SYLVIA

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DECLARATION

I Manchishi Sylvia do hereby declare that this dissertation on Factors Contributing to Low Achievement Levels in Mathematics among children with hearing impairment is my own work and that the sources I have used or quoted have been indicated and acknowledged by means of complete references.

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MANCHISHI SYLVIA

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DATE

DEDICATION

This dissertation is dedicated to:

My husband, Ngalasa Donald, for his unwavering support, encouragement and understanding during the time of my study.

My eldest daughter Lushomo for her understanding and encouragement during the research.

My parents for their unending encouragement and support.

CERTIFICATE OF APPROVAL

This dissertation by Manchishi Sylvia is approved as a partial fulfilment of the requirements for the award of the degree of Master of Education in Special Education of the University of Zambia.

Signed:.....Date:.....

Signed:.....Date:.....

Signed:.....Date:.....

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Abstract

Performance of many learners in Mathematics has continued to decline. For learners with Special Educational Needs (SEN), their academic performance is far below their non disabled peers. Further comparison tests on performance in Mathematics among different SEN learners indicate that those with Hearing Impairments (HI) were lagging behind. This study attempted to highlight the factors that contribute to low achievement levels in mathematics among pupils with hearing loss and to suggest measures that would improve their performance.

The focus was to establish methods used in teaching pupils with HI, ascertain factors that contribute to poor performance in mathematics among learners with HI as well as to determine the qualifications of teachers in teaching mathematics to learners with HI. The study also explored measures that can improve performance of learners with HI in mathematics. The research adopted a case study design and employed both quantitative and qualitative research methods. The population comprised of pupils and teachers from two schools, one primary and the other secondary schools in Zambia. A sample of 10 teachers and 22 pupils were purposively chosen. Questionnaires, interview guides, classroom observation checklists and group discussion guides were used to collect data. The learners were clustered into groups of 6 (Grade 5, 6 and 7), (Grade 11) and (Grade 12) before being engaged in group discussions.

The inquiry showed that hearing loss significantly affected their ability to learn mathematics due to their failure to comprehend the mathematics language. Teachers were not enough and not all of those available were well qualified, supportive and with positive attitudes towards learners with HI. Teaching and learning materials were also inadequate. The study recommended the need to ensure that only trained and specialized teachers are deployed in classrooms for the HI. While schools offer literacy programmes such as Primary Reading Programme, New Break Through to Literacy and Step InTo English, there is need to ensure that they have numeracy components so as to aid in the mastery of mathematics especially for the HI. One option is to introduce simultaneous communication which comprises the spoken and signed parts of a language. The rationale of adoption is that deaf children who are exposed to speech and signs at the same time would develop their speech and lip-reading naturally, so extra speech training can be avoided. Furthermore, Examination Council of Zambia needs to consider modifying the examinations for the HI by removing certain components such as those that are sound-based and may be difficult for the Deaf to understand.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter introduces the background, statement of the problem, purpose, significance of the study, research objectives, delimitation, limitation and an explanation of key concepts in Mathematics associated with this study.

1.1 Historical background of the education of Children with Hearing Impairments

Hearing Impaired (HI) learners especially those who are deaf and dumb have been a subject of educational attention for many years. In fact, systematic teaching of the hearing impaired is adversely affected by prejudice from hearing educators and parents who believed that deaf and dumb children are either incapable of learning or have serious limitations to their potential because of their deafness and lack of or distorted speech. Fortunately, a number of studies show that these prejudices are unfounded (Marschark, 2003).

Stein (2013) is of the view that being able to do mathematics is a necessary and valuable life skill. Whether you are shopping for groceries, paying a bill, or cooking from a recipe, mathematics skills are important. However, it is the process of learning which can be affected by different abilities and disabilities. Hearing impairment is one of the disabilities that can affect students' abilities to learn mathematics, and understanding these issues is essential to helping students overcome them.

For a child, hearing is an essential tool of learning, playing, and developing social skills therefore hearing loss can significantly affect his/her life. Hearing impairment can make it difficult for a child to do well in school for many reasons. Hearing impaired children might attend special schools, regular schools with special education classes, or regular schools with regular classes depending on the child's needs and the severity of their impairments. Among the hearing

impaired, other disabilities are more likely to be found than within the hearing population. It can be difficult to identify additional learning disabilities because being hearing impaired has itself its own learning disability often causing a child to have delayed language acquisition, which in turn delays academic skills (Stein, 2013).

History shows that people were not kind to those born deaf. The Arizona Office for Americans with Disabilities (2014) says that early historical accounts revealed that ancient Greeks thought of deaf people as being incapable of education and early religious accounts viewed children afflicted with deafness as evidence of God's anger. However, in the 1600s, the Benedictine monk Pedro Ponce de Leon thought differently. He developed a means to teach deaf people to speak. At about the same time in Italy, Geronimo Cardano, a physician, successfully taught his deaf son to communicate using a variety of symbols (Arizona Office for Americans with Disabilities (2014).

The My Heroes Project Inc. (2010) of the United States, says that historically, HI children have shown that they are capable of comprehending what they are taught. In 1760, the French priest Charles Michel de L'Eppe, created the first free public school for the deaf. He developed a system that used finger spelling and signs. By 1788, he had published a French sign language dictionary. Alexander Graham Bell, the inventor of the telephone, was also a deaf educator in the mid to late 1800s. His mother was born hard of hearing and his father worked on a form of sign language called "visible speech." He used the funds from his telephone invention to develop the Volta Bureau, a school to teach hearing-impaired children. And Frodstad (2015), states that Bell was among several influential people of the time, who viewed deafness as something that should be eradicated, and also believed that with resources and effort, they could teach the deaf to speak and avoid the use of sign language, thus enabling their integration within the wider society from which many were often being excluded. In several schools, children were mistreated, for example by having their hands tied behind their backs so they could not communicate by signing—the only language they knew—in an attempt to force them to attempt oral communication. Owing to his efforts to suppress the teaching of sign language, Bell is often viewed negatively by those embracing deaf culture, (Wikipedia Foundation Inc., 2015: para 19).

In World War I and II, deaf citizens aided the war effort through defense work, volunteer efforts and military service. While most deaf people were excused from military service, the adult children of deaf parents were a great asset to the armed forces, who used sign language as a "secret language" to communicate sensitive information (Black, 2008). The writer also states that while many countries including the United States still discriminate against the deaf, they are missing on an opportunity to add value to their respective militaries as these people are capable of serving in armies. According to Black (2008), enrolment in the U.S. Military is at an all time low, while ex-convicts are now serving in the active military, Deaf and hard of hearing citizens are still denied a place, because of having severe hearing loss, these individuals are deemed to be too different to accommodate into the existing military life. To the Deaf community this is a form of discrimination that has no place in America, and that if allowed, many of their community would gladly serve. What is odd about American military standards are that they are not on par with those of other modern nations. Israel requires military service out of Deaf citizens just like everyone else, and provides training in Sign Language (SL) to those who could use it. And while American Deafs could not join the Army in World War Two, there are many stories circulating about Deaf individuals serving in the German army (Vego, 2009).

Deaf learners in most countries including Zambia have had access to the main curriculum although Marshark, Covertino & Larock (2006) report that, in the past, the curriculum for deaf learners' education emphasized on language development that is, English and moral development. Since the famous work of William Stokoe in 1960, Sign language has come to be accepted as a true and complete language. According to an American Charity, Disabled World (2009), the American Sign Language (ASL) is said to be a complete, complex language that employs signs made with the hands and other movements, including facial expressions and postures of the body. It is the first language of many deaf North Americans, and one of several communication options available to deaf people. ASL is said to be the fourth most commonly used language in the United States. Before then, teachers of the hearing impaired refused to recognize Sign language as a true language, hence they tried numerous methods of educating the deaf. Teachers of the deaf banned Sign language and emphasized oral methods where they trained the Deaf in speech while others tried to come up with unnatural systems of signing such as Pure Signed English and Signed Exact English. These systems were based on medical models

where hearing loss was seen as a disability stemming from a biological deficit- the lack of hearing (Wakumelo, 2009).

Locally, the first attempts to teach children with disabilities were made in 1905 in the Eastern Province of Zambia by missionaries. The first schools for Children with Special Education Needs (CSEN) were established in 1923 and 1929, respectively. By 1950, other schools for these children by missionaries included Magwero School for Blind in Chipata District, Mporokoso School for the Blind, Ndola and Sefula (in present-day Nalolo), schools for the Blind, Chileshe Chepela in Kasama, and Kabulonga Boys Special School. The Zambia Council for the Handicapped continued with the service delivery under the then Ministry of Labour and Social Services until 1971, when the Ministry of Education took over the task of educating children with special education needs (Kalabula, 2006).

The Government of the Republic of Zambia through the Ministry of Education recognized the rights of persons with special education needs to have access to good and quality education, (Ministry of Education, 1996). Muwana (2010) notes that the Educating Our Future Policy (1996), marked an important advance in special education compared to the previous policies. In it, equality of educational opportunity was described as providing students with disabilities the same educational opportunities as their peers without disabilities. Thus, this policy endorsed the inclusion of children with disabilities i n general education settings and set the stage for inclusive education in Zambia (Muwana, 2012).

The ministry embraced the principle of integrating the children with special education needs to the greatest extent possible in the mainstream schools. Zulu (2014) explains that in Zambia, Children with and without disabilities were to learn together in the same classroom and with the same teachers. When pupils with disabilities enrolled, they were assessed to ascertain their ability to adapt to mainstream schools. First, they were kept separate and taught by specialist teachers, and then they graduated to be included in mainstream classrooms to study with non-disabled children. At the moment learners with disabilities are exposed to the main curriculum with teachers challenged to make adaptations to suit individual needs of learners.

Most of the activities for deaf learners were related to English which include speech reading and structure. As such, it led to over emphasis of language in deaf education at the expense of academic subjects (McIntosh, Sulzen, Reeder & Kidd, 1994). Content areas such as mathematics, social studies and science received minimal attention. Studies globally have revealed that learners with hearing impairments perform poorly as compared to their hearing peers. Therefore, general low academic achievement levels of hearing impaired learners in many school subjects was the main source of concern of this study as it sought to locate the cause of their poor performance in mathematics in Zambia.

The term deaf or hearing impairment is an umbrella term which includes learners who are deaf and dumb, deafened and hard of hearing. Hearing impaired or deaf learners therefore include those with congenital and acquired hearing loss of varying degrees (Marshark & Harris, 1996). According to the Canadian Academy of Audiology (2015), there are different causes of hearing loss. Hearing loss can be congenital, meaning from birth, or occur as a result of a disease or accident. Some of the diseases that affect hearing include Scarlet Fever, Meningitis, Mumps and Measles. Traumatic skull or ear injuries, exposure to loud sounds, ear pressure problems incurred while scuba diving and more can lead to permanent or partial hearing loss. Hearing loss occurs in one of two areas, that is, a conductive hearing loss, which is due to a mechanical problem within the outer or inner ear, or sensorineural hearing loss, which has to do with the tiny nerve cells in the ear experiencing injury, disease or malfunction.

Thus, the effect of a hearing loss is described by the degree of loss, the type of loss, and the age at which the loss occurred (UNESCO, 1996).The Disability Education Act (IDEA), a United States Federal law enacted in 1990 and reauthorized in 1997 and 2004, defines hearing loss as that which is so severe that it limits the processing of linguistic information through hearing without amplification or hearing aids and greatly affects learning.. Thus deafness may be described as a permanent or fluctuating condition that prevents an individual from receiving sound in all or most of its forms (UNESCO, 2006).

In order to compensate for loss of hearing, pupils with hearing impairments use oral or manual means of communication or combination of both. Oral communication includes speech, lip reading and use of residual hearing while manual communication involves sign language and

finger spelling. Total communication as a method of instruction is a combination of the oral method plus signing and finger spelling (Luterman, 2002). In terms of academic performance, there is an exceptional achievement at an age-appropriate level for the hearing impaired and the majority does not attain a grade-level of mathematical computation that should enable them to succeed in national assessments.

The American National Centre for Learning Disabilities (2014), states that Mathematics disability is an unexpected learning problem despite a classroom teacher or other trained professional providing the student with appropriate interventions for a sustained period of time. Typically, students with a hearing impairment have a mathematical disability as they have difficulty making sufficient progress in mathematics compared to their hearing counterparts of age group despite the implementation and documentation of validated teaching practices over time (Moores, 2000).

According to the American Academy of Pediatrics (2006: p 9), hearing loss contributes significantly to delays in language development and academic achievement. It says these delays are apparent for both children with mild and moderate hearing loss, as well as for those whose losses fall in the severe and profound ranges. The American Academy of Pediatrics concludes that despite advances in hearing aid technology, improved educational techniques, and intensive interventions services, there has virtually been no change in the academic statistics of this population since the systematic collection of national data dating back to 1976. This was after comparing various data which indicated that the average deaf student graduated from high school with language and academic achievement levels below that of the fourth-grade hearing student. Similarly, for hard-of-hearing children, achievement was also below that of their hearing peers with average scores for high school graduates at the fifth-grade level. Thus, it was concluded that limitations in hearing had a pervasive negative impact on overall academic achievements.

In Zambia, the situation is similar in that fewer children with hearing impairment have access to education. The Ministry of Education in its Annual Statistical Bulletin (2011) revealed that the levels of enrolment for these children were low. The Bulletin reported that pupils with hearing impairment who had access to schooling from Grade One to Grade Nine were 20,075 from a total population of 175,361 of Children with Special Education Needs (CSEN). This translated

into 16% access among these children. Reasons cited were inadequate facilities, lack of community involvement and awareness. It should also be noted that the number of CSEN had risen by that year in that in 2006, it stood at 161,044 (Ministry of Education, 2006). It is likely the situation has not improved much. Similarly, the Zambia Federation of Disability Organizations (2014: p.3) says one in 10 of the country's 15, 021,002 population is disabled, and that 3% of the population (450,630) are persons with severe disabilities of which 53% are males, while 47% are females. And the new Minister of Education Michael Kaingu admitted recently that challenges still existed in terms of inclusive schools. Speaking when he launched the International Fund for Health Care and Education Services' Medical and Education Aid Needs Scheme (MEANS) in Lusaka, Dr. Kaingu stated;

> *"Because of the Government's focus to ensure that all children of school-going age access education, schools have been mandated with thousands of children, with the result that quality education delivery has been compromised. It for this reason that the Ministry is now focusing it's attention on the provision of quality and equitable education for all. However, with poverty levels in Zambia continuing to be high, many a parent is unable to send their children to tertiary institutions. The need, therefore, for other stakeholders like yourselves to come in becomes cardinal" (Kaingu, 2015: 3).*

Muwana (2012), also observes that given the Zambian Ministry of Education's movement towards inclusive education over the past two decades, general and special educators, may be facing challenges in providing services in general education settings that were historically provided in special classrooms. The emphasis is on the child fitting the system rather than the system adapting to meet the needs of the students. In general, integrated education "has been provided mainly to students with mild disabilities who are considered easy to include in general education classrooms. In most cases, students with severe disabilities do not attend school, although occasionally, they may attend a special school" (Muwana, 2012: 9).

This now brings us to the question of inclusive schooling in Zambia. Before independence in 1964, the education of people with disabilities was provided by voluntary agencies, which were mainly concerned with visual and hearing impairment and physical disabilities. In 1971, however, the then Republican President Kenneth Kaunda, directed the Ministry of Education to

take over the responsibility of Special Education. The concept and practice of inclusive schooling in teacher curriculum which was reviewed in 1997 was now being taught at both pre and in-service teacher training. Zambia Teacher Education Course (ZATEC) students can decide on Special Education as an area of curriculum strength (Mwanza, 2010).

A survey assessing attitudes of 1, 636 Zambian and Finnish teachers towards inclusive education and consequently the perceptions of appropriate educational environment for children with different disabilities, showed varied and critical reactions (Moberg, 2003:417). The structure of the attitudes was found to be similar in both countries. The factor analyses extracted four attitude dimensions, namely, social justice, meeting special needs of pupils with severe disabilities, teachers' competence, and quality of education for non-disabled students.

Moberg (2003) said the Finnish ordinary teachers were the most critical group and the Finnish special education teachers the most optimistic. Most respondents felt that inclusive education enhanced social justice. However, the pursuit of inclusion in practice, especially the guarantee of good and effective education for all, was seen as problematic. Compared to Finnish respondents, the Zambian respondents preferred a more segregated educational environment for children with different disabilities. Type and severity of disability affected the preferred educational setting and there were clear differences in this regard between respondents from the two countries. Findings supported the idea that teachers' attitudes towards inclusion were important in developing inclusive school systems and that inclusive education was best understood as a multi-dimensional concept, which, at the practical level, was highly context-dependent (Moberg, 2003).

Special education teachers seemed to be more positive towards inclusion than regular education teachers or teachers who did not have any additional training. Many teachers accepted inclusion in principle, but were skeptical towards it in practice, expressing doubts especially on the effectiveness of teaching in inclusive settings and on the ability of regular education teachers to meet the needs of pupils with disabilities (Mwanza, 2010). There were also fewer teachers willing to implement the principle of inclusion in their own classes, and a good number believed that they had insufficient time, resources and training to do so (Moberg, 2003).

Kaoma (2007) revealed that the issue of inclusion of children with disabilities had not been dealt with effectively by education authorities in this country. The inclusion of children with special education needs differs from mainstreaming, in that the latter may refer to a variety of degrees of contact with hearing students, whereas in inclusion, the student who is deaf is actually placed in a classroom with hearing students. It describes inclusion as involving an assortment of services, including interpreters, note takers, teacher aides, teachers of students who are deaf, and consultants, but these services are provided within the context of the regular classroom.

Government's policy directive to include special education as a core function of the MOE was in line with its view that pupils with disabilities, including the hearing impaired, had the right to go to school with their non-disabled peers. The other position was the need for full inclusion, whereby all pupils with disabilities were to go to regular schools. Parents, who wished their deaf child to be in an inclusion programme, were free to indicate this preference during discussions with school authorities. However, some schools and units indicated that an inclusion option was not available for deaf children in their area or that inclusion was not appropriate for that parent's deaf child (Kaoma, 2007).

Opportunity for communication with the hearing world in an inclusion setting helped students who were deaf to better develop their ability to communicate with hearing people, leading to skills they would need in later years. It increased the opportunity for learning the standards of the hearing world that pupils who were deaf and attended schools for hearing children may be able to master the norms of hearing society better than those who were immersed in the culture of a special school for pupils who were deaf (Kalabula, 2006).

Much as inclusive education provided an opportunity for deaf students, it was critical to look at some limitations of inclusion which were responsible for continued isolation. Some of these environments did not comprise individual's competence at communicating in deaf pupils' preferred language and mode of communication, but it was good to note that opportunities for direct instruction were limited. Inclusion of deaf individuals often meant receiving translated or transliterated messages through an interpreter or translator. Opportunities for direct and independent interaction and communication with peers and the professional support staff were limited (Kalabula, 2006).

Deaf individuals constantly require an interpreter to communicate effectively with peers and professionals. School counselors, medical personnel and administrators often are not able to communicate directly with a pupil who is deaf, which limits their access to support services that are readily available to other pupils. The most important issues, when contemplating inclusion for a deaf individual, are related to language and communication. It is wrong for an association of the deaf or disabled pupils to presume that inclusion is appropriate for a child who is deaf without incorporating issues in supportive policies. Likewise the Government cannot presume that a deaf child belongs to a centre, unit or residential school for deaf children only when the world is busy promoting a society for all (World Federation of the Deaf, 2014).

A research conducted in 2007 in Chongwe District (Ndhlovu, 2008) to determine challenges faced by pupils with disabilities in accessing inclusive education in selected schools revealed inadequate funding to schools, non user friendly infrastructure, inadequate appropriate teaching and learning materials and lack of skills in sign language for communicating to pupils with disabilities especially those with hearing, among other problems. The 424 informants suggested that Ministry of Education should ensure that infrastructure was modified so that it was accessible by all pupils. In addition, all teachers needed to be trained in sign language. The findings from the current study show that not much has been done to empower individual teachers and schools.

According to Ndhlovu (2008), practicing inclusive schooling promotes access to education in schools by all learners regardless of their disabilities. Despite the efforts of the Ministry of Education through the Inclusive Schooling Programme (INSPRO) to make schools conducive for inclusive education, studies indicate that most schools do not have facilities or resources conducive for inclusive education thereby excluding a lot of children with disabilities from accessing education in schools.

In Zambia, the situation shows that a large number of persons with disabilities are also excluded from schools. In 2008, there were 256,690 persons with disabilities in Zambia. Out of this number, 43.2% had no formal education, 39.7% had primary school education, 14.5% had secondary school education, 1.3% had A level and another 1.3% had attained tertiary education (Ndhlovu, 2008). Bedding & Mtonga (2013) concluded that while Persons with Disabilities in

Zambia (PWDs) are entitled to access any service of their choice at any time and place as need arises, they were still being discriminated against from accessing the services and facilities within the community due to attitudinal, cultural practices and physical barriers. Thus, the public continues to hinder persons with disabilities from full participation in areas of life such as education, training, employment and economic development and empowerment, (Bedding, & Mtonga, 2013).

Mandyata (2001) stated that teachers generally seemed to exhibit a more positive attitude towards the integration of students with physical and sensory disabilities than to those with emotional-behavioral and intellectual difficulties. Teachers' attitudes could be linked more to practical procedural classroom concerns than to affective responses or general attitudes towards working with pupils with disabilities. Among the practical concerns, teachers' own feelings of self-efficacy as professionals and past experiences were highlighted. Teachers who felt confident of their professional skills and had positive experiences of inclusion were more positive towards inclusion (Mandyata, 2001).

Mandyata (2002), states that teachers' positive attitudes towards inclusion in Kasama depended greatly on their teacher education and availability of support, class size and workload. According to children with disabilities, they could however, learn in an inclusive setting. But teachers needed to allow the children to progress at their own pace. On the other hand, Moberg (2003) said perceived lack of self-competence and insufficient training were found to be major stressors of teachers in inclusive settings.

As indicated earlier, loss of hearing has adverse effects on the academic performance of the child and how one relates to the environment and communicates. Such children have difficulties when it comes to reading and solving mathematical problems. Merry (2002) states that children with severe hearing impairment do have challenges in processing linguistic and mathematical information through hearing, with or without amplification, which negatively affect their educational performance. This is why the educational performance of students with deafness is often delayed in comparison to their peers, with reading and language being primary areas that present difficulties.

Merry (2002), however, states that statistics show that deafness, by itself, does not impede the child's ability to learn and manipulate abstract symbols and symbolic relations. By contrast, the median reading achievement of 17–21-year-old deaf students leaving American secondary schools is at the 4th grade level. This wide performance gap between language tasks as compared to non-language tasks is a common profile among deaf children worldwide. These academic performance patterns illustrate the great difficulty experienced by deaf children perceiving and learning spoken language and visual representations of speech, namely, written and read language. Indeed, the effects of deafness on spoken language development increase as degree of hearing loss increases. For example, students with mild to moderate hearing losses read at lower levels than do students with normal hearing. Furthermore, students with severe to profound hearing losses read more poorly than do students with moderate losses but on math computation they show equivalent achievement (Merry, 2002).

Reed, Antia & Kreimever (2007), say that deaf children tend to fall behind in mathematics at school as a direct result of particular experiences in the classroom. For instance, deaf children may find it hard to follow the teacher's presentation of basic concepts, but on the other hand quite abstract mathematical ideas are more challenging. Another possibility is that before they start school, they may either be worse than hearing children at early, nonlinguistic number representations, or they may be behind in learning the culturally transmitted number string, or both. This may result in deaf children failing to develop informal problem-solving strategies, which prepare most children for the more formal learning of number and arithmetic that they will have to do at school.

Despite the widespread agreement about low achievement levels in mathematics among the deaf, there remains considerable doubt about why mathematics is so difficult for this group of learners. Scholars like Cockcroft (1992: 52) hold that mathematics is generally a difficult subject not only to pupils but also to teachers when it comes to learning and teaching. He argues that, "firstly, the subject demands the use of memory, an area where the children with a hearing impairment have a deficit" However, despite, the memory deficit, which is of importance for operation, a child, needs to have a clear and sufficient understanding on the operations that are involved. Such an understanding can be possible if one has language needed to interpret and apply the necessary operations but this aspect appears to be lacking among hearing impaired children. Most deaf

learners experience barriers with regard to literacy (Chikopela 2013), therefore, achieving mathematical concepts becomes an even greater challenge.

Although solving mathematical problems is known to be a problem among most hearing impaired learners, it must be understood that, there is the aspect of individual differences in grasping mathematical concepts. Thus mathematical reasoning in children with hearing impairment has been found to be different from the hearing children (Wood et al, 1999). These children are said to perform badly in comparison with their hearing counterparts. However, King & Quigley (2005) observe that, in some cases, particularly those concerned with concepts that are non-verbal, the hearing impairment perform just as good as the hearing. They only seem to lag behind on concepts based on verbal tasks. Similarly, other researchers such as Moores (2000) argue that despite the enormous problems that pupils with hearing impairments face in learning mathematics, they can learn with serious interventions.

Appropriate mathematical interventions include the early use of tested instructional practices and the monitoring of responses to the mathematics interventions to determine the effect on performance in mathematics. This view is supported by the argument that the most efficacious instructional strategies are those that cognitively engage learners with hearing impairments (Vershaffel & De Cortel 1996).These includes using hands-on learning or by doing, participation and use of interactive and experiential way to learn. The teacher also facilitates learning by inquiry where knowledge is built from experience and process, especially socially based experience. Under this premise, learning develops best in group discussions, discovering facts and relationships for themselves. However Vershalf & De Cortel (1999) further state that practices which stress on "minds on" activities, however, are as critical, or more so, than those encouraging "hands on" manipulation of materials in the mathematics classroom.

As for learning styles, every subject has subject-specific concepts and terminologies that learners do not meet in other subjects. As a consequence, it is every teacher's obligation to make sure that pupils master these concepts using sign language. Concerning mathematics, there is a great amount of well defined subject- specific concepts and related terminologies in spoken/written languages that learners need to master. An equivalent terminology for mathematics in sign language should be found. Meanwhile, it appears that the field of deaf education suffers from a

shortage of trained teachers as most teachers who teach the HI are not trained making it difficult for learners to understand (Chikopela, 2013).

Despite a general agreement that HI learners exhibit low academic achievement in mathematics, very little is known about why this is so which formed basis of this research. Thus this study investigated the causes of poor academic achievement in mathematics among HI children in Zambia with the view to generate recommendations for improvement in mathematics achievement among this group of learners.

1.2 Contextual Background

"Mathematics is the mother science of the abstract world" (Chiu, 2007:64). It is considered as the most important science because its development affects the development of other sciences like biology, physics and technology; therefore it may be a hindrance to vocational development (Pau, 2008). The basic developments in mathematics such as equations, addition, subtraction and division are implicitly used in everyday application like buying and selling, measuring, sharing and counting. It is therefore believed to be an essential, creative and powerful discipline of modern science recognized globally.

Barbosa (2014) suggests that children's earliest mathematical learning experiences are informal in nature and take place through everyday life events that require them to count, build, share, and group, and that incorporate opportunities for the use of mathematical language and problem solving. For example, parents may remark on the number of fingers or toes the child has while bathing or focus the child's attention to a specifically shaped, favorite toy or even refer to the child as the big brother. Thus, mathematics concepts and skills are learnt as children make sense of the world around them.

Therefore, supporting young children's use of mathematics include the building of new concepts on existing mathematical knowledge and experiences, interaction with mathematical idea and the use of numeracy during daily activities. Although it is recognized that children's understanding of mathematics concepts early in development may be intuitive, a lack of explicit awareness of mathematics concepts may make it difficult for young children to make use of their prior knowledge and to form essential connections when encountering formal mathematics in school.

Whereas understanding of number is most critical, young children's mathematics performance in all concept areas can be used to predict levels of academic achievement well into high school and in content areas beyond mathematics, such as reading and science, as well as to identify those who may be at risk for learning disabilities in mathematics. Given the research with HI children that shows poor mathematics achievement with this population, it is critical that the factors that contribute to the achievement gap in mathematics that exists between hearing and HI learners be uncovered and detailed so that specific areas of weakness can be addressed at an early age prior to having an impact on later learning.

National Research Council of Kenya (2012) also explains that mathematics is a subject recognized as the mother of all learning with other subjects deriving their concepts from it, in both the arts and sciences. The council further says mathematics is also an international language and is essential in almost every field such as handling money, measurement in fashion, angles in sports such as bowling and billiards, technology and economics, consequently, a good performance in the subject is important.

In an increasing technology based society, effective mathematics learning from an early age has become even more important (Pinkham, 1996). Schools therefore, continue to prepare learners for daily effective functioning because without it, learners will have difficulties in interpreting various mathematical representations. That is why at present, the Zambian grade 10-12 curriculum consists of a small number of core subjects such as English, mathematics and science subjects and a wide range of optional subjects to ensure that all learners are subjected to learning mathematics (Ministry of Education, 1996).

Incidents of readily failure can be prevented with early and sustained intervention measures. Lyon (1995) suggests that the earlier pupils learn to read, the more likely it is that their schooling will mitigate the negative effects of social, cultural, economic and academic interaction. Also, if problems are left unchecked for too long, the lower the rate of success and the cost of stopping, reversing and rectifying the course of failure will be high. In other words, children with hearing impairments must be availed opportunities to start reading early enough, thereby exposing them to new vocabulary and literature. Well designed sign language skills and visual coding offer deaf

pupils a phonological link, and in turn, this enriches their written English skills. These skills will further be useful to them as they read and handle mathematical problems.

Most of the children who are hearing impaired are born in hearing families. Thus, from the onset, they have no mentors or role models to help them acquire a language as they grow. The crisis continues as these children enter the school where it is now mandatory for pupils to learn in their mother tongue from Grade One to Two, using the New Break Through to Literacy (NBTL) programme, before transitioning to learning in English in Grade Two under the Step Into English (SITE) arrangement. Maambo (2010) states that NBTL is the first stage in the primary education course where pupils learn in the language of initial literacy, with learners being guided from the known to the unknown. Aspects of numeracy are integrated as pupils are introduced to practical activities such as counting. SITE is time for pupils to become more familiar with letters, vowels, consonants, simple words and the alphabet. This presents a general literacy problem for the hearing impaired pupils, and when it comes to numeracy aspects, the levels of comprehension are low and such pupils usually take time to pick up. Maambo (2010:2) says;

> "Although the deaf learnt using the NBTL course, they were still different from their mainstream school peers in terms of communication. They had no spoken language. The only mode of communication that they used were signs. In Zambia, the local signs are those used in the home for the purpose of communication with parents, siblings and the local community. Therefore, deaf children may use different local signs which they also carry with them as they start Grade One. The signs may not be easily understood by their hearing impaired classmates and teachers. The mode of instruction that is used to access the curriculum is in sign language. Reading is the key to learning content of the school curriculum. Failure to access the curriculum through reading disadvantages the child."

Generally, hearing problems affect academic performance of students. There is an inverse relationship between hearing impairment and achievement, the more severe the impairment, the lower the achievement. This discrepancy between ability and achievement hinges on the lack of mastery of the English Language among students who are hearing impaired (Chikopela 2013). Academic achievement is strongly related to the reading ability of students regardless of the

mode of communication used. Thus, over the years the performance of CSEN has not been improving tremendously as anticipated, with the tradition being maintained of learners with hearing impairments consistently trailing behind their hearing counterparts in academic performance (University of California, San Francisco, 2014).

During the period 1999 to 2008, National Assessments in reading in Zambia showed low performance in reading. The outcomes were as follows: 199 (33.2%), 2001 (33.4%), 2003 (33.9%), 2006 (34.5% and 2008 (35.3%). And in 2008, performance in reading among CSEN who were visually and hearing impaired, and mentally challenged were as follows: mentally challenged (55.8%), visually impaired (41.8%) and hearing impaired (33.5%). The assessment cited syntactic differences between Sign and English languages as the major reason for the low performance. In 2012, regional mock examination pass rate for learners with hearing impairments in Grades 10, 11 and 12 at Solwezi and Munali Secondary Schools from the year 2010 to 2012 ranged between 34% and 43% (Ministry of Education, 2012: 7).

In trying to improve performance among learners, the Ministry of Education, Science, Vocational Training and Early Education (MESVTE) introduced the Primary Reading Programme (PRP), NBTL and SITE. But this has not improved the situation for children who are hearing impaired and it appears no efforts were made by education authorities to ensure these programmes responded more effectively to deaf children.

The performance of many learners in mathematics has continued to decline. For instance, in 2011 the Southern African Consortium for Monitoring Learning Quality (SACMEQ) consistently reported poor pupil learning achievement in both reading and numeracy pointing to quality concerns prevailing in the education system among children in regular schools, (Spaull, 2011). With respect to Zambia, National assessment Surveys done by Examinations Council of Zambia show low achievement levels in mathematics (Examinations Council of Zambia, 2010).

For learners with Special Educational Needs (SEN), their academic performance is far below their non-disabled peers. The mean performance in mathematics for SEN learners is low in comparison with their hearing peers. Further comparison tests on performance in mathematics among different SEN groups who include; the Hearing impaired (HI), Visually Impaired (VI) and intellectually challenged revealed that, the performance of learners with HI was lagging

behind. The mean score for the HI was the lowest with 38.4, 41.9 for the VI while the intellectually challenged scored highest with 45.5 (ECZ 2008).These school results raise a concern about low achievement levels among the hearing impaired who are said to perform badly even in comparison to other children with SEN.

Despite the substantial achievement gap being recorded between the hearing impaired and their hearing counterparts, it is unclear however when this performance gap begins to emerge and the factors that contributes to low achievement levels. The present research therefore investigated the reasons for the poor performance among hearing impaired children in Zambia and sought to find ways of improving mathematics achievement levels in tests or examinations.

1.3 Statement Of The Problem

Despite efforts by the Ministry of Education in ensuring that all children have equal access to quality education, including those with disabilities, summarized statistics of National Assessments by the Examinations Council of Zambia have consistently shown low performance of children in Mathematics in general and Hearing Impaired (HI) children in particular. While a number of studies have been carried out on the education of children with HI, most of the available literature has focused on language and literacy levels (Chikopela 2013). This knowledge gap prompted the researcher to conduct a study to determine factors that contribute to poor performance in Mathematics among children with HI in selected schools of Lusaka province, Zambia.

1.4 Purpose Of The Study

The purpose of this study was to investigate HI learners' low achievement in mathematics by determining factors that contribute to low achievement in mathematics among learners with HI. The study was guided by the following objectives:

1.5 Research Objectives

1. To establish methods used in teaching pupils with hearing impairments.
2. To determine factors that contribute to poor performance in mathematics for learners with hearing impairments.
3. To ascertain the qualification of teachers in teaching mathematics to learners with hearing impairments.

4. To explore measures that can improve performance of learners with hearing impairments in mathematics.

1.6 Research Questions

1. What are the methods used to teach mathematics to pupils with hearing impairment?
2. What factors contribute to poor performance in mathematics for learners with hearing impairments?
3. What are the qualifications of teachers in teaching mathematics to learners with hearing impairments?
4. Are there measures that can be put in place to improve performance of hearing impaired in mathematics?

1.7 Significance Of The Study

It is hoped that the study would generate information on factors that impede higher attainment levels in mathematics among learners with hearing impairments. It is further hoped that the findings of this study might guide policy direction and help teachers come up with effective strategies to teach mathematics to learners with hearing impairments.

1.8 Delimitation Of The Study

The study of hearing impairment and educational achievement is very vast and spinning fields to all relevant areas of this study. The questions that were answered, the material, method and delimitation of the study were to be chosen under the impact of given requirements and magnitude of conducting this study. Several areas were thus chosen for exclusion in this study. The medical aspect of hearing impairment and the extent of hearing impairment had been scrutinized in education settings would not be accounted for this study. The study limited itself to factors that drive poor performance in mathematics among hearing impaired learners and to explore measures that could improve achievement levels in mathematics among hearing impaired learners in Zambia.

1.9 Limitations

This is a case study which has a small research sample which may not be representative of the entire hearing impaired population of learners in public schools. Secondly, by virtue of being a case study, its findings may not be generalized because case studies are generally tied to people's

perceptions of specific events, settings, or situations hence the aspect of replication and verification by others in other settings is not possible.

1.10 Theoretical Framework

The theoretical framework of this study was drawn from theories of social constructivism by Vygotsky (1978). Vygotsky believes in the primacy of culture in shaping learning. He regards effective instruction as one that involves interaction with adults or more advanced peers in which there is active involvement of all participants. Therefore constructivist approach to learning mathematics relies on children developing their own unique understanding of mathematics and places emphasis on how children "come to know" (Begg, 1995). As regards teaching hearing impaired children, Meadow-Orlans (1980) states that mathematical concepts can be learnt in the same sequence and manner as their hearing peers and that what matters is the learning environment. This study therefore explored the participation of hearing impaired children in the learning of mathematics and the conditions or environment under which they learn the subject.

1.11 Operational Terms

A number of terminologies have more than one meaning embodied in them; these depend on how they are used in each context. For the purpose of this study, the terms listed hereafter have been defined according to the way they were used in the study.

Academic performance: how well students deal with their studies and how they cope with or accomplish different tasks given to them by their teachers.

Comprehension: the capacity for understanding fully.

Communication: the activity of conveying information through the exchange of ideas, feelings, intentions, attitudes, expectations, perceptions or commands, as by speech, gestures, writings, behaviour.

Hearing impairment: a partial or total inability to hear.

Language deficiency: a condition in which an individual has not got enough or lacks the ability to express themselves through words, sounds, or grammar used by people to carry a meaning for a purpose of communication.

Literacy: the ability to read and write.

Mainstreaming: integration of children with special educational needs, in to conventional classes and school activities.

Mathematics: a science of numbers and the structure of measurement and shape.

Numeracy: the ability to reason and apply simple numerical concepts. Basic numeracy skills consist of comprehending fundamental mathematics like addition, subtraction, multiplication, and division.

Reading: the ability to understand writing, obtain meaning, interpret and translate from print.

1.12 Summary

This chapter presented the theoretical and contextual background of the study, statement of the problem, purpose and significance of the study, objectives of the study, research questions, and limitations of the inquiry, theoretical framework and operational terms used in the research. In the background of the study, available literature has shown that pupils with hearing impairment have a challenge in acquiring literacy and numeracy skills, and very few studies have been done in Zambia on the HI and their numeracy skills hence the present study to investigate factors that contribute to poor performance in Mathematics among children with HI.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Chapter Two of this study locates global literature on hearing impairment and learning with focus on academic performance of hearing impaired learners in mathematics. Section 2.1 discusses the implication of hearing loss to learning in general while Section 2.2 focuses on the implication of hearing impairment and learning by identifying and discussing the actual factors which affect achievement in mathematics among hearing impaired learners. Besides these sections, section 2.3 looks at the pedagogy in mathematics learning among hearing impaired learners by exploring the common strategies, approaches and techniques used by many teachers in teaching of mathematics to hearing impaired. Lastly, Section 2.4 makes a brief summary of the chapter.

2.1 Hearing Impairment and its Implication on Learning

Hearing impairment is defined by the American Individuals with Disabilities Education Improvement Act as impairment in hearing whether permanent or fluctuating that adversely affects a child's educational performance. Deafness is defined as a hearing impairment that is so severe that the child is impaired in processing linguistic information through hearing with or without amplification. Thus, deafness is viewed as a condition that prevents an individual from receiving sound in all or most of its forms (United States Department of Education, 2007).

Hearing loss potentially causes handicapping conditions to learning, that is, deafness in children does not only make it difficult for them to communicate with other people, it also slows down, or even prevents altogether their learning potential. A great deal of what children learn comes from what they (over) hear. They hear their family members talking, people in the community talking, they hear other children talking, they hear the radio or the television and they learn. However, children with HI miss out on this entire incidental learning of various concepts and vocabulary from the environment thereby limiting their communication skills. This therefore poses a limitation on their ability to learn (Markides, 1989).

In other countries, the few studies known to investigate younger preschool Deaf and Hard of Hearing (DHH) pupils show a variety of findings. In 1984, it was found that DHH children in the United States and Belgium, respectively, ages 3–7 years and exposed to sign language, demonstrated an age-related lag of approximately two years in their knowledge of the counting string- perhaps due to limited related opportunities and experiences (Pagliaro & Kritzer, 2013). These studies, however, also indicated that these signing children had as good or better skills in other sub-concepts of number such as object counting and providing the number after a given prompt, especially with lower numbers. The researchers attributed this performance to the facility of counting up in signed languages and the tendency of signing DHH children to track objects with number signs, providing thus a one-to-one correspondence between object and sign (Pagliaro & Kritzer, 2013).

A study by Wollman (1965) tested one third of the pupils from 13 schools for the deaf in the United Kingdom and a comparison of 162 pupils in secondary schools. The deaf pupils had an average score that was 1 standard deviation below the hearing pupils' average. The performance of pupils in mathematics of deaf pupils aged 7 to 16 years was examined and it was found that there was a significant delay in the deaf pupils' mathematics age. The 10-year-olds had an arithmetic age of 8 years, and the 15-year-olds had an arithmetic age of 10 years. In 1984, another study showed a delay in 3.5 years in the mathematical competence of deaf school leavers who were 16 to 17 years of age, (Titus, 1995). More recently, it was reported that deaf children in England in the range 8 to 12 years had a mean standardized score in mathematics achievement that was more than 2 standard deviation below the mean. Similar results were observed in Norway and Sweden (Zarfaty, Nunes & Bryant, 2004:324).

Achievement tests for deaf and hard-of-hearing pupils carried out in the United States confirmed this lag again. Well over half of the pupils aged 9 years or older and as many as 90% of the 15-year-olds were given tests that were appropriate at grades lower than their own (Zafarty, et al, 2004). This in itself suggested an educational delay. The two mathematics tests of Problem solving and Procedures showed results that were similar in some way- the curve for the deaf and hard-of-hearing pupils were much flatter than those of hearing pupils. In Problem solving, the national median for 11-year-olds was equivalent to the performance of hearing children in their third year in school (aged about 8 years) and reached the equivalent of Grade 5 by the time the

pupils were 16 to 18 years old. In Procedures, the national mean for 11-year-olds was between Grades 3 and 4, and almost reached the equivalent of Grade 6 by the time the children were 17 and 18 years old. These levels were considered below basic. Students in the 80th percentile were at the same below-basic level in Procedures by age 14, but were at the next level, basic, in Problem Solving at this age (Zarfaty, Nunes & Bryant, 2004:325).

Other Studies in Great Britain found that young, oral, DHH children (ages 3–4 years) could represent number at least as well as their hearing peers when items were presented spatially or temporally (Kritzer, 2009). However, the studies did not provide complete information related to number knowledge and called for further research in this area. In a more recent study done in the United States, 28 DHH children (signing and oral) between 4 and 6 years of age were tested for their mathematics knowledge and skills using the Test of Early Mathematics Ability (TEMA-3). None achieved scores higher than "average" based on normative ranking with the majority receiving scores substantially below average, (Kritzer, 2009: p 409). Eleven children, that were about 40%, earned scores that indicated performance of a year or more behind hearing peers. In a secondary qualitative analysis of the performance of the participants completing the TEMA, specific areas of weakness within the concept of number were noted including story or word problems, skip counting, number comparison, reading and writing of two to three digit numbers, and addition and subtraction facts (Pagliaro and Kritzer, 2012).

Kritzer (2009) suggest that children's earliest mathematical learning experiences are informal in nature and take place through everyday life events that require them to count, build, share, and group, and that incorporate opportunities for the use of mathematical language and problem solving. For example, parents may remark on the number of fingers or toes the child has while bathing or focus the child's attention to a specifically shaped, favorite toy or even refer to the child as the big brother. Thus, mathematics concepts and skills are learnt as children make sense of the world around them.

In a 2003 study in the United States, 23 percent of fourth-grade students and 32 percent of eighth-grade pupils scored below basic on the National Assessment of Educational Progress Mathematics Assessment (Gurganus, 2010). Although scores have improved since 1996, when 37 percent of fourth graders and 39 percent of eighth graders scored below basic, between one-

fourth and one-third of pupils could not meet grade-level standards in mathematics on the 2003 assessments (Gurganus (2010).

Those students with mathematics disabilities identified under the federal Individuals with Disabilities Education Act of 2004 in America, were typically classified under the categories of specific learning disabilities, mild to moderate cognitive disabilities, emotional disabilities, language impairments, and other health impairments (such as ADHD), where the disability had been identified as having a significant impact on learning. Students with these identified disabilities could be served anywhere on the continuum of placement options, but most were served in regular classrooms or in limited but intensive pull-out programs, (National Resource Centre on Attention-Deficit/Hyperactivity Disorder-ADHD, 2014).

Other American students who performed below standards on state or district mathematics tests sometimes had individual intervention plans depending on district or state policies. The No Child Left Behind (NCLB) Act of 2001 made no provisions for meeting the needs of individual students who did not meet standards, other than the option to transfer schools if their overall school did not meet criteria for adequate yearly progress. Students from low-income families could qualify for supplemental after-school or Saturday services under the NCLB provisions for Title I schools. Some of these students were served in remedial mathematics programs funded through a variety of sources and others were served primarily in the regular classroom (Wikipedia Foundation Inc. 2014).

The students who had problems learning mathematics or failed to meet grade-level standards were usually identified between third and fifth grade, much later than those identified for reading problems, and were referred for special education services or other remedial programs. Special education and remedial teachers found that these pupils' basic concept and skill development were generally one to two years behind their peers upon identification. Even with interventions, the achievement gap for many pupils with identified disabilities continued to widen. These mathematics achievement problems were usually due to a combination of teaching and pupil factors including language, cognitive, meta-cognitive, motor, social and emotional factors, habits of learning, and previous experiences (Foistack, 2007).

A language disorder impairs comprehension and/or use of spoken, written, and/or other symbol systems. The disorder can involve form, content, or function of the language. Even if a student does not have an identified language disorder, he or she may exhibit language deficiencies related to his or her disability (American Speech-Language-Hearing Association, 2014).

Most pupils with mild to moderate HI disabilities have cognitive factors that impede learning. These may be perceptual, memory, attention, or reasoning factors. Perception involves taking in information from the environment and processing that information for storage or use. It is not just seeing the symbols for numbers but seeing and copying them. It is not just hearing the oral number sequence but hearing it and continuing the sequence. It is not the seeing or hearing alone, but also the discrimination and interpretation of visual and auditory input. Perceptual problems show up with difficulties keeping place on a worksheet or within a column of numbers, differentiating numbers or symbols that are close in form, copying shapes or symbols, following directions with algorithms or graphs, recognizing patterns or sequences, and understanding oral directions or drills (Martin & Wilcox, 1999).

Memory problems can affect long-term, short-term, or active, working aspects. Memory capacities, in the information-processing model, serve to store and retrieve information needed to interact with the environment. Long-term memory is the background knowledge and prior experience to which new information is added in various forms. Inefficient organization and integration of information going to long-term memory will cause problems with retrieval later. Short-term memory is the briefest register of new information, most of which is filtered and discarded. Active working memory is where new information is organized, filtered again, and the destination for previous learning to be retrieved for active use during a learning or problem-solving situation. The pupils' processing depth, organization, attention, and integrative abilities affect how well these capacities work (Banikowski, 1999).

Attention is a regulator for learning. It is concerned with alertness, mental effort, shifting attention, focus, and self-regulation. Pupils with attention problems either lack organized executive processing abilities or fail to apply efficient strategies and controls. In the mathematics classroom, attention problems are evidenced by difficulty sustaining focused attention during a

lesson or while solving a problem, inability to filter out irrelevant parts of problems, and failure to complete work (Meyer, 2003).

Meyer (2003, observes that reasoning is a higher-order cognitive ability that is essential for mathematics success. It involves various forms of conceptualization, deductive and inductive thought, working in the abstract, and solving problems. Pupils who have trouble with tasks involving reasoning have trouble seeing patterns and relationships, use faulty logic, typically accept things at face value rather than questioning and analyzing, and can't explain the "why" behind a math process (Meyer, 2003 p 20).

Then there are Metacognitive factors. Allsopp (2012) describes Metacognition as awareness of the skills, strategies, and resources that are needed to perform a task and the ability to use self-regulatory mechanisms, including adjustments, to complete the task. It is the process involving being aware of and monitoring the use of executive and cognitive strategies. Pupils with metacognition problems have trouble selecting and using effective learning strategies. They do not monitor their own use of strategies and have difficulty with generalization across time and setting. For example, a pupil may have trouble deciding how to solve a non-routine word problem. Even if the pupil attempts the problem, he or she does not monitor the process or results. Furthermore, the pupil cannot draw on experiences with similar problems because he or she does not appear similar in his/her conceptualization of the problem.

Motor problems with written work are most evident in younger pupils, but even adolescents with no physical disabilities can struggle with number and symbol formation. Motor skills, like perceptual ones, involve more than one process. They may involve memory of the symbol along with its actual formation. They may involve visual perception and transfer or copying. Or they may involve integration of fine muscles with task demands. Indicators of motor problems are highly visible in poorly formed symbols, little control of spacing, excessive time for a task, and avoidance of written work (Dummer, Haubenstricker & Stewart, 2014).

According to Muir, Crouch & Ficca (2010), in mathematics class, language problems are evident when students have trouble using symbols of mathematics, expressing math concepts to others, and listening to mathematics explanations. Problems also appear with reading or writing word

problems and writing and expressing mathematical sentences. Language can provide the bridge between the concrete representations of mathematics and the more abstract and symbolic forms. As pupils advanced in mathematics learning, they also used language to think—they manipulated concepts and ideas through language without having to rely on concrete materials.

Unfortunately, some students have few opportunities to talk about mathematics. Teachers, who mainly focused their lessons on lectures and demonstrations, and use of worksheets, are likely to limit their pupils' language development and related mathematical progress. Pupils should be responding frequently and discussing mathematics problems and concepts with each other and the teacher. Pupils whose parents continued the dialogue at home had additional benefits.

According to Clifford (2012), there are 840 babies born each year in the United Kingdom with significant deafness, and 20,000 children aged 0 to 15 years are moderately to profoundly deaf. Despite this, educational provision for these children has been identified as being limited.

In the late eighties cochlear implants were apparently heralded as the new cure for deafness, (American Speech-Language-Hearing Association, 2014). As a result many doctors told the parents of deaf children that learning Sign Language was unnecessary. These instructions continue today. This leads to denial about being deaf, meaning that the child misses the chance to embrace the richness gained from an immersion in deaf language and culture, and it is one reason academic attainment among DDH pupils remain low, (Deasy & Lyddy, 2009).

One of a mathematics teacher at Munali unit for the deaf found that the deaf children in class would understand the work, but after returning from holidays it was as if all their knowledge had evaporated. This shows how importance language is in helping improving memory and recall. If young people are not encouraged at home during the holidays to actively use language, whether sign language, speech or English, then their ability to recall will be hampered and the gap in educational attainment will never be narrowed. This is also why homework is justified (Clifford, 2012).

A study done by Akach and Mweri (1990) also report that, too often, deaf or HI learners face academic and personal obstacles which can prevent academic success. They have challenges with literacy, that is reading and writing. Wong (1989) reports that learning to read is a

formidable challenge to many children with hearing impairment in lower grades as they do not have mother language.

Longitudinal research indicates that once HI pupils fall behind in the language based on the skills of reading they find it very difficult to catch up and fail to excel in numerous academic domains which depend on reading. A five year study in the United States involved 197 deaf or hard-of-hearing students with mild to profound hearing loss who attended general education classes for 2 or more hours per day (Anita, Jones, Reed & Kreimeyer, 2009: 293). Average student progress in each subject area was consistent with or better than that made by the norm group of hearing students, and 79%–81% of students made one or more year's progress annually. Students' expressive and receptive communication, classroom participation, communication mode, and parental participation in school were significantly, but moderately, related to academic outcomes. Whereas the communication difficulties of students who are deaf and use interpreters may be obvious to teachers, the communication difficulties faced by hard-of-hearing students are often invisible. Because many hard-of-hearing students use spoken English as their preferred mode of communication, they are often perceived as having more in common with hearing than with deaf students. Their communication and educational needs may be overlooked because of the belief that they can function easily in oral environments and have less need for support services than students who are deaf. However, poor classroom listening conditions can create considerable difficulty for hard-of-hearing students thereby limiting their access to academic content (Anita, Jones, Reed & Kreimeyer, 2009: 294).

Pupils with HI also encounter difficulties in alphabetic languages which contribute to reading problems. Lack of knowledge on names of letters of the alphabet and the sounds they represent at entry into school becomes one of the strongest single predictors of short and long-term failure in learning to read (Adams, 1990; Stevenson & Newman, 1986). Understanding the conventions of print which is left-to-right and top-to-bottom orientation, the difference between pictures and print on a page, and the functions of print for example that the print tells a story or gives directions also appears to be very helpful in the process of learning to read (Purcell-Gates, 1996; Purcell-Gates & Dahl, 1991).

Some deficits of reading in pupils with hearing impairment is lack of phonological awareness which includes problems of retrieval, difficulties of phonological memory, fluency difficulties in reading and comprehension (Carver, 1993). The New breakthrough to Literacy reading programme requires all pupils in the first grade to be conversant with the above components in order for them to become good readers. This has made it difficult for the pupils with hearing impairment to catch up in reading because they do not hear sounds that they can relate to letters.

Conversely, their written language is a source of concern. Consensus findings of a study done by the department of audiology in Manchester outlined by Webster (2000) reported that deaf children have a written language which is often both linguistically immature and deviant. They use shorter, simpler sentence structures than their hearing peers, with more errors and non-standard usages ("deafisms"). Sentences are said to be more rigid and stereotyped, sticking to a well rehearsed pattern. Other writers such as Wilbur (1987) pointed out that deaf children appear to write sentence- by- sentence, with little awareness of connectives, or ways of achieving cohesion through cross reference. They may also show poor awareness of the rules which govern how words are used with each other.

Ray (2001) argued that deaf and hearing-impaired children had a limited language base that could prevent them from understanding and developing mathematical language. Other related issues that influenced mathematical development were parental involvement and comprehensive support in the home environment, together with a greater emphasis on the use of mathematical resources and specific strategies for teaching mathematics to deaf/hearing-impaired children.

Hall (2013) explained that a few hours of extra teaching helped deaf children overcome numeracy problems, which left them struggling to keep up with their peers. It was estimated that deaf children were three and a half years behind hearing children in numeracy skills. Researchers at the Institute of Education in London believed one of the reasons was that they missed out on much non-direct learning. This included games which helped teach children numeracy skills and general background conversation, for example, about shopping and the value of money.

Nunes, Pretzlik, & Olsson (1999) say that while hearing children could find out how numbers worked through incidental learning in everyday life, deaf ones had fewer opportunities to pick up

on environmental conversation, and so missed out on crucial bits of experience which is vital for Mathematics. The researchers add that so much of education of deaf people was geared to teaching about words. The researchers also spoke to the parents of deaf children and found that the birth of a deaf child to hearing parents could provoke a crisis in communication. Some 90% of deaf children are born to hearing parents. Parents had to decide how to communicate with their child and some rejected sign language, fearing it was a very visible sign of disability and could stigmatise their child. Others chose to use hearing aids and other hi-tech gadgets, telling their children that many children had problems and deafness was just another thing to be overcome. Thus, such parents chose a medical model, seeing deafness as something like needing glasses to read. But for most deaf people it was not as simple as that. Sign language might not solve all the problems, but at least it is a more direct way of trying to communicate with children (Nunes, Pretzlik Olsson, 1999).

2.2 Determinants of Learning among Hearing Impaired Learners

Studies on HI and learning of mathematics have revealed that learners with hearing impairments have difficulties in learning mathematical concepts. Flexer (1999) indicates that a study conducted by Michigan Department of Community Health revealed that a strong relationship exists between language and poor conditions in mathematics. Learners with HI have more difficulties in learning mathematical concepts than any other concept. The investigation revealed that, various factors prevent hearing impaired learners from successfully constructing mathematical knowledge. One core theme, language and mathematical concept acquisition, emerged together with four further influences on mathematical development. These are; cognitive development and the influences on mathematical processes, mathematical resources and partnership with parents (Giménez,, Rosich, Latorre & Muria, 2010:5).

Mellon, Ouellette, Greer & Gates-Ulanet (2009) revealed that HI learners lagged in cognitive development and were not exposed to mathematical thinking across the range of contents of the mathematics curriculum. With all children, the understanding of mathematical concepts involves availability of resources and considerable experience with particular problems being presented in familiar and different ways. In early childhood settings, developing and enhancing children's mathematical knowledge requires parents to facilitate learning experiences through play that is meaningful, spontaneous and which allow children's existing knowledge to be built upon, while

at the same time should allow them to refine their existing knowledge and ideas in constructing new knowledge.

While knowledge is not passively received through communication, this does not alter the fact that language (including symbols, signs and gestures) has an important role. Knowledge is actively built up and all experiences including language experiences and social interactions are part of the experiences that contribute to knowledge. The prior ideas that a child has are shaped by language which is an integral part of learning and this provides the context in which experience occurs. One implication of this is to move subjects such as science and mathematics from being viewed as language free or as part of an objective reality; to something that is unique to each learner, and that reflects their language abilities which in turn influences how they organize and make sense of their experiences and how they are able to communicate with others (Giménez, Rosich, Latorre & Muria, 2010, p3). Inadequate language skills among hearing impaired learners are manifested in difficulties to understand verbal and written mathematical concepts, (Ray 1993).Some distinct features of mathematical language make it complex and foreign for many learners with hearing impairments, including having familiar words with precise meanings that differ from their usual meanings. This suggests that the interpretation of the language of mathematics with its ambiguous language is challenging for hearing impaired learners (Mason, 1997).

As regards written language as a barrier to learning mathematics for hearing impaired learners, Pau (2008) also maintains that, these learners do not only lack the basic mathematics knowledge, but even language in general and vocabulary needed for them to be able to understand mathematical concepts and processes. For example, verbal arithmetic problems contain certain linguistic forms which are particularly difficult for hearing impaired learners. Without a basic understanding of nouns, verbs and other parts of speech, hearing impaired learners hardly grasp what they are tasked and are expected to do (Mason 1997). Therefore, to understand the main relationship of language and mathematics, it is important to understand the main components of language as it is used in the mathematics classroom. Vocabulary in the mathematics classroom does not only includes specialized terms such as quotient, multiplication, divisor, denomination, minuend and subtraction but also everyday terms that take on new meaning when used in mathematical context.

Barton (2005) also observes that, in contrast to their hearing impaired learners, hearing learners are exposed to language from birth and have an understanding of everyday language. This acts as a language pad for developing their understanding and use of mathematical language. However, learners with a hearing loss, whether slight or profound in nature, if unmanaged, can have a negative impact on the development of not only spoken language but also academic competencies. Therefore, hearing impaired learners' overall learning, including mathematical learning is generally delayed because of a limited language base (Kristoffersen, 2013).

Stigma is essentially an attribute that is discredited by others. Stigma appears to play a role in-group formation, particularly in minority group formation. Jones (2002) explains that deaf persons, like other individuals who are stigmatized by society, for example, on the basis of race, religion, sexual orientation, gender and the like, have been known to transform their stigmas into the basis for group identification. One explanation for these phenomena is based on the assumption that each individual desires to have positive self-esteem. Since the concept of stigma can be negative, because it separates the individual from the norm, an individual must re-define the stigma in order to maintain positive self-esteem. Thus Jones (2002) concludes that having any salient feature that distinguishes oneself from everyone else in a social context is at least uncomfortable and at worst devastating to self-esteem.

Language has been shown to be an important tool that people use to express their identity and to make judgments about other people. Language can also be viewed as an inseparable dimension of culture and heritage. It has even been demonstrated that people identify more with people who speak the same language than with people who share the same familial background (Giles, Bourhis, and Taylor, 1977).

Foster and Brown, (1988), suggest that when people with disabilities identify other people who have disabilities they do not regard themselves as stigmatized, but as members of a select group. People with disabilities, like all people, want to be worthwhile members of a group, to feel that other people share their life experiences, that they have other traits other than a disability, and that traits associated with a disability are positive. Thus, a person who is deaf might identify with other deaf people in order to maintain a sense of self worth. A person who is deaf will likely be

comfortable with peers who are deaf because within the peer group being stigmatized as deaf is not a determinant of one's role within the group.

One of the reasons given for this feeling of separation is that deaf people cannot be fully integrated into the mainstream. This perceived closure of the hearing world to the world of the deaf may be one reason why deaf people have chosen to react against the values of much of the mainstream that labels deafness as disability.

The Zambian government has over the years taken steps to address the problem of stigma and discrimination by introducing inclusive learning. Serpell (2011) notes that in rural Mpika District, the Inclusive Education Project had its benefits extended well beyond acquisition of cognitive skills and knowledge by CSEN to reduction of prejudice against children with conspicuous physical abnormalities, deformities and disabilities. The life-course of CSEN was very likely to be impacted by such changes in the social environment, and indeed a number of parents testified to that effect. Other benefits noted were an increase in the level of local accountability, as teachers negotiated with parents the desirability of enrolling their disabled children in school, and enhanced sensitisation of teachers to individual differences among their pupils' learning needs, styles and preferences. Striking opportunities were found for applying and refining the Child-to-Child approach through which primary school pupils had been mobilized in earlier programme in the district to take responsibility for nurturing the healthy growth of their younger siblings, their less able classmates, and other needy persons in their neighbourhood (Serpell, 2011:216).

Serpel (2011) explains that in 2002, the total number of CSEN in basic education was just over 23,000, representing only 1.1 per cent of the total school population. By 2004, the number had risen to over 73,000 pupils, representing 2.9 per cent of all the pupils'. Moreover, the number had grown to170, 084 by 2007. This was during the Basic education Sub-Sector Investment Programme (BESSIP). This impressive statistical indication of growth concealed a major distinction between CSEN whose presence in the main-stream schools was reported without any indication of the level of support being provided for their special needs, and a much smaller number of seriously disabled children enrolled in special schools and units staffed with

trained specialist teachers and equipped with relevant specialized resources to enable them to overcome the special challenges to learning posed by their particular disabilities (Serpel (2011).

According to the Ministry of Education (2002), the main objectives of BESSIP were to provide relevant education for all children in relevant age range and particularly for disadvantaged groups, increase gross enrollment and retention to 90 per cent, and improve learning outcomes for all children. Other objectives were to improve the procurement and distribution of learning materials, teacher recruitment and deployment, health and nutrition of children, promote gender equity and fight the spread of HIV in the education sector. The teachers in basic schools also benefited as they were supported in improving their qualifications and teaching capacity, (Communities Supporting Health, Education, and Gender Equity in Schools-CHANGES-Program).

It also supported the schooling of the 'children at risk', improving and expansion of Primary school infrastructure supported demand-driven community construction modality. Curriculum-development component supported the revision of basic school curriculum to emphasise the core skills of literacy and numeracy and the design, piloting of new instrument for curriculum and learning assessment. Administration and capacity-building component supported training and advisory services to assist the Ministry of Education in restructuring, de-centralization, improving planning, monitoring and evaluation functions and strengthening information systems.

BESSIP was also expected to ensure SEN received the right attention given that the support rendered to this area in education by international non-governmental organizations and development agencies had been discontinued. There were 2,000 out of 250,000 children with SEN in primary schools (Educating Our Future, 1996). The Ministry of Education (MOE) stated in this policy document that it would ensure equality of educational opportunity for children with special educational needs. The BESSIP was expected to address this SEN as part of the overall efforts in proving the primary sub sector. This also explains why the programme was heavily funded by government and its cooperating partners.

It is noteworthy that, despite including equity and affirmative action for the disadvantaged, among its objectives, this massively funded BESSIP initiative made no explicit reference to the

special educational needs of children with disabilities. In practice, government diverted attention from the nation's explicit plans for the development of a comprehensive programme of inclusive education for CSEN, in favour of a much heavier emphasis on targeting economically disadvantaged, rural communities. The majoritarian philosophy in-forming BESSIP afforded little or no opportunity for attaching priority to fine-tuning educational provision to the unique individual needs of learners with challenging disabilities (Serpell, 2011: 229). To a large extent, BESSIP focused on teacher training and infrastructure development.

Responses to the survey showed that the CSEN teachers trained in the earlier period only received training for addressing the special needs of children with one particular type of disability, whereas the group that had received training more recently had acquired a wider range of specialized educational skills (Serpell, 2011). This disparity reflected a deliberate change in the curriculum at the Zambia Institute for Special Education (ZAMISE). From 2006, the Institute changed its curriculum from a specialized type of approach to a more holistic approach where students were given training in all the different areas of disability instead of just specializing in one area.

This change was necessitated by the observation that after students graduated from ZAMISE, they were in some instances deployed to areas that did not have a unit for pupils with the type of special needs in which the teacher had specialized. Furthermore, the range of children enrolled in special units usually included children with a wide range of impairments instead of one type. Based on these observations, the Institute decided that it was imperative that a holistic approach be made a part of the curriculum so as to better equip the teachers to teach and interact with children who had various types of impairment (Mulonda, 2013: p 3).

Mulonda (2013) however adds that, whether the teachers received training in the holistic approach or not, they considered their training had adequately prepared them for the challenges they encountered at work. The fact that teachers during their first posting found very little or no specialized teaching resources on site highlighted the need for more investment in such resources. Some which had units with some equipment when they were initially established became dilapidated over time and never had these replaced, thereby making teaching a challenge for the teachers. One of the most pressing issues was the need for improved infrastructure,

teaching and learning materials, followed by the need for an increased number of trained special education teachers. Teacher motivation was an issue as special education teachers were not given enough incentives to continue working within the field of special education.

The use of sign language as a first language has been the foundation upon which much of the pro-Deaf culture advocacy has been based. The use of sign language is so important to the Deaf culture that any perceived threat to the use of sign language is seen as a threat to the efficacy of Deaf culture (Lane, 1992 p. 226-228).

It is evident that the concept of Deaf culture and its antitheses can be explained in part using psycho-social theories that examine the nature of stigma, language and prejudice. Stigma, language and prejudice have contributed to the formation of the Deaf as a minority group. The disassociation from the majority group that inevitably resulted from this formation has fueled the discussion of whether or not deafness constitutes the basis for a culture. The stigma of disability can be equated with other stigmatizing labels that lead people to form groups composed of people like themselves. Such groups reflect a basic need to normalize stigma in order to maintain a high self-esteem.

Similarly, a study done by Meadow-Orlans (2000) in Australia on the influence of language on learning mathematics among the HI children revealed that, HI learners to a certain extent are unable to take part in group activities such as discussion because they do not have the language required to undertake such tasks. The study further established that mathematical ideas which involve concepts related to volume, shape, size, comparisons and measurement are particularly difficult for HI children to grasp. Thus, the respondent teachers in this study acknowledged the potential for language inability to create barriers to learning mathematics and the need for teachers to attend to the role language plays in understanding of mathematics.

In addition to the above argument Haynes (1999) says engagement in mathematical processes such as problem-solving, developing logic and reasoning and communicating mathematical ideas depends upon learners having good communicating skills. Pau (1995) similarly holds that it is vital that any teaching programme designed to improve the hearing impaired learner's problem-solving level includes general text-comprehension and, in particular, mathematics text-comprehension activities.

In addition to the above explanation of the inability by HI pupils to effectively tackle mathematical tasks, Mousley and Kelly (1998) also maintains that learning of mathematical concepts proves to be a challenge for HI learners in that language of mathematics is unique. It confronts them with a wide range of recurring patterns and that the mastery of mathematics requires the formidable mathematical vocabulary such as denominator, and numerator, isosceles and equilateral among others. Much of this vocabulary is not part of everyday conversation, and hence, must be learned without the assistance of contextual clues.

Another challenging area in learning mathematics is keeping up with the advancement in mathematics technology with the advancement in mathematics technology. There is a lot of advancement in technology in education. O'Connell, Freed & Rothberg (2010) are of the view that students who struggle to understand auditory inputs are less able to experience deep engagement while learning new content because the decoding process consumes a disproportionate share of working memory. Similarly, many students with sensory disabilities must spend significantly more time just accessing information than their nondisabled peers. This is why technology should be regularly integrated into educational programs and practice to facilitate learning for students of all abilities across all grade bands, (O'Connell, Freed & Rothberg, 2010:4).

Pagliaro and Kritzer (2012) citing a study in Brazil said that results evidenced a clear distinction between mathematical cognitive skills more dependent and less dependent on linguistic stimuli, notifying that deaf children had the same performance, or in some cases even higher performance than hearing children in skills less dependent on linguistic stimuli. However, both deaf children and younger hearing children from public schools had a significantly lower performance in comparison to older hearing children from public schools and children from private schools. These result indicated that deafness was not a cause of poor academic performance in mathematics. Thus, it seemed necessary to establish forms of pedagogical intervention which could ensure the successful learning of mathematics for both deaf children and hearing children who attended public schools in Brazil.

2.3 How is Mathematics Taught to Learners with Hearing Impairments?

The fields of mathematics education and developmental psychology show that children begin to develop mathematics concepts that are quite complex at a young age, (Foistack, 2007). Infants have been found to demonstrate an implicit awareness of quantity. During the preschool years, formal number knowledge begins to be mapped onto this implicit awareness of quantity as number words and symbols are learned. As young children begin to interact more with their environment, geometry concepts are learned including shapes, locations, and language to describe spatial relationships. Measurement concepts are also beginning to develop and may serve to connect the young child's knowledge and understanding of geometry and number. This understanding of measurement may begin with a perceptual awareness of size and become more refined as numbers are mapped onto this early awareness.

Pagliaro and Kritzer (2012 says that during these years of early mathematics development, general cognitive skills are also developing. Young children increase their attention spans, learn to stay on task, hold more information in their minds, and acquire the ability to shift between tasks. Each of these cognitive skills is useful and necessary in mathematics learning.

Barbosa (2014) also says that there is a great deal of evidence that children begin to grasp mathematical concepts long before they go to school. This is evident in their ability to discriminate different sets of objects with the same number and ability to reproduce a set of objects with the same number as the one that they had just been shown. The understanding of number that children acquire through informal learning before they enter school plays an essential role in their learning about mathematics when they begin receiving formal instruction about the subject at school.

As already alluded to, Meadow-Orlans (2000) observes that learners with hearing impairments can learn mathematics just like their hearing counterparts. For all learners, the understanding of mathematical concepts involves considerable experiences and particular problems being presented in familiar and different ways. According to Meadow- Orlans (2000), in early childhood settings, developing and enhancing children's mathematical knowledge requires teachers to facilitate learning experiences through activities that are meaningful, spontaneous and

which allow children's existing knowledge to be built upon, while at the same time constructing new knowledge. This requirement also applies to hearing impaired children.

Hayness (1999) also notes that it is paramount that hearing impaired learners experience mathematics in a concrete and meaningful way in order to develop an understanding of mathematical concepts. There is research evidence that hearing impaired learners who use concrete materials actually develop more precise and more comprehensive mental representation, often show more motivation and on-task behaviour, and may better apply these to life situations (Shea 1994).Therefore, Moores (2000) suggests that concepts learning should be taught in such a way that learners develop the ability to think mathematically, experiencing new situations which allow them to refine their existing knowledge and ideas in constructing new knowledge.

In view of the above observation, Chen (2009) notes that, for HI learners to develop cognitively, particularly in mathematical sense, they need to be introduced to a diversity of mathematical experience with a rich language base in order to extend the opportunities for them to engage in mathematical thinking across the range of content strands of the curriculum. Thus, either special teaching strategies or methods or both should be used when teaching mathematical concepts to hearing impaired learners. Teachers should realize that in teaching mathematics to this group of learners, they are going to need to incorporate a variety of techniques they have used in the hearing classroom.

Chen (2009) further observes that for HI impaired learners to develop cognitively, particularly in a mathematical sense, the learning environment must have a wide range of meaningful mathematical experiences that are visually engaging and can be physically manipulated. Activities should be purposeful and have relevance to everyday life so that they can be experienced in a context other than a purely mathematical one.

From the above assertion, it can be said that learners with HI learners who have individual challenges that are influenced by any degree of deafness, the age at which they become deaf, the nature of deafness and their experience of language; whether spoken or signed, and communication with their family members as they grow up can still learn mathematics if the above strategies are employed by their teachers.. The challenges of HI learners in learning mathematics may revolve around the interaction between the learners. HI learners therefore may

need more time to assimilate new information, make sense of text based materials, more or differentiated explanation, visual aids and signed support in order to understand mathematical concepts and subsequently perform better in national examinations (UNESCO, 1996).

2.4 Summary

The studies reviewed in this chapter show that children with hearing problems are capable of learning to handle basic numeric problems. Literature has also shown that phonological awareness contributes positively to the acquisition of reading and numeric skills among the hearing impaired. Perpetual challenges and fluency in literacy were also noted to be among the causes of mathematical difficulties among the HI. Literature also showed that while reading programmes like PRP, NBTL and SITE facilitated English reading skills mostly to hearing students, it did not help much to support the acquisition of mathematical skills among the hearing impaired**.** Thus, the knowledge gap appears to be that although a relatively small number of studies have investigated the performance of HI pupils in Zambia on specific areas of literacy, (Chikopela 2013, Chibuye 2013) those that tend to target mathematics and challenges faced by these students in numeracy are not adequately addressed. This study therefore sought to establish factors that contribute to poor achievement levels in mathematics among the HI.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This section describes the research design that was employed, the target population, sample size, sampling procedure, research instruments, data collection procedures, data analysis and ethical consideration issues in the study.

3.1 Research Design

Yin (1994), defines a research design as "an action plan for getting you from here to there." The research design therefore acts as a guide through which a researcher is taken when conducting research. Yin (1994) further indicates that a research design mainly deals with four main questions, that is; (i) what question(s) to study, (ii) what data is relevant, (iii) what data to collect, and (iv) How to analyze the results.

Therefore, the study on factors contributing to low achievement levels in mathematics among learners with HI adopted a case study method which embraced a mixed methods design. Since there are different approaches to mixed-methods designs that have been developed (Greene et al., 1989), revised (Creswell & Plano Clark, 2007), and reorganized (Teddlie & Tashakkori, 2009), this study adopted an embedded paradigm which was sequential in nature. Quantitative data was collected first and this was followed by qualitative data. This mixed methods design was predominantly qualitative and can be designated symbolically as **quan + QUAL**. The lowercase implying less emphasis and the upper case implying more emphasis.

This study takes an interpretive and naturalistic approach. Denzin and Lincoln (2000:3) indicate that "qualitative research involves an interpretive and naturalistic approach: This means that the

researcher studied things in the natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them."

Family Health International (2005) defines qualitative research as that inquiry that aims at gathering an in-depth understanding of human behaviour and the reasons that govern such behaviour. The qualitative method investigates the why and how of decision making and not just what, where, when something happened. Hence, quantitative methods can then be used to seek empirical support for such research hypotheses. In sociology, quantitative research refers to the systematic empirical investigation of social phenomena via statistical, mathematical or numerical data or computational techniques. The objective of this method of inquiry is to develop and employ mathematical models, theories and/or hypotheses pertaining to phenomena. The process of measurement is central to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationships. Quantitative data is any data that is in numerical form such as statistics, percentages, and the like (Family Health International, 2005).

Qualitative methods are used to gain an understanding of underlying reasons and motivations, provide insights into the setting of a problem, generating ideas and hypotheses for later quantitative research. It also helps uncover prevalent trends in thought and opinion.

On the other hand, quantitative methods quantify data and generalize results from a sample to the population of interest. They are used to measure the incidence of various views and opinions in a chosen sample. This is sometimes followed by qualitative research which is used to explore some findings further. Therefore, the study used both research methods to understand the problem under investigation to enrich the findings.

3.2 Population

A population is generally a large collection of individuals or objects that is the main focus of a scientific query. It is for the benefit of the population that research is done. A research population is also known as a well-defined collection of individuals or objects known to have similar characteristics or traits. However, due to large sizes of populations, researchers often cannot test every individual in the population because it is too expensive and time consuming. This is the reason why researchers rely on sampling (Williams, 2013). The target population in this study

comprised of learners with hearing impairments and their teachers in selected schools in Lusaka province. The selected schools were drawn from Lusaka urban district. The unit of analysis were learners with HI and their teachers.

3.3 Sample

Schulze (2002) defines sample as an element that is, a smaller group of target population which is selected for inclusion in a study. Booyse (2002) states that it is impractical to mount a survey that includes the entire population, hence the sample is drawn that is representative, in that those included in the sample display the same characteristics as that of a target population. The sample comprised of 32 respondents. Recognising that the population of teachers and pupils that interact was small, purposive availability sampling was employed in this study (Willians, 2013). Purposive sampling implies the researcher subjectively determining the type of sample to be enlisted in a study (Creswell 2003). For the sampling purpose, what the researcher had in mind was to enlist learners with hearing impairments and teachers who handled them in mathematics. On these bases, the students with hearing impairments and their teachers were picked from two special schools, namely, Munali Secondary School Special Unit and UTH Special School.

3.5 Instruments for data collection

Three types of data collection instruments were employed in this study and these were focus group discussions, semi structured interviews and classroom observations. One semi- structured questionnaires was used to collect qualitative data from teachers. One semi-structured interview guide was also used to collect in-depth qualitative data from pupils. As correctly argued by Lindlof and Taylor (2000), the advantage of a semi- structured interview allows for new questions to be brought up during the interview as a result of what the interviewee says. The focused group discussions were conducted with pupils using a focus group discussion guide. An observation checklist was used in both schools and all lessons were observed. The Participant observation is the process enabling a researcher to learn about the activities of the people under study in the natural setting through observing and participating in those activities (Kawulich, 2005). The lesson observations were aimed at having a true picture of the situation in the

classroom and obtain data that could not be obtained through questionnaires, interviews and focus group discussion guide instruments.

3.6 Procedure for data collection

The study took place in selected schools that host pupils with hearing impairments in Lusaka urban district. Permission was sought from the head teachers to carry out the research. The researcher was then introduced to heads of department by the head teacher and then to class teachers. For this study, the specific strategy of interviewing involving one-on-one interview method was employed when administering the questionnaire to solicit responses from pupils. Pupils were further engaged in group discussions and some lessons were observed. The observation technique was included in order to understand the level of preparedness among teachers to teach, resources at their disposal and teaching methods, as well as pupil participation and comprehension. The process was an opportunity to examine what was happening in class. This enabled the researcher to gather data on the physical, human interactional settings and program of learning.

Focus group discussions were conducted using open ended questions. The groups provided information about individuals' opinions and feelings concerning the problem of low performance in Mathematics among HI pupils. It also helped the researcher to gain insight into the respondents' reasons for those opinions. The open-ended questioning was a way to explore participants' comments. The participants were more willing to express their opinions. The process created an atmosphere of sharing and discussion.

3.7 Data Analysis

Conjecture Corporation (2014) defines Data analysis as, "a practice in which raw data is ordered and organized so that useful information can be extracted from it. The process of organizing and thinking about data is key to understanding what the data does and does not contain. There are a variety of ways in which people can approach data analysis, and it is easy to manipulate data during the analysis phase to push certain conclusions or agendas. For this reason, it is important

to pay attention when data analysis is presented and to think critically about the data and the conclusions which were drawn" (Conjecture Corporation, 2014:1).

The researcher collected both qualitative and quantitative data from the respondents. From the semi structured interviews and class observations, the researcher was able to sieve out questions that had categorical and numerical data to compute descriptive statistics. Initially, quantitative data was double entered and verified using Access 2000 (Microsoft Corp., USA). Descriptive statistics were run to determine relative frequencies, percentages and averages when needed. Analysis of relative frequencies were done using SPSS version 20.0 for Windows (SPSS Inc., USA). The main thrusts of the analysis were to generate descriptive statistics.

For qualitative data, interviews and focus group discussions were tape-recorded using a Nokia hand phone and a video camera. Because of the exploratory nature of the research, the recordings were transcribed in full. Since the researcher wanted to provide an "explanatory understanding" of causes or motives of behaviors, as Weber would like to call it (Weber, 1962:35, 40), the interview data were analysed with two main purposes in mind. First, to establish a descriptive picture of what was happening on the ground and second, to explore the meanings and understandings of the health or social actors in order to gain a fuller appreciation of the subject matter and second, to tease out only what was very critical or informative. Use of Hycner's (1985) framework informed structural content analysis. This involved listening to the interviews and focus group discussions to get a sense of the whole, delineating units of general and relevant meaning, eliminating redundancies, clustering units of relevant meaning and identifying and contextualizing themes from the latter. Briefly, transcripts were segmented into paragraphs, and each paragraph examined in-depth to generate categories ('line by line coding'). As the number of categories built up, 'constant comparison' was used and this was done using cross-referencing.

3.8 Ethical Considerations

Resnik (2011) defines ethics as rules for distinguishing between right and wrong. There are several reasons why it is important to adhere to ethical norms in research. First, norms promote the aims of research, such as knowledge, truth, and avoidance of error. For example, prohibitions against fabricating, falsifying, or misrepresenting research data, promote the truth and avoid

error. Second, since research often involves a great deal of cooperation and coordination among many different people in different disciplines and institutions, ethical standards promote the values that are essential to collaborative work, such as trust, accountability, mutual respect, and fairness.

Many of the ethical norms help to ensure that researchers can be held accountable to the public. Ethical norms in research also help to build public support for research. Many of the norms of research promote a variety of other important moral and social values, such as social responsibility, human rights, compliance with the law and health and safety. Ethical lapses in research can significantly harm human and other subjects, students, and the public (Resnik, 2011). Confidentiality was observed and maintained by not requesting for identities of the respondents and by ensuring that the information they provided had no direct connection to them. Permission was obtained from the head teachers of both schools visited during the study before the research was conducted. The assurance of security of respondents for participating in the research was made.

3.9 Summary

This section described the research design that was employed, target population, sample size, sampling procedures, instruments used to collect data, data collection procedures, data analysis and ethical issues that were considered in the study.

CHAPTER FOUR

PRESENTATION OF FINDINGS

4.0. Introduction

This chapter presents the findings of the study aimed at determining factors that contribute to low achievement levels in Mathematics among learners with hearing impairments. The findings are presented according to the objectives of the study, starting with the findings from pupils at primary school then secondary school and then teachers. The questions of the study were:

1. What methods did teachers use when teaching mathematics to pupils with Hearing Impairments?

2. What are the qualifications of teachers in teaching mathematics to learners with hearing impairments?

3. What factors contribute to poor performance in mathematics among learners with hearing impairments?

4 Are there measures that can improve performance of learners with hearing impairments in mathematics?

In order to present the results succinctly, since this is a mixed methods design, recognizing that central to any mixed methods research, is how researchers justify their approach. This is especially important with regard to the question of mixing. There are at least three options available when deciding how and why to mix your data presentation. Data can be merged by transforming and/or
integrating two data types together, one data type can be embedded within another, or they can be presented separately and then connected to answer different aspects of the same or a similar research question (Creswell and Plano Clark (2007: 80). In this section, the researcher opted to integrate two data types together.

The data that is presented below is about 32 respondents. Ten (10) teachers were selected from a total population of 48, of whom 8 were female and two (2) were male, representing 20.8% of the teacher population. There were 6 pupils (3 female and 3 male) out of the total 35 pupils in the three grades at UTH Special School and 16 pupils (7 female and 9 male) out of the 81 pupils in grades 11 and 12 at Munali Girls' Secondary School Special Unit, who were selected (total 22) to make a sample representing 19% of the total pupil population.

4.1.0 Methods used in teaching mathematics to pupils with HI

To determine methods used when teaching and learning mathematics, it was important to begin by finding out whether all pupils participating in the study learnt mathematics. All the 22 respondents unanimously said they learnt Mathematics. Among aspects of the subject they liked were multiplying numbers, counting, subtraction, division, formulas used, matrices, discussing angles, solving problems and calculations. They further said it was a good subject, and that it was an important subject; good examples that were encouraging.

For the pupils at primary level, reasons for these responses were that the subject helped them acquire skills to add, multiply and subtract numbers, think, understand and change money. It also helped them to do a lot of other things. One respondent in Grade 6 found Mathematics useful even at home and said:

It enables me to understand money (change) when I am sent by my parents.

Another grade 7 pupil indicated that

Mathematics helps me learn new things.

At secondary level, pupils attested to the fact that mathematics was an important subject because it was a determinant factor of one's future. Pupils said it was a requirement for one to be accepted to tertiary education and being guaranteed a job as a teacher, banker or engineer. One grade 11 respondent mentioned that:

Mathematics is found in all subjects so it is a must.

Another one said:

Mathematics helps to pass examinations and go to college or university.

Other reasons cited by pupils at secondary level were that Mathematics was important as it related to most of things done in life, thereby being a must for one to learn it. Two (2) pupils cited having a good Mathematics teacher as the reason for liking the subject. Only four (4) pupils said there was nothing that amused them about the subject. But of these four (4), two of them said the subject was important, while the others said it was not. There were a total of four (4) pupils who were of the view that the subject did not matter to them. One grade twelve (12) pupil had this to say:

> *I don't like mathematics, and I have never liked it since I started school. I would rather stay away during mathematics lessons so that I read other notes.*

Two of these said it was easier to learn English and other subjects than Mathematics as one of them suggested that:

> *It is better for me to learn English because it is easier and will help me communicate with people; mathematics is not good for me.*

4.1.2 Mode of Communication with Teachers of Mathematics

In establishing methods used to teach HI pupils, it was important to understand the mode of communication between pupils and their teachers. It is through this process that the learning took place. Eighteen (18) of the respondents said they used Sign Language, three (3) said they used Total Communication, while one (1) said they used Lip Reading.

Table 1 Mode of communication used by pupils

Reponses	# Respondents
Sign Language	18
Total Communication	3
Lip Reading	1
Total	**22**

4.1.3 Feedback from teachers on whether mathematics was taught

All teachers positively said mathematics was taught and that mathematics was just an essential science required in everyone's life. Others observed that mathematics is an important requirement for one to persue his/ her academic carrier. One teacher indicated that

> *Without mathematics, you simply cannot go through the educational hierarchy, especially at tertiary level.*

One teacher handling a Grade 12 class at Munali Girls' Secondary School also mentioned that mathematical concepts were found in almost everything we do; hence it had to be a must for every learner. He observed that;

> *Issues to do with mathematics are found in everything we do, even simple things like sharing things, recognizing shapes, even calculating walking steps. So it is important to develop the science in children by exposing them to mathematics lessons.*

4.1.4 Methods used to teach mathematics

Results indicated that out of the 10 participants, 5 respondents indicated that they used pictures and concrete objects where possible to help them consolidate the concept they tried to put across using sign language. One Grade 7 teacher noted;

> *Effective teaching to HI learners involves the use of pictures and concrete objects to help them assimilate concepts; otherwise explanation by just signing does help them much.*

One grade 11 teacher however indicated that he was supposed to teach using a variety of teaching aids but did not do so due to non availability of required aids, hence depended heavily on sign language. He wrote;

> *Ideally, we are supposed to teach with teaching and learning aids but we rarely do so because the aids are simply not there, we have no option but just to sign.*

When asked on the mode of communication used, all of them indicated that they strived to use total communication that is sign language, finger spelling and speech. However, 2 teachers

faithfully indicated that they were incompetent in sign language and were still struggling to learn the language. A Grade 7 class teacher at UTH Special School noted that;

> *Because of the variations of hearing loss, we use total communication in order to cater for those with residual hearing, those that can lip read as well as finger spelling words that are not provided for in sign language*.

Concerning teaching methods, 8 out of the 10 teachers reported that they used a variety of teaching methods which included question and answer, demonstration, observation, and lecture. Two teachers however said they heavily depended on question and answer and demonstration methods. To this effect, one Grade 12 class teacher at Munali Girls Secondary School however responded that;

> *Other methods such as cooperative learning which involve working in groups are challenging to incorporate during lessons because they sort of cause confusion. We therefore opt to use methods which help us take full control of the class, for instance question and answer.*

4.2.0 Qualifications teachers have to teach mathematics to learners with the HI

Qualifications of teachers are key in the quest to provide quality education to learners. It was therefore cardinal that the qualifications and experience of individual teachers was established as this could have a bearing on the performance of learners under their care. There were 10 teachers, 3 were university graduates, 6 were diploma holders and 1 was not trained yet as a teacher but was assigned to teach the HI at primary level on the basis of vast knowledge of sign language.

This teacher handling the Grade Five Class said;

Am not a qualified teacher yet, am just helping to teach the deaf with the knowledge and experience I have in sign language because there are few teachers who know sign language here.

Table 2 Teachers' Qualifications

Tertiary Qualification	# Teachers
University Graduate	3
Diploma holder	6
Certificate holder	-
None	1
Total	**10**

Of the 10 teachers who took part in the study, 7 were trained in special education and sign language (3 university graduates and 4 diploma holders) and competent teachers. One teacher was a diploma holder trained in special education but had a bias towards teaching practical skills. The other teacher was equally a diploma holder and had some training in sign language, but was not good at the language because her area of specialty was to teach intellectually challenged learners. One teacher was untrained though she was a good Sign language teacher because she had extensive experience interacting with the hearing impaired.

Apart from the variations on teacher's levels of academic attainment, their competences in sign language also varied. Among the 10 teachers, 7 indicated that they were very good in sign language, 2 of them (both female) at UTH Special School said they were not good at all and one (1) was very poor. One of them who was poor in sign language and complained that;

> *I have no idea about sign language. I have a diploma in special education but with a bias towards teaching practical skills to the intellectually challenged. Am totally misplaced here and it seems the administration does not want to listen to my plight.*

Table 3Teachers' competence in Sign Language

Tertiary Qualification	# Teachers
Very Good	7
Good	1
Not Good	1
Poor	1
Total	10

Nine out of the 10 teachers were trained special education teachers, but in terms of ability to teach Sign Language, one of them had her training biased towards practical instruction while the other one had specialized to teach the intellectually challenged pupils, hence their low and poor competence levels. The untrained teacher had mastered the Sign language because she had extensive experience interacting with the hearing impaired.

Table 4 Teachers trained to teach Mathematics to HI pupils

Tertiary Qualification	**No. of Teachers**
University Graduate	3
Diploma holder	3
Certificate holder	-
None	-
Total	**6**

Six of the 9 trained Special Education teachers were specialized to handle Mathematics lessons for HI pupils. Thus, the deployment of teachers not specialized in Mathematics Education and untrained ones, to offer Mathematics lessons to HI pupils, becomes vivid here.

4.3.0 What factors contribute to poor performance in Mathematics among learners with HI?

It was important to hear from both teachers and learners on the factors that contributed to poor achievement levels in mathematics among learners with HI since both groups were stakeholders in the learning process.

Pupils in primary and secondary school generally play a very small role in defining or governing the school system that educates them. Although preparing pupils for their future is the whole point, it is generally agreed that teachers and school administrators run the show, while pupils are expected to focus on learning. This study offered an opportunity to HI pupils to have a say on challenges they encountered when learning Mathematics and to suggest possible solutions to some of the problems encountered in accessing quality mathematical lessons. Thus, it softened the teacher-led model of schooling, and thereby opened room for their participation, an opportunity they had been missing, given that one of the roles of our schools is to prepare young people for their roles as citizens in a democracy.

4.3.1 Learners' view points

Negative attitude towards mathematics.

8 pupils said mathematics was a difficult subject. Pupils in grade 5 said they were more excited when learning subjects like social studies than mathematics. The attitudes pupils had towards the subject had a bearing on how much effort they put in when learning the subject. One pupil attributed the negative attitudes to poor, difficult language of mathematics and explained:

> *Mathematics is difficult because it has a lot of new words which we have never known. Most of the terms are new and difficult to remember.*

Lack of materials

Pupils indicated that most of the basic materials required for mathematics were inadequate. As a result, teachers rarely used them. One grade 7 pupil noted that:

> *The materials like abacus, calculators and books are not enough and we do not usually use them. We need such things to help us understand.*

Teachers' incompetence in sign language.

Pupils attributed their poor performance in mathematics to poor communication skills by their teachers. The said a good number of teachers do not know what to do with them because they do not know the language to use to effectively communicate with them. One grade 6 pupil said:

> *We cannot understand, some teachers just write things on the board and ask us to sign what is on the board. So we sign if we know the word but if we don't know it, the word will be left like that without explanation.*

Poor mathematics background

Problems in mathematics begin as far back as grade one and are left unattended to while pupils progress to the next grade. That itself gives them a poor foundation for further learning in the subject.

Teacher' absenteeism

Results indicated that sometimes teachers missed lessons which made it very difficult to build up on concepts and resulted in de-motivation to learn mathematics. For instance, only 6 respondents said they learnt mathematics very often while half of the respondents (8) said they Often learnt Mathematics and 5 said the Rarely learnt it.

Table 5 Frequency of Learning Mathematics

Reponses	# Respondents
Often	11
Very Often	6
Rarely	5

Teachers' incompetence in sign language

8 learners noted that their performance was poor because it was difficult to communicate with a teacher who did not know sign language. One learner mentioned that:

> *Some teachers do not know sign language; we are the ones to teach them signs, so it is difficult to communicate with them and also to understand what they are saying. Sometimes they use wrong signs and confuse us.*

Five other learners said some of their teachers learnt sign language from them, so the time to learn mathematics was reduced as part of the time was used to teach the teacher signs.

(c) Slow to grasp mathematical concepts

Some learners admitted that they were slow to understand, therefore needed the teacher to at least repeat the explanations. Two learners complained on the pace of learning and one of them had this to say;

> *The teacher is too fast, he does not take his time to explain, so sometimes when he asks us if we have understood, we just say "yes" so that he continues and goes away.*

Nature of mathematics

The other notable factor was the nature of mathematics. They said that even some teachers appeared to be having difficulties in teaching Mathematics. Some things were said to be complicated for them to grasp. One learner explained that,

> *Mathematics is a bit complicated because it is not like English where you are shown pictures and match the word to the picture for you to understand. Here we mainly depend on the teacher's explanations.*

(*e)Frequency of teachers using available learning resources in class*

Availability of learning resources is one thing and putting them to good use is another. Thus, it was important to establish how often the available learning resources were being utilized in Mathematics education (chalk board, mathematical sets, books, calculators, charts, stones, graphs and counters). Only 7 out of the 22 respondents said they Often used Mathematical learning resources, 4 said they used them Very Often, while half (11) said they Rarely used these resources.

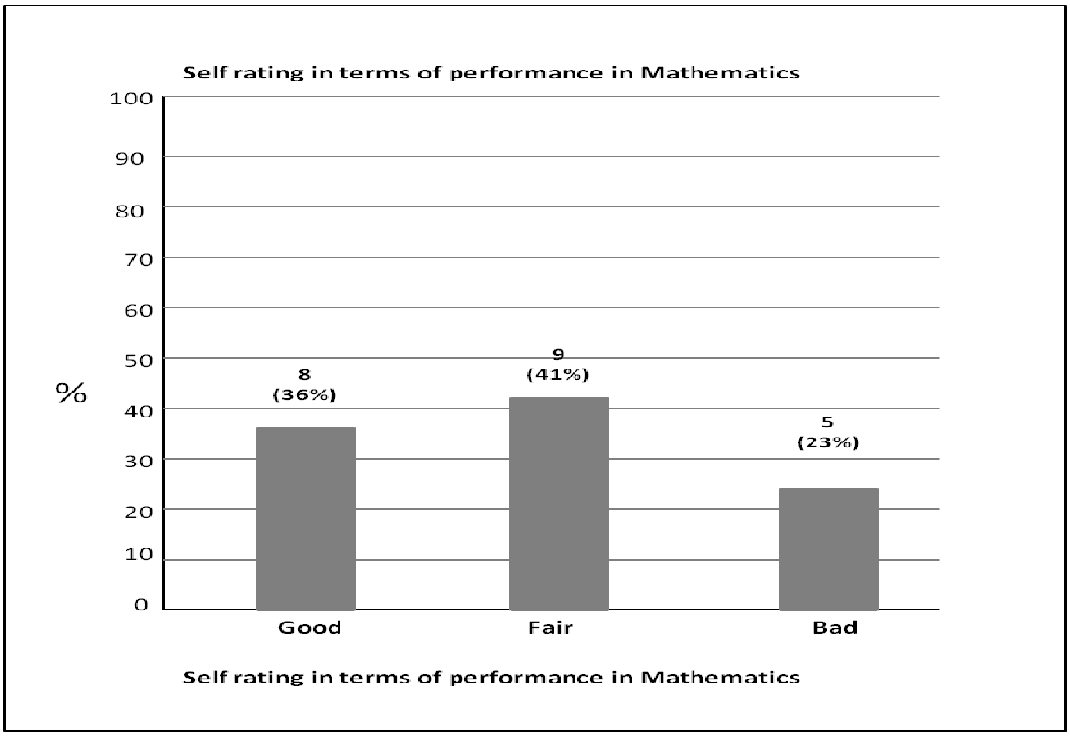
Table 6 Frequency of using Mathematical learning resources

Reponses	# Respondents
Often	7
Very Often	4
Rarely	11
Total	**22**

Self Rating in terms of performance in Mathematics

This question provided an opportunity for the respondents to have a say on how they gauged their individual performance in mathematics. Eight (8) pupils rated their performance in the subject as Good, nine (9) said it was Fair and five (5) said it was Bad.

Figure 2 Self Rating in terms of performance in Mathematics



i. Reasons for Good Performance

Pupils said they usually strived to remember everything taught by teacher. They also said that some topics like addition were easy to understand, while multiplication was difficult. Hard work was cited as a solution when work appeared difficult. These pupils said they at times had difficulties when repeating questions asked by the teacher, seeking clarification, and being accurate when responding. Thus they were able to repeat fewer questions posed by the teacher. Three of the pupils in Grade 11 at Munali Girls Secondary said they required a significantly greater number of repetitions, sought a greater number of general clarifications, and correctly answered more questions.

ii. Reasons for Fair or reasonable Performance in Mathematics

The respondents said Mathematics was a problematic subject which used language that was not friendly. They said some topics were difficult to understand. Other reasons cited were forgetfulness among some individual learners. They said their performance was fair because they performed better in topics that were simpler like addition and subtraction. They further justified their fair performance by highlighting that they can do better if all factors that contributed to their poor performance were to be minimized. One pupil who gauged his performance in mathematics as being fair said:

It is difficult to understand especially when the teacher does not know the sign language. So I cannot say my performance is bad because I can do better if everything was fine.

iii. Reasons for Bad Performance

Respondents generally regarded the subject as difficult with too many strange words and formulas, new things, and unclear concepts. One pupil put it bluntly:

Mathematics is too difficult.

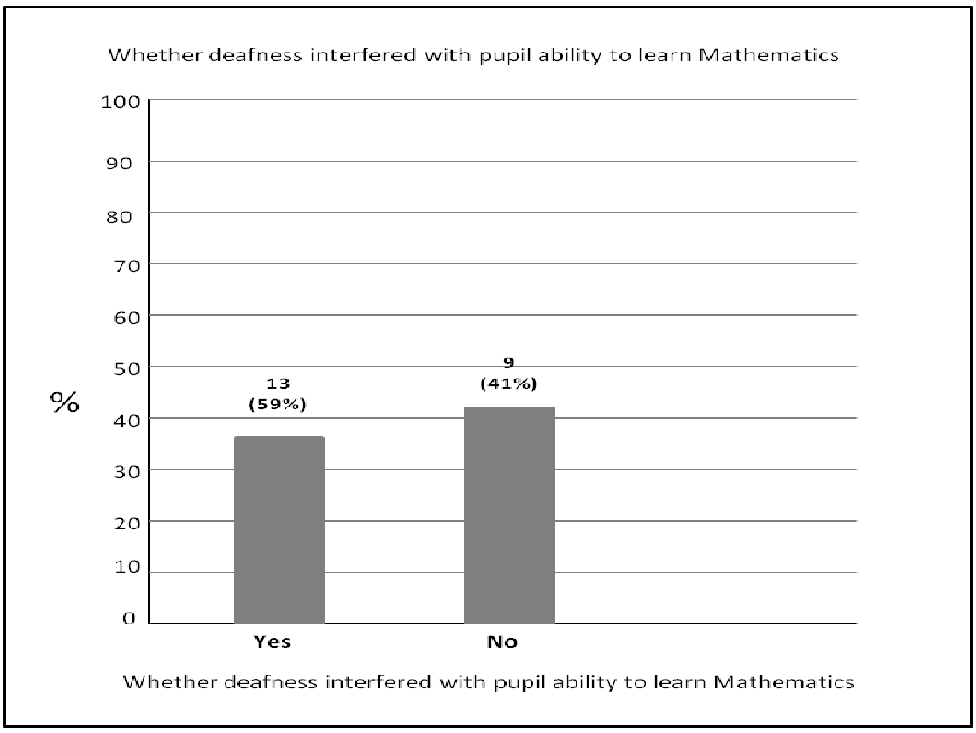
Another pupil said:

I can't hear, so I can't understand what our teacher explains.

Whether deafness interfered with pupil ability to learn Mathematics

This question sought to establish personal views of learners in that these attitudes (both positive and negative) have an impact on how pupils learnt Mathematics. Thirteen (13) pupils said that the disability interfered with their abilities to learn the subject, while 9 said it was not a problem

Figure 3 Whether deafness interfered with pupil ability to learn Mathematics



Those that said deafness was an obstacle said they had problems understanding instructions from the teacher. Pupils indicate that there were teachers who did not know sign language, therefore teaching and communication was sometimes not effective. Some topics were reportedly difficult to understand in sign language and that certain mathematical words are not there in sign language, as such teachers just finger spelled words without necessarily providing meaning or ignored them. The hearing impaired were sometimes slow to understand concepts.

On the other hand, those who were of the view that hearing impairment was not an obstacle said that some topics such as Addition and Multiplication were easy to understand, one needed to work hard and memorize formulas, they said deaf children were just as good as their hearing colleagues.

4.3.3 Feedback from Focus Group Discussions

In order to consolidate on the information collected from the questionnaires, learners were engaged in group discussions to get first hand information. Learners were able to give in-depth

information about their experience during mathematics lessons. The following were some of the challenges they encountered.

When asked on whether they learnt Mathematics, all the participants indicated that they learnt Mathematics and that the subject was important.

Responding to the question on methods used to learn the subject, responses from pupils at primary school included; question and answer and observation. Learners further said teachers explained using signs, charts, pictures, or sometimes concrete objects like stones, counters and so on. The respondents also said they used learning materials such as pupil's text books during lessons.

At secondary level, pupils said that they learnt mathematics through observation, demonstration, question and answer, expository methods and sometimes using materials such as charts and text books. However, pupils observed that the materials were few, and one of them reported that

The learning aids were few and were rarely used.

Performance in the subject ranged from good and fair to poor and bad. Fair and poor performances were due to lack of some learning materials, lack of qualified teachers, limited attention from the teacher. Pupils pointed out that some teachers complained about teaching the HI. One grade 5 pupil said:

Some teachers just walk into the classroom and talk; they do not know what to do or how to communicate with us who are HI.

The learners at secondary level were quiet elaborate and pointed out that existence of difficult topics in the subject, limited methods of teaching and limitations posed by the disability itself were among the factors that contributed to their poor performance in Mathematics. The pupils said Mathematics syllabus is not favourable for learners with HI. Some topics are too difficult for the HI to understand. Learners unanimously agreed that Mathematics is highly abstract. Topics such as vectors are highly verbal. One grade12 pupil said:

Some topics just need hearing for one to understand, they are not easy for the HI.

Another grade 12 pupil noted that:

> *Mathematics topics become more difficult as they progress from one grade to another.*

The respondents however were positive that their performance could improve if certain measures such as provision of qualified teachers, and adequate teaching and learning resources were made available.

One respondent said that:

We need qualified staff, learning and teaching resources, and enough time to learn.

4.3.4. Perceptions of Teachers on factors that contribute to poor performance

Hearing Impairment does not hinder a pupil from performing well in mathematics

Teachers who responded to the questionnaire believed that learners with HI could perform just as good as their hearing peers because both categories of children had the same cognitive potential that could help them excel in mathematics as long as a few factors that seem to contribute to poor achievement are dealt with. Two teachers handling Grade 12 classes at Munali Girls' Secondary School went on to say they had taught HI learners who performed even better than their hearing peers. On the other hand learners also had their own observations, and these views were reflected in responses to questionnaires.

Inadequate learning resources

The question on the availability of learning resources was relevant in that these are aids to learning Mathematics. Most teachers did not use concrete objects because there was lack of basic materials. In both schools, there were inadequate mathematics materials for both teachers and pupils. The only learning materials cited were the chalk board, mathematical sets, books, calculators, charts, stones, graphs and counters. Teachers noted that the problem of teaching the HI was even compounded when teaching materials were in short supply. One teacher said;

Generally, learners face challenges to assimilate concepts which they are taught without teaching aids.

(c) Changing teaching staff between classes

Some teachers reported that changing from one class to another poses challenges. Teachers reported that they did not teach one class for more than one year but were given new classes almost every year. The lack of consistency poses problems because teaching styles vary hence both teachers and pupils find it difficult to adjust.

Large class size

Three (3) teachers were of the view that class sizes of 15 for Primary level and 40 and 42 for Secondary level were too large for CSEN, as the ideal sizes were supposed to be 4 to 5 children (Primary) and 10 to 15 or 20 (Secondary). Teachers felt that the size of the class made it difficult to give individualized attention to the pupils with HI. One teacher noted that;

These pupils need individual attention but the classes we handle are sometimes too big to be given that kind of service; it is therefore not easy to give a one to one attention to all learners who seem to be lagging behind.

Formulas involved when solving mathematics problems

Another factor that contributed to low performance in Mathematics among the HI were some long mathematics formulas. Some formulas used to solve mathematics problems made it difficult for deaf pupils to remember what they had been taught. Teachers said that some of HI learners had difficulties understanding certain concepts in areas like division, fractions, multiplication and expanded notation due to long methods used. Similarly some topics were also reported to be difficult to teach due to their abstract nature. One grade 12 teacher admitted having challenges to teach when she responded:

Topics such as vectors, Earth geometry, linear programming and circle theorems are not easy for me to teach because of their abstract nature. So we skip them because children simply cannot understand.

Another cited division and fractions as being difficult to handle:

> *They are too abstract, hence difficult to find suitable sign language to explain them.*

Language barrier

One other notable factor that contributed to low achievement levels in the subject, was the language barrier, contributing to slowness among pupils to assimilate concepts and failure to understand abstract concepts. Four teachers said deafness contributed somehow to low performance in Mathematics as one teacher noted:

> *Learning is achieved fast when a learner is able to hear. Inability to hear slows the pace of learning among learners with hearing impairment therefore making it difficult for them to excel.*

Another factor was that Mathematics was taught in English, an area in which the hearing impaired had a challenge as they could not read and understand the questions. One teacher mentioned that;

> *Those who are able to read at least do better than those who cannot. Sign language is characterized with shortcuts and this seems to have a negative effect on their reading and understanding.*

Teachers further observed that it was generally demanding to teach a child with hearing problems to understand some formulas.

4.3.5 Classroom Observations

This activity was important and was undertaken to enable the researcher to observe how mathematics lessons were conducted, mode of communication used and the materials used during lesson delivery. All the 10 teachers were observed more than once by the researcher during lessons. The researcher sat in and took notes, taking note of the proceedings. The researchers briefed the concerned teachers about the activity and this in turn made those being

observed to be confident. The administrators for the two schools also ensured all teachers involved in the study took the activity seriously to be able to benefit from it.

In three of the sessions, lesson preparation was not done despite having made an appointment to observe the lesson, while in two others, lesson objectives were not clearly stated because they were incomplete. In one of the sessions, pupil participation was very good and it was in this session where lesson objectives were clearly stated. In one session, it was average despite the class being small. In four of these sessions, lessons were pupil centered but question and answer mode of teaching was mainly used, in one it was a lecture method. The other notable challenge was the struggle to communicate due to poor sign language skills displayed by some teachers. In one session learners were unable to read and understand the questions written on the board and therefore had the class activity wrongly done.

Teaching aids were not available in five of the sessions. Only one teacher taught with the support of a teaching aid to explain the subtraction of integers, in another session, the teacher had to improvise stones as counters to explain the concept of addition. In two sessions the teacher used pictures from a pupils' book. In the absence of learning aids, teachers heavily depended on explanations to facilitate learning. In two sessions the strategies seemed to help learners learn, and in one, this seemed to work somehow, but in six others it did not work. And only in one session did pupils do a group activity, and only one pupil did the exercise well. The rest needed help from the teacher.

4.4.0 Measures that can improve the performance of learners with HI in Mathematics

4.4.1 Feedback from learners

Positive attitude towards mathematics

This study was aimed at finding reasons for poor performance in mathematics among the HI pupils. So it was important that they had a say on how best they thought they could be supported

in order for their performance to improve for the better. One of the suggestions was to, have a positive attitude towards learning mathematics. One grade 6 pupil mentioned that

> *We need to work extra hard to learn all the subjects because all of them are important.*

Work in groups

Pupils reported that they use team work by studying in groups or having group discussions so that they help each other in areas where they have challenges. 10 participants were of the view that it could be helpful if they sought the assistance of teachers and fellow pupils whenever they encountered difficulties in learning aspects of the subject. One pupil said that:

> *I copy from my friends and ask even other teachers to explain where I don't understand.*

Coping notes from the board

Pupils said they copy notes and examples from the board when the teacher is teaching. They later use these notes and examples given by their teacher to study and practice solving mathematics problems during their individual study time.

Revision of school work

Revision of school work using past examination papers and books, striving to work harder and group work, were also cited as useful methods of coping with challenges faced while learning Mathematics.

Seek remedial work from teachers

Fourteen (14) suggested that teachers needed to be supportive to pupils struggling in Mathematics. The respondents said that teachers needed to provide them extra work in the form of remedial and home work. Learners further explained that they needed guidance in solving some mathematical problems by slowly showing them how to go about it and explaining what was required to answer a particular question. Teachers also needed to simplify difficult questions and repeating difficult topics with examples.

Memorizing formulas.

Pupils also reported that they memorize formulas to be able to calculate or solve mathematical problems. One pupil said

I keep a lot of formulas in my head which I use to calculate.

Availability of trained teachers and relevant materials

Other highlighted areas were the need for teachers who were competent with sign language. There was also a felt need for more trained teachers who would be able to handle more difficult topics, use of assorted teaching materials, and create more time to teach so as to help them understand topics which seem to be impossible to other teachers.

One pupil put it this way:

I need a teacher who knows sign language and should know every math formula.

Another one said:

Through use of many materials. Give us more trained teachers.

It was suggested that teachers should have a passion for the deaf and understand the culture of the hearing impaired and keep encouraging pupils lagging behind to develop more interest in the subject. One learner had this to say;

We need teachers who understand us to help us prosper. Mathematics is very important in order for one to prosper

Consistency in learning mathematics

There were also those who felt that the subject needed to be taught everyday unlike the current situation where learning is inconsistent due to teachers' absenteeism.

Revise mathematics curriculum for the deaf

There were some who felt that the Mathematics syllabus was overloaded and suggested that a number of topics be reduced.

One grade 12 pupil said:

> *There are too many things to learn, that is why we forget some of them. Remove some of them.*

4.4.2 Feedback from teachers

Provision of teaching and learning aids

Because of the lack of teaching aids, teachers reported that they made teaching and learning aids using resources that were available in the school. One teacher said;

> *We use initiative; sometimes we draw diagrams to help us explain certain topics.*

Teachers were of the view that the ministry needed to provide adequate teaching and learning materials for learners with HI. 4 teachers observed that the performance for HI learners could improve if appropriate materials were provided.

One teacher said:

> *Teaching the HI can only be effective if the ministry provided the necessary teaching aids.*

Teach at a pupils pace

Some teachers suggested that one way of overcoming some of the difficulties was to teach at a slower pace and sometimes repeat the same lesson twice or three times. The teachers said that when one appeared to be fast when teaching, HI learners found it difficult to grasp concepts and they complained when such a teacher rushed through the work.

Modification of pupils' work

Teachers reported that they made modification to topics in the syllabus to suit the needs of their learners. One grade 6 teacher felt that modification is important if HI learners were going to learn mathematics.

Sharing ideas on how to teach difficult topics

Teachers revealed that one way of improving their teaching of mathematics to the HI was by sharing ideas during Continuous Professional Development (CPD) meetings on how best to handle learners with HI. One teacher reported that;

> *We hold CPD meetings where we share ideas on how best to teach certain topics perceived to be difficult.*

Enhancing monitoring of teachers by Standards officers

Another suggestion was that monitoring in schools must be strengthened in order to improve the quality of education especially for CSEN. It was reported that teachers were not monitored regularly by Education Standards Officers. The response was from 4 out of the 10 teachers. One of the teachers had this to say;

> *Standards officers should improve on monitoring in schools. There were instances of some teachers having a casual approach to work. Some teachers have even stopped preparing lessons and make little effort to improvise even simple teaching aids. So monitoring will encourage teachers to work extra hard, thus improve performance levels among the HI.*

Improving sign language skills

The need for improving sign language skills for special education teachers offering lessons for the deaf was emphasized. Some teachers suggested that preparation programs should start preparing all pre-service special teachers to possess basic qualities of master teachers, who

could also handle mathematics lessons. The teachers noted that well trained instructors in sign language communicated well because they tended to demonstrate strong communication skill, employed cognitive strategies, were usually up-to-date, had a passion for teaching, worked collaboratively and created independent learners.

One teacher suggested that teachers should improve on their sign language skills during training so that there is effective communication between them and learners when they are finally deployed in schools to handles classes of HI pupils.

They also said;

> *More teachers should be encouraged to polish up their sign language skills when teaching mathematics to deaf learners. It is just fair that sign language is effectively used to the deaf because that is their mode of communication.*

Another suggestion was that sign language should be revised to include more mathematics words. One teacher indicated that;

> *There is need to revise sign language to include more mathematical (terms) signs. This can help teachers improve teachers' efficiency when teaching mathematics.*

Teacher deployment should be appropriate

One teacher noted that well qualified teachers performed well. She said;

> *Qualified teachers usually focus on teaching, planning, attitude, and assessment. Their methods of teaching include using content knowledge and deep representations, making use of problem solving skills, and using improvisations. In their planning, the set up optimal classroom environments, provide high expectations for students, and impart sensitivity to context.*

The teacher further said that qualified teachers also promoted inquiry and problem solving skills, have a passion for teaching, and show respect for pupils. Lastly, the respondent noted that qualified teachers employed multidimensional perception, monitoring progress and supplying feedback, and testing hypotheses.

These were 2 teachers not competent with sign language and 1 without an idea about sign language suggested that;

> *School administrators should consider teachers' competences in sign language before they are placed in HI classes.*

Improving of literacy skills

One teacher suggested that;

> *To improve performance in mathematics, there is also need to first work on their literacy skills as reading is a pre requisite for learning all subjects.*

Working with parents

Teachers also felt that there was need to enhance collaboration between home and school by ensuring that teachers work closely with parents. One teacher said

> *There is need for parents to get involved in the education of their children. Sometimes it is so frustrating to see a child come back to school with their homework unattended to.*

Providing a different curriculum for deaf learners

Another teacher felt that:

> *The government should consider providing a different mathematics curriculum for CSEN that would exclude certain topics that seem irrelevant to the HI as well as provide a separate national examination for pupils with hearing impairments.*

The purpose of having a specific core curriculum for pupils who are deaf or hard of hhearing is to be a resource for the Ministry of Education when developing educational plans for such pupils. This curriculum will be learner-friendly and address those identified areas that are either not taught or require specific and direct teaching, including in Mathematics. HI pupils have the same curriculum as pupils without this disability, and like others, pupils with disabilities have

specialized needs not covered in the general education curriculum. Hearing loss adds a dimension to learning that often requires explicit teaching, such as information gained through incidental learning.

4.4.3 Summary

This chapter has presented the findings in line with research questions which were presented as follows: what methods are used to teach mathematics to learners with hearing impairments, establish teachers' what qualification do teachers have to teach mathematics to HI pupils, what are the factors that contribute to poor performance in mathematics among learners with hearing impairments; and are there measures that can improve performance of learners with hearing impairments in mathematics.

CHAPTER FIVE

DISCUSSION OF RESEARCH FINDINGS

5.0 Overview

This chapter discusses the findings of the study on low levels of achievement among hearing impaired pupils in Mathematics in selected schools in Lusaka. The discussions of findings are presented according to the objectives of the study which were;

1. To determine methods used in teaching pupils with hearing impairment.

2. To establish teachers' qualifications to teach mathematics to learners with hearing impairments.

3. To determine factors that contribute to poor performance in mathematics among learners with hearing impairments.

4. To explore measures that can improve performance of learners with hearing impairments in mathematics.

The findings are presented in the same sequence they have been presented in the preceding chapters.

5.1.0 Methods used to teach mathematics to learners with hearing impairments

The study revealed that teachers mainly used question and answer, expository, demonstration and observation methods. Others tried to incorporate cooperative learning by introducing group activities during lessons but complained that the method was ineffective as HI learners faced difficulties to engage in group discussions as well as to give feedback to the rest of the class on findings from their group work. This was attributed to the limitations they experienced in mathematical language. Teaching methods used were limited, some teachers reported that they

had limitations in their teaching methods because they lacked resources and teaching methodology to handle the deaf. One teacher said;

> *Am not a trained teacher, am just helping out because of the knowledge I have in sign language.*

These findings are consistent with Chikopela (2013) who reported that the ministry lacked qualified teachers to handle learners with SEN. According to Chikopela (2013), some educators involved in teaching HI learners have received no formal training in SL linguistics, literature or teaching methodology. This has resulted in learners receiving restricted instruction, implying that they have little access to the regular curriculum. Many learners therefore end up performing poorly in national assessments.

Conversely, a study done by McIntosh, Sulzen, Reeder & (1994) in South Africa also revealed that some teachers may be dedicated and enthusiastic about teaching deaf students, but lack effective guidance, training and resources based on educational research. In their study on deaf learners in science, they reported that, Mathematics is a science and science teaching is mainly dependant on observation and experimentation. They noted that, although observation and experimentation are conducted when teaching science, a basic theory of instruction has not been defined.

Knoors & Marschark (2014) revealed that learning styles of deaf adolescents are limited. They indicated that they rely on organizations and structure in the instructional environment and may be classified as "dependant learners." Dependant learners are those that look to authority figures for guidelines on what to do. They find it difficult to develop skills for autonomy and self direction. Similarly, all learners in this study admitted that they liked mathematics but depended on their teacher to learn the subject.

McInerney, (2001) notes that the pupils' liking for mathematics stems from the way a teacher handles the subject. It says that good teachers love the subject they are teaching. On the other hand, if a teacher feels negative towards mathematics, it may show up when one is teaching the children and can affect them. Similarly, little children usually like numbers and mathematics, yet

many pupils in public school develop a phobia towards it and may end up disliking the subject, (McInerney, Etten (2001: 33).

A pupil might get more motivated if she/he knows where mathematics is needed. In this study, some students talked about possible occupations they intend to join where the subject is a prerequisite. So many times pupils question the needfulness of things they study. It is therefore important for a teacher to emphasize and point out how the everyday applications of mathematics may help them.

The basic mathematics of the lower grades is obviously much needed in everyday life, such as measuring, estimating the bill when grocery shopping, cooking, sewing and woodwork. Understanding percent, large numbers, and basic statistics are essential in order to understand information in newspapers and schoolbooks. As adults, people need to calculate taxes, compare payment methods, and figure out loans and home budgets, and the like (Home School Math.Com, 2014).Pupils need to be given this basic information from early stages to motivate them and some of those who said they like the subject in this study were likely to know some of these other benefits.

According to Anghileri (2007) learning and teaching mathematics involves helping children coordinate their understanding of the logic of quantities with the representation of quantities. Mathematics teaching in English primary schools currently gives more attention to representational systems and how to use these systems. It is necessary to pay more attention to the development of children's understanding of the logic quantities and its coordination with the systems of representation. Anghileri (2007) establishes the connection between logic and learning mathematics when it says that logical understanding at the start of school is a good indicator of how well they will learn the subject. Logical-mathematical thinking develops from children's reasoning in many situations in everyday life, therefore, stimulation is crucial. Children who do not do well in logical-mathematical reasoning are at risk for difficulties in learning mathematics. Interventions that help them develop this logical understanding result in better mathematics learning (Anghileri, 2007: 71).

The Scottish Sensory Centre (2008) worked well for deaf children who usually lagged behind their hearing peers when they started school. In a project to boost skills of deaf children, the Centre adopted the methods used with hearing children to improve understanding of logic. The study involving 57 pupils from 12 schools was aimed at improving deaf children's understanding of each of the three logical aspects of reasoning, namely, inverse relation between addition and subtraction, additive composition and one-to-many correspondences. Some children showed poor performance on tasks, but their understanding of logical principles improved through instruction, indicating that instruction had a positive impact on the pupil's learning of mathematics. Thus, researchers concluded that it was possible to promote understanding of these principles through instruction. The children appeared to profit more from the mathematics teaching when they received instruction, meaning that logical reasoning about mathematical principles had a positive impact on deaf children's mathematics learning.

Bishop (1988) states that teaching pupils' topics such as algebra and trigonometry will enable them study science, electronics, commerce, physics, mathematics, medicine or various other fields further in the college or university. Algebra also develops thinking skills. The idea here is that many of these youngsters know what they want to do after school.

Some students are likely to be more motivated because they asked open questions, are involved in the development of concepts, and given very open-ended exercises. Some pupils in this inquiry liked simplified topics. Granted, this kind of teaching style may require a lot of planning from the teacher, probably a good understanding in mathematics, and good materials.

Tests are a part of school but they do not need to be the ultimate goal. The goal is to learn mathematics so that the child can use it in life, (Herman, Drayfus & Golan, 1990). Tests, especially timed tests, and the way they are valued so high are one main reason for mathematics anxiety in school pupils. There is also an exact right and wrong. Many people like knowing that something is perfect other than partially right (Herman, 1990).

Pupils who are good at Mathematics tend to enjoy the subject, and this is natural. Then there are pupils who like challenges, and when they have a chance to understand something in life using a mathematical model, they do everything better in this case. In other words, there is a certain

satisfaction when one comes across a difficult problem and is able to conquer it. Like mountain climbing, it is really nice to see how nature works, especially when you start to find certain ratios and relationships popping up in all sorts of different applications, from radiation heat exchange, to compound interest, to the pine cones in the woods (Aashalata & Paul, 2005). It gives one a sense that there is an order to the universe, and shows that things really have an underlying structure to them. And because mathematics is challenging, it requires a lot of thinking. Most important of all, mathematics is fun. It makes one feel a great sense of an achievement when the person can solve a hard problem or at least problems that one have had trouble with (Bishop, 1988).

The subject as a discipline is absolute and discrete, in that in a mathematical problem, there is only one correct answer. Aspects of mathematics are found in many other subjects. Mathematics teaches one to think objectively and logically. Math teaches one to work with problems that are totally outside ones normal daily activities and experiences. No other discipline does this (Annenberg Foundation 2014).

Posamentir (2013) suggests that motivating students to be receptive is one of the most important aspects of mathematics instruction. He says that effective teachers should focus attention on the less interested students as well as the motivated ones. One way is use of extrinsic motivation which involves rewards that occur outside the learner's control. These may include token economic rewards for good performance, peer acceptance of good performance, avoidance of punishment by performing well, praise for good work and so on. However, many students demonstrate intrinsic goals in their desire to understand a topic or concept to outperform others, or to impress others. The last goal straddles the fence between intrinsic and extrinsic.

A teacher may present a few simple exercises involving familiar situations, followed by exercises involving unfamiliar situations on the same topic. The more dramatically a teacher does this, the more effective the motivation. Closely related to the above technique is that of having students appreciate a logical sequence of concepts. This differs from the previous method in that it depends on students' desire to increase, but not complete, their knowledge. One example of a sequential process is how special quadrilaterals lead from one to another, from the point of view of their properties, (Posamentier, 2013).

Discovering a Pattern is another method. Setting up a contrived situation that leads pupils to discovering a pattern can often be quite motivating, as they take pleasure in finding and then owning an idea. The exercise gives students an enlightening experience. And when students are challenged intellectually, they react with enthusiasm. However, great care must be taken in selecting the challenge. The problem must definitely lead into the lesson and be within reach of the students' abilities (Spencer, 2015).

Verma (2005) notes that pupils feel good when the usefulness of a topic is made clear. Introducing a practical application can be of genuine interest to the class at the beginning of a lesson. Some enjoy mathematics because of recreational methods involved. Recreational motivation may consist of puzzles, games, paradoxes or facilities. In addition to being selected for their specific motivational gain, these devices must be brief and simple. An effective execution of this technique will allow students to complete the recreation without much effort. Unfortunately this study discovered that teachers seemed irresponsive to this aspect as they utilised very limited teaching methods; mainly question and answer.

Teachers of mathematics must also understand the basic motives already present in their learners. The teacher can then play on these motivations to maximize engagement and enhance the effectiveness of the teaching process. Exploiting student motivations and affinities can lead to the development of artificial mathematical problems and situations. But if such methods generate genuine interest in a topic, the techniques are eminently fair and desirable (Ngoepe, 2014).

Lang (2006), states that teachers of mathematics must also consider reading comprehension in all aspects of instruction, especially the use of textbooks and multimedia. He noted that being slow to read among some deaf students compared to their hearing peers, tend to increase throughout their school years and this influences deaf learners' access to mathematics learning opportunities. Innovative teaching strategies that have become popular in mathematics are using children's literature and the use of journals to encourage reflective thinking. Other strategies include providing children with opportunities to use and appreciate technology. Majority of HI mathematics students appear to be additionally handicapped by a restrictive learning environment. Although mathematics can be taught effectively in the kitchen of any home, one

may hypothesize that there is a relationship between the quality of facilities, the quality of instruction and achievement levels (Lang & Propp, 1982).

5. 2.0 Teacher's qualifications to teach mathematics to learners with HI

The study showed that teachers had various qualifications while others had not been trained in sign language and teaching methodology. The results revealed that there was a shortage of qualified teachers to teach mathematics to pupils with hearing impairments, with 6 out of the 10 teachers being qualified to teach it. Education systems are complex and are influenced by numerous actors but no education system is better than its teachers. The shortage of teachers, combined with absenteeism and the lack of qualifications, is a major barrier to learning. This study revealed that some teachers were not proficient in sign language while the learners relied on it to understand the subject better. Some of these teachers were not trained to teach. Thus, these teachers had little or no knowledge of handling such children. One teacher said;

> *I do not know sign language, so am totally misplaced here.*

Another one indicated that;

> *Am not a qualified teacher, am just helping out because of the knowledge I have in sign language*.

These findings are similar to a research conducted by Simalalo (2006) in Zambia which revealed that some teachers working with CSEN learners had inadequate training to handle such learners. The teachers commented that they felt incompetent to handle learners with SEN and would like in-service training or workshops to improve their teaching skills. More recent studies such as a study done by Chikopela (2013) still indicate that teachers teaching the deaf were incompetent to teach the deaf as they had inadequate qualifications. An explanation to this could be that teachers proficient in sign language and qualified to teach learners with HI could be there but decided to teach hearing pupils in the mainstream because of the negative attitudes they have towards learners with HI. A study conducted by Mandyata (2001) on teachers' perception towards CSEN revealed that some teachers had negative attitudes towards such learners. This situation therefore calls for government to improve the working conditions for teachers handling CSEN in

order to motivate more qualified teachers to come on board and teach mathematics to the HI and probably improve the achievement levels.

5.3.0 Factors that contribute to poor achievement levels in mathematics among learners with hearing impairments

Teachers and learners did point out the factors that contribute to poor achievement levels in mathematics. The factors within the two groups were not similar and this is because each group has a peculiar role they perform in the school environment. Table 7 below shows the differences in the perceptions of factors.

Table 7 Perceived factors that contribute to poor achievement levels in mathematics among learners with hearing impairments

Learners' Observations	Teachers' observations
Teacher absenteeism	Language and mathematical language acquisition
Teacher's lack of competence in sign language	Cognitive development and the influences on mathematical development
Nature of mathematics	Engagement in mathematical processes
Inadequate Learning resources	Mathematical teaching and learning resources
Negative self rating in terms of performance in Mathematics	
Deafness and its implication on learning Mathematics	

The discussion of these details are contextualized as follows

Teacher absenteeism

Teacher absenteeism is not a new phenomenon in such studies. Robert, Kulik & Kulik (2013) state that learning and testing advocates have suggested that more frequent classroom learning and testing stimulates practice and review, gives students more opportunities for feedback on their work, and has a positive influence on students' study time. Reviewers of relevant research and evaluation literature, however, have expressed uncertainty about whether such benefits are

actually realized in classrooms since teachers are frequently absent. But studies continue to show that students who take at least one test during a 15-week term score about one half of a standard deviation higher on criterion examinations than did students who took no tests. Better criterion performance is associated with more frequent practice and testing (Robert, Kulik & Kulik, 2013).

Ellis (2002) says language processing is intimately tuned to input frequency. Examples are given of how frequency effects in the processing of phonology, phonetics, reading, spelling, lexis, formulaic language, language comprehension, grammaticality, sentence production, and syntax. Determinants of pattern productivity include the power of practice, cue competition and constraint satisfaction, connectionist learning, and effects of type and token frequency. In line with numeracy, frequency plays a large part in explaining variations and change. Learners' sensitivity to frequency in all these domains has implications for theories of implicit and explicit learning and their interactions. Frequency underpins regularity effects in the acquisition of basic aspects of mathematics.

Our respective languages build on personal experiences and our embodiment that represents the world in a very particular way. The different degrees of salience or prominence of elements involved in situations that we wish to describe affect the selection of subject, object, adverbials, and other clause arrangement (Lowry, 2015). With Zambia participating in a globalized economy, there is great need for all citizens to be consistently and adequately trained in mathematics. Educators therefore should try to ensure that learners have adequate numeric experiences so that they emerge competent in the subject and excel in life. HI learners need to be guided consistently to see links between mathematics taught in class and their daily lives. There is ample justification for recognizing low frequency as a pervasive causal factor for low achievement.

Joe (2010) also explains that although explicit, elaborative learning at the semantic level is crucial maintenance of numeric knowledge; implicit knowledge and explicit attention to number form also contribute to long-term retention, just as is the case in language. The rote rehearsal alone is not as effective as deeper elaborate rehearsal for storing and processing knowledge, but

substantial quantities of rote rehearsal may activate lexical items, thereby facilitating subsequent numerical recognition.

Many studies suggest that repeated exposure to the regularities of numbers and features in written input helps learners to recognize and produce those forms subsequently. Subsequent exposures to these familiar numbers and numeric sequences serve to consolidate their long-term representation both receptively and productively. Conversely, the greater the exposure to numbers, the increased long-term storage of these concepts. Meadow-Orlans, Spencer & Koester (2015) support this idea by indicating that, with all children, the understanding of mathematical concepts involves considerable experience, with particular problems being presented in familiar and different ways Taking quality of input or output and frequency together, these studies indicate that all three aspects contribute to long term numeric acquisition. However, the role of frequency appears to be most important. Receptive and productive knowledge of numbers involve attention to their forms, meanings, and uses in a range of contexts. Without exposure, it would not be possible to develop these different dimensions of numeric knowledge, (Joe, 2010).

Teacher's lack of competence in sign language

A good number of pupils with hearing problems confirmed their preference to use sign language as medium of communication and language of instruction yet teachers seemed ill prepared to communicate effectively with them. Although some students indicated being taught correctly using sign language, challenges with communication were there as they reported helping teachers learn aspects of sign language. The language of instruction strongly influenced the ability of children to comprehend and learn. This has been established in previous research. Zaitseva, Pursglove & Gregory (1999) discuss Vygotsky's attitude towards sign language. As far back as the 1930's Vygotsky noted the importance of sign language to HI learners. He asserted that sign language was a complex language with its own syntax, a very richly developed language fully capable of expressing different abstract concepts, including ideas thoughts and facts of socio political nature. According to Vygotsky, sign language is not only a means of interpersonal communication but also a means of inner thought in the child himself/herself. In support of this Molander, Pedersen & Norell (2001) in their discussion of sign language in

Sweden, state that, thelanguage plays a major role in special schools. It enhances pupils' thinking and creativity. Teachers therefore need to acquaint themselves in the language so as to facilitate effective learning.

Nature of mathematics

Learning mathematics due to its abstract nature is one factor which has been established in previous research. This is compounded with the language demands of mathematics instruction. Moores (2000) stated that this challenge is obvious because much of the expositions in mathematics techniques rely on the use of verbs, adverbs; an area where the HI have a challenge. Some topics were said to be complicated, with long formulas. Some words were difficult to comprehend. The findings in this study are consistent with Barton (1995), who says several distinct features of mathematical language make it complex and foreign for many learners, including having familiar words with precise meanings that differ from their normal meanings. This would suggest that the interpretation of the language of mathematics with its ambiguous vocabulary is particularly challenging for deaf/hearing-impaired children.

Hearing-impaired children find it difficult to understand verbal and written mathematical problems. Pau (1995) states that in order to solve written problems correctly hearing children need to correctly interpret every one of the words contained in the problem's text. In terms of verbal problems hearing-impaired children attempt to simplify the problems by converting them into understandable linguistic forms. Pau (1995: 290) suggests that "It is therefore vital that any teaching programme designed to improve the child's problem-solving level should include general text-comprehension and, in particular, mathematics text-comprehension activities".

Inadequate Learning resources and frequency of use

There was a complaint related to inadequate learning resources and frequency of use. Similarly, The United States Department of Education (2007) cites lack of adequate learning materials as being among barriers to quality learning. The departments pointed out that outdated and worn-out textbook are often shared by six or more students in many parts of the developing world.

Workbooks, exercise sheets, readers and other core materials to help students learn their lessons are in short supply. Teachers also need materials to help prepare their lessons, share with their students, and guide their lessons. The persistent digital divide and uneven access to information and communication technologies (ICTs) have severe implications for education. ICTs can transform not only instruction but also the learning process. They empower both teachers and learners.

Johnson (2012) says that when materials are lacking, pupils have to share everything. It takes longer for a teacher to teach a 30 minute lesson because one has to pass around the books and other resources as the lesson progresses. Sometimes the teacher has to break up pupils into small groups and teach the same lesson a few different times. Small groups are great for children to learn, but they also need to be taught in a whole group. The students need to learn how to act, react, and participate in whole group discussion. This problem takes more learning time away from the class as a whole and results in not getting through all of the material.

When the teacher does not have the resources to be able to teach every aspect that needs to be taught, the pupils miss gaps on their education and the opportunities for hands-on learning experiences. Some pupils are kinesthetic learners. If the school lacks the supplies to provide these opportunities, then they miss out on a learning opportunity. These missed opportunities result in lack of knowledge and material and subsequent poor performance in national assessments.

The development of each pupil into an individual is also affected. This is because the lack of materials means that they are not getting the experience in knowing how to act in a correct classroom setting. They get bored to get down to the depths of it (Joe 2010). The pupils need school supplies in order to enrich their learning experience, and also in order to make sure they are getting the right learning experience. It would be good to have pupils who can do their multiplication, division, addition, and subtract, and also know how to use a calculator to find a logarithm. This means that teachers will be preparing pupils to be able to function in a modern world. So there is need to give teachers the equipment and supplies for them to do their best in educating pupils and their teaching effectiveness will definitely rise.

Self-Rating in terms of performance in Mathematics

The fact that learners self-rated themselves rather poor achievers confirms the difficulty there is to
understand instructions as well as make computations. This finding has been established in previous research (Foistack, 2007; Pagliaro and Kritzer, Barbosa, 2014).

*Deafn*ess *and its implication on learning Mathematics*

Learners said deafness was an obstacle because they had problems understanding instructions from the teacher, there were teachers who did not know sign language, teaching and communication was sometimes not effective, some topics were difficult to understand in sign language and that certain mathematical words are not there in sign language so, teachers just finger spelled such words without providing meaning or ignored them, The hearing impaired are sometimes slow to understand concepts. Similarly, there are some studies that have shown that deaf children's reading develops at a slower rate and that they make approximately a third of the reading progress each school year when compared with their hearing peers. As a result, this causes Mathew effects because the severity of their reading delay increases as they progress through schooling, culminating in the average deaf school leaver having a reading age equivalent to that of a 9-year-old hearing child. This idea is also shared by Stein (2013), who argues that having a hearing impairment or being deaf can adversely affect a student's ability to learn. Not only is it difficult to communicate, but since most teaching is done through speaking, the barrier for hearing impaired students can seem insurmountable. Hodson (1993: 690) states that:

> *"Language is a cultural artifact. The way, in which we use it for remembering, reasoning, evaluating communicating, and so on are socio culturally determined and have to be learned. In the context of multicultural mathematics education, there are several aspects to the "language problem"; diversity of mother tongue, the language of mathematics (specialized terminologies, use of everyday words in specific restricted contexts, and style of written communication), the stylized language of the classroom interaction in general and the use of language based activities to bring about learning."*

Most hearing parents find it difficult to communicate with their HI children and this means that children are getting no form of language input until they start school. By this stage, it is often too late for the HI to acquire the natural language foundation (Zambian Sign Language) needed for other languages such as English (South African Deaf Association 2006: 14). In Zambia, another significant issue facing the deaf is the use of NBTL programme to learners in the grade one. The implication of this to mathematics education is that these HI learners may be learning mathematics in their second or third grade.

Lee (1997: 22) also points out that; "the norm of mathematics instructional practices have significant implication for students from diverse culture and languages. These students bring with them their own way of looking at the world that are a representative of their own culture and language environments." Learners' way of knowing and thinking may be incompatible with the norms associated with mathematics. When the students' language is in conflict with the subject, they may avoid learning the subject. In agreement with this, Hodson (1993) adds that, learners with limited linguistic skills can become frustrated when faced with an early insistence of precise terminology (vocabulary) and formal writing style. This can lead to withdrawal or even alienation from mathematics.

In particular, mathematics is a subject with abstract ideas that cannot always be communicated with signs. However, accommodations that address both the environment and the teaching/learning styles can bridge the gap and enable the hearing impaired student to be successful.

However, recent studies show that higher levels of reading achievement have been reported in some studies of deaf children with cochlear implants and also in studies with selective populations of orally educated deaf children. One of the investigations was conducted at the Western Pennsylvania School for the Deaf (WPSD) in the United States. Like other schools for the deaf, WPSD has seen its enrollment of children with implants increase steadily. For instance, in 2006 children with implants accounted for approximately 20% of its total enrollment. Each student with an implant had been matched with a student without an implant on the basis of birth

date, gender; and enrollment in academic, transition, or applied studies programs. Pupils were compared on the basis of their scores on the Stanford Achievement Test, 9th Edition, and the Pennsylvania System of School Assessment. In none of the 4 years evaluated was there any significant difference between the implant group and the matched comparison group on any of the seven subtests (Rhoten, Marschark & Fabish, 2007).

The second investigation was an examination of deaf college students' learning and academic achievement as it related to a variety of demographic and communication variables. Fabich (2005) analysed data on 509 deaf students (with hearing comparison groups) enrolled at Rochester Institute of Technology (RIT) in the New York metropolitan area, either in the National Technical Institute for the Deaf or in one of RIT's seven other colleges. Experiments involved interpreted lectures provided by RIT faculty members on science-related topics. Learning was evaluated using multiple-choice tests designed in collaboration with the instructors. In one analysis, relations of cochlear implants and learning among 35 deaf students with implants and 35 randomly selected students with hearing aids were examined. No significant difference in learning was observed. In a second analysis, nine entrances and placement test scores available for deaf students enrolled at RIT during the 2004–2005 academic years were examined. Scores were available for 83 students identified as using cochlear implants, and they were compared to 71 randomly selected peers with hearing aids. No significant differences were observed on any of the tests (Fabich, 2005).

A series of studies conducted by Geers (2004) took advantage of a summer camp designed to allow testing of large numbers of children with cochlear implants. These studies reported outcomes from 8- to 9-year-old children, all of whom had received cochlear implants by age 5 years. Data on 136 children, tested 4–6 years after cochlear implantation. Geers found that better reading scores were associated with age (9-year-olds better than 8-year-olds), age of hearing loss onset (better among children who became deaf later), and higher nonverbal intelligence. Among the implant-related characteristics, duration of SPEAK software use, number of active electrodes, and dynamic range were all associated with higher reading scores.

Findings of this sort do not allow assessment of whether it is children's post-implantation language orientations or their early language skills that are responsible for their reading success

because the children who performed better had later hearing loss onsets and hence longer, exposure to spoken language. Marschark (2007) explained that a similar caveat could be argued with regard to Geers' finding that enrollment in mainstream settings was associated with higher reading scores relative to enrollment in separate programs for deaf children, because random assignment to different school placements was not feasible for such studies (Marschark, 2007: p 52).

Although clinicians usually emphasize the importance of spoken language skills for children with cochlear implants, several studies from a research group at the University of Iowa have evaluated the reading abilities and academic achievement of children with cochlear implants who were exposed to both sign language and spoken language. Most of those children have received support from sign language interpreters throughout their school years and appear to use sign and speech in various contexts (Spencer, Tomblin & Gantz, 1997).

Thoutenhoofd (2006) studied school-aged deaf students in Scotland, and the research included evaluation of academic achievement in mathematics and writing as well as reading. He found that differences between deaf and hearing children in academic achievement were attenuated by cochlear implants, as students with profound hearing losses and implants functioned more like hearing aid users who had moderate losses in mathematics and like students with moderate to severe losses in writing as well as reading. Most deaf students with cochlear implants still performed below the national average across academic areas, however. Thoutenhoofd did not examine relations between language and achievement, but he reported that 79% of the students were exposed only to spoken English at home and 46% were exposed only to spoken English at school.

Archbold (2005) suggested that children with implants may appear to hearing teachers as having no hearing-related difficulties, and thus they also may appear not to require any support services in the classroom. However, in typical noisy educational settings with increasingly demanding curricula, the child needed sensitive support, and monitoring of the functioning of this complex technical system they wear. At secondary school level, the implanted deaf child may have excellent intelligibility of speech but lack the sophisticated language to deal with complex curricula, particularly in noise and with changing teachers (Archbold, 2005: p. 54)

A substantial number of pupils in this study shared the view that the hearing impaired had capacity to excel academically in mathematics just like hearing ones. This view was also supported by teachers, especially the experienced ones. Conversely, Nunes and Moreno (1998) also argue that hearing loss cannot be treated as a root of difficulty in mathematics but a risk factor that places children at risk for difficulties to learn mathematics. The difference between risk factor and causal factor is that it is possible to prevent a risk factor from leading to negative outcomes if necessary steps are put in place.

There is surprisingly little research that seeks to evaluate specific communication interventions with deaf people. Frodstad (2007) observed that in part, this is because of the heterogeneity that exists among deaf people, making group studies extremely challenging. Nevertheless, much can be learned from series of carefully conducted single case studies, as in many other areas of speech and language therapy.

Much of current clinical practice with deaf people draws on interventions developed with other client groups in mind. Research that seeks to evaluate specific interventions with deaf people represents a key area for future developments in this field. As for now, it will be reasonable to assume that the hearing impaired who still think the disability was a hindrance in learning mathematics shared some of the myths still working against persons with hearing problems, and is a clear case of self-discrimination! And in terms of academic performance, these students only comprised of those who performed badly and fairly (average) in the subject- and thus, the reaction was not unusual as they already had a negative attitude towards the subject. Those who were good performers and those striving to improve performance said the disability was not a hindrance.

Similarly, teachers who were not trained in using sign language, the untrained and less experienced were of the view that the disability was a hindrance to performing better in mathematics. These views have more to do with negative personal attitudes, lack of adequate information on CSEN, inadequate academic qualifications and skills.

Language and mathematical language acquisition

The main theme involved hearing-impaired children's acquisition of mathematical language and the effect that a limited language base has on hearing-impaired children's mathematical learning. The teachers believed that hearing impaired children lack the basic mathematical, or even general, vocabulary needed for them to be able to understand mathematical concepts or processes. This is in line with Pau (1995: 4) who suggested that "verbal arithmetic problems contain certain linguistic forms which are particularly difficult for deaf subjects." One teacher noted that without a basic understanding of nouns, verbs and so on, hearing-impaired children have no idea what questions are being asked of them and thus what is expected of them. Barton (1995) observed that, when learning the language of mathematics in the early days of vocabulary development, it was important that the words selected help in understanding rather than present a new item to be learnt. It was realized that if base words could be built upon to form vocabulary for more complex terms, then mathematics learning could go hand-in-hand with vocabulary learning.

In contrast to their hearing-impaired peers, hearing children are exposed to language from birth and have an understanding of everyday language. This acts as a launching pad for developing their understanding and use of mathematical language. This is in line with Flexer (1999: 14) who notes that a child with a hearing impairment need to be taught directly those skills that other children learn incidentally. The implication of this for teachers is that they need to be aware of, and focus on, those areas of learning or language skills that hearing-impaired children find particularly challenging because it is more difficult for them to incidentally acquire those skills from their environment.

One teacher in the inquiry noted that hearing-impaired children, to a certain extent, are unable to take part in group activities/discussions because they do not have the language required. Mathematical or cognitive concepts which involve specific language related to volume, shape, size, comparisons, measurement and reasoning are particularly difficult for hearing-impaired children to grasp. This relates to Barton's (1995) view that mathematics discourse has distinct features not found in normal English. For example, it is particularly dense, it is very precise, it is read in multiple directions (not just from left to right), and it contains familiar words with precise meanings which are different from their normal meanings.

The challenges that hearing-impaired children encounter with regard to mathematical language were also evident during lesson observations, when it became apparent that the children did not understand concepts such as in front of, behind, positive integers, and negative integers.

One teacher felt that with a limited language base it is difficult for hearing-impaired children to solve mathematical problems beyond a basic level. Mousley and Kelly (1998) suggest that several factors contribute to the difficulties experienced by hearing-impaired children with regard to problem-solving and general reasoning skills. These factors include difficulties in building meta-cognitive skills and the tendency of many hearing-impaired students to proceed too quickly when attempting to solve a problem rather than pausing to think it through or develop a coherent plan.

Cognitive development and the influences on mathematical development

Teachers believed that pupils with hearing impairments can achieve as much as their hearing peers in Mathematics. The biggest challenge however has been the delay in cognitive development and this tends to influences on mathematical development. These findings are in agreement with previous research. Meadow-Orlans (1980) indicates that there is evidence to suggest that deaf children learn concepts in the same sequence and in the same manner as hearing children do. However Flexer (1999) suggests that hearing impairment, whether slight or profound in nature, if unmanaged, can have a negative impact on the development of not only spoken language but also academic competencies. One teacher noted that hearing-impaired children's overall learning, including mathematical learning, is generally delayed because of a limited language base.

When mathematical concepts are taught 'visually' they are easier for hearing-impaired children to understand. Based on the classroom observation, it was discovered that the children were more likely to attempt, and in due course understand, a mathematical problem when they used hands-on, visually engaging mathematical activities and resources. In order for hearing-impaired children to develop cognitively, particularly in a mathematical sense, they needed to be introduced to a diversity of mathematical experiences along with a rich language base. Haynes

(2000: 100) comments that "as children play, and think mathematically, they are engaged in thinking across all content strands". This suggests that hearing-impaired children also, as for all children, should be presented with a wide variety of experiences in order to extend the opportunities for them to engage in mathematical thinking across the range of content strands of the mathematics curriculum (Ministry of Education, 1992). Learning experiences might include: number – for instance, using play money to represent numbers, finding halves and quarters of everyday objects such as the division of a sandwich/cake, measurement – for example, estimating and measuring using bottles/containers at the water-trough, geometry - exploring space and shape by putting items inside, on, behind, in front of other objects, algebra - exploring patterns and relationships by arranging coloured bears in a repetitive sequence, statistics - the sorting of pictures and objects like personal clothing, washing.

Measurement is one concept that children appeared to find particularly difficult to understand. From the class observation, it was revealed that when a toy truck was propelled along the floor with and without a full load, and the distance it traveled was measured, the children were unable to express either by word or gesture that they understood the concepts of length, distance, lighter, heavier or faster and slower. Mousley & Kelly (1998: 335) have said that "the internalization and application of new knowledge and skills is enhanced by repetitive practice, active participation, interactive discussion and evaluative feedback". Conversely teachers confirmed that hearing-impaired children need to receive constant repetition of mathematical concepts in order to retain them.

Engagement in mathematical processes

Engaging in mathematical processes such as problem-solving, developing logic and reasoning and communicating mathematical ideas depends upon children having good communication skills. Kaur & Dindyal (2010) supports this view when they say that it is crucial therefore that the learning environment allows for ease of communication. Problem-solving is a skill that teachers saw as problematic for hearing-impaired children in terms of their communication skills. Problem-solving requires children to use their observations to make predictions, which in turn requires a sound language base. For instance, when displaying statistical thinking, such as

sorting pictures of clothing, food and animals into categories, the children need to understand what is being asked of them. They do not need to follow the direction of the teacher's eyes in order to correctly categorize the pictures, or require a lengthy and repeated explanation from the teacher before they begin to grasp the concept.

Kaur & Dindyal (2010) suggests that learners could be encouraged to make connections of their learning with other subjects, for example, the use of Snell's Law in Physics whereby the faster path obeys the law of refraction. The modeling task requires students to go beyond finding the mathematical solution and requires students to examine the feasibility of the solution in the context of the real world. By engaging in the mathematical modellling process, students develop skills such as communication, collaborative skills, thinking skills, metacognitive skills and Information and Communication Technology skills.

The development of logic and reasoning in young children generally begins with the classification of objects, numbers and ideas within a range of meaningful contexts. Johnson (1993, cited in Davis, 1996) suggests that an individual develops logical thinking when language skills are sufficiently developed to allow that person to construct chains of casual thought. Hearing-impaired children's ability to successfully interpret mathematical information and to use words or symbols in a mathematical context would be disadvantaged by their level of development of communication skills.

Communicating mathematical ideas involves children using their own language and the language of mathematics to express mathematical ideas. As already discussed Barton (1995) believes that learning mathematics is like learning a language. For some hearing-impaired children the language of mathematics features as their third or fourth language, after Zambian Sign Language, English, and sometimes a non-English home language. This is challenged by Barton's idea that the process of using more than one language to express mathematical ideas is additive in itself. That is, given sufficient proficiency in both languages, students are liable to have better understanding because they have two modes in which to think and communicate. An appropriate physical environment is a crucial component for successful mathematical learning for all children. Haynes (1999) supports the importance of the physical environment for early childhood settings, in particular, where children learn very much through their senses and motor skills.

Mathematical teaching and learning resources

The teachers believed that it is paramount for hearing-impaired children to experience mathematics in a concrete and meaningful way in order to develop an understanding of mathematical concepts. Haynes (1999) writes that concept learning should be taught in such a way that children develop the ability to think mathematically, experiencing new learning situations which allow them to refine their existing knowledge and ideas in constructing new knowledge. Haynes (1999) emphasizes that integral role that teachers play in developing young children's mathematical learning through supporting them to make mathematical sense of their world. This highlights the need for teachers especially in primary schools to have the mathematical knowledge to capitalize on resources provided for children's play. Haynes (2000) focuses on the gains to be made in children's mathematical learning, by realising the importance of informed insight into the creation of environments which are meaningful in terms of a child's personal context. This study revealed that some teachers do not make efficient or frequent use of the mathematically-rich resources available to them in their schools One teacher at the UTH Special School noted that too often resources are ignored because of the time involved in using them, the energy needed and the fact that classes were generally too large.

Pagliaro & Roudybush (1998: 373) write that research results reveal that there is an "insufficient level of mathematics preparation among deaf education teachers". They found that few teachers of the deaf hold qualifications with a focus in a mathematics-related field and only a moderate number have sought professional development in that discipline. They believe that it is imperative that researchers should investigate mathematics instruction and learning within deaf education with more frequency and depth, so as to provide a better education to deaf and hard of hearing students.

To enhance even further the children's mathematical learning through appropriate use of resources, teachers revealed that the onus is on teachers to take every opportunity to use mathematical vocabulary alongside appropriate resources to consciously provide richer opportunities for mathematical learning.

5.4 Summary

This study has demonstrated that hearing impaired pupils experienced difficulties in learning mathematics despite the availability of literacy programs, availability of some teachers and teaching materials. However, teachers were not enough and not all of those few available were well qualified, supportive and with positive attitudes. Materials and equipment were lacking. Teaching methods were also limited.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.0 Overview

This chapter concludes the study and also makes recommendations based on the findings of the study.

6.1 Conclusion

The challenges that hearing-impaired pupils encounter when learning mathematics are many and far-reaching, and several issues have been identified in this study that prevent these children from learning mathematics effectively. Most of the pupils with hearing impairments find it challenging to develop mathematical skills because of language barrier; Problem-solving is particularly difficult for them as a sound language base is needed for putting observations into words or making predictions. Without these language skills, children with hearing impairments become isolated in the learning environment and are unable to participate fully in group activities and mathematical discussions.

Teachers were not well trained in sign language and mathematics. Learning materials and aids were also in short supply. Teachers used limited methods to teach and rarely availed learners opportunities to do practical activities owing to inadequate learning resources.

More than one mode of presentation should be used, comprising manipulative, verbal, pictorial, and symbolic modes. Pupils should be encouraged to translate between sign language, English and particularly the language of mathematics, and to make connections between all modes presented.

In order for teachers to assist hearing-impaired children to achieve positive mathematical learning outcomes they must be fully conversant with both the mathematics curriculum and the language of instruction. It should be noted that the emphasis placed on intellectual development in numeracy requires that teachers of mathematics have a firm grasp of sign language to ensure a firm positive interaction of this language and cognitive factors as pupils learn to manipulate complex concepts in increasingly sophisticated numeric forms. When this is the case, they will then have an in-depth knowledge of both children's mathematical thinking, and the requirements for creating holistic learning environments which facilitate mathematical learning. This knowledge, together with an insight into the specific learning styles and developmental needs of these special children, will reduce the challenges that these children encounter in mathematical learning.

This study also brings to fore the misconception among pupils that mathematics is a difficult subject. With this misconception, they do not attempt to understand the subject, subsequently causing them to fail. This phobia needs to be addressed by the teachers and parents.

It was further revealed that Social and emotional factors are sometimes overlooked in the academic realm, and yet they can cause as many learning problems as cognitive ones. The range of these factors is as diverse as the pupils served. Some pupils have trouble with peer or adult relationships, causing problems in cooperative learning settings or seeking assistance. Others have self-concept and self-esteem problems that lower motivation, task persistence, and effort. Impulsive pupils make careless errors and do not take the time to understand the deeper concepts and connections. Pupils with extreme anxiety, either towards mathematics or school in general, tend to avoid the source of their anxiety or perform at much lower levels than their abilities.

The present study furthermore provides some new information on HI learners' low performance with specific concept areas in mathematics. The findings here not only show areas of strength among pupils and teachers in mathematics education, but also indicate the level of their understanding in other areas and in sub-concepts within all areas. Such information can provide more specific indicators of potential breakdowns in the knowledge and use of foundational mathematics concepts and skills. Given that understanding of early mathematics concepts especially in number has been linked to later academic achievement, this information can have

significant implications for HI pupils 'academic success, perhaps providing a road map of sorts by which teachers can guide learning.

In addition, the current findings suggest that young children with hearing loss may not have the foundational skills they need to address mathematics concepts. This partly explains why many HI pupils may be behind in numeracy. This delay in language may cause interruptions in other areas in which mathematics knowledge and skill is needed as well. Therefore, there is a strong possibility that mathematics development may be hindered by the absence of appropriate early interventions and HI pupils' limited experiences and reduced ability to access incidental learning because of language barriers and the possible lack of understanding and support from teachers regarding the development of mathematics concepts, as well as a pervasive belief that mathematics is not as important as language or literacy may contribute to poor academic performance in this area.

The results present strong evidence that HI pupils face a number of difficulties in mathematics, before they enter formal schooling and during their time in school, and that these may be the root of the continued poor achievement in numeracy and problem solving experienced by these pupils. It is critical then that early intervention, responsive teacher deployment, a supportive and conducive learning environment and effective instructional methods receive the right attention and support from policy makers, school managers and teachers. When this is done, it will guarantee a robust and comprehensive foundation on which future mathematics learning for HI pupils can be built.

6.2 Recommendations

Based on the research outcomes, there are a series of recommendations and strategies that could be employed to mitigate the observed factors and enhance learner performance achievements in mathematics and the following areas are noted.

1) Although various factors barred HI learners from effectively learning mathematics, the Ministry ought to avail materials such as computers, projectors and charts that would

assist teachers present such topics in a differentiated manner. There is also absolute need for teachers to be innovative (Gallian, 2010: xi).

2) Modification of learning content is one strategy that could work (Mukinde, 2012; Hardman, Drew & Winston (2014:172) and one way is by teachers establishing a contract with the child that provides him or her with reinforcement for appropriate behavior. Such contracts may be either written or spoken. On the other hand, Teachers ought to make modifications to their teaching methods. There is need to teach mathematical concepts and techniques at a slow pace (Napier, 1974).

3) Teachers need to work closely with parents to ensure that there is continuity of learning at home. Similarly, Virginia Department of Education (2014) suggests that working with parents in supporting the learning process of these children can improve their performance.

4) There is need to train more teachers who would use proper sign language as well as understand the deaf culture. As Tang, Lam, Lee & Chan (2004) observed, natural language does not necessarily imply the use of speech. Government in turn should ensure that more trained and specialized teachers are deployed in classrooms for the HI.

*5)*The Ministry of Education should also introduce Sign language as a taught and examinable subject in schools to ensure total emersion of the Deaf in their first language which is Sign language, while learning written English at the same time as a second language.

6) ECZ officials responsible for examinations should be orientated in the special needs of deaf candidates so that they consider modifying their examinations.

7) Literacy programmes such as PRP, NBTL and SITE should be revised to ensure they have numeracy components so as to aid in the mastery of mathematics. One option is to introduce simultaneous communication which comprises the spoken and signed parts of a language.

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Appendix 1:

Interview Guide for learners with hearing impairments

Sr.NO.---------- DATE:____/____/____

SECTION A: BIO DATA

1. What grade are you? ----------

2. What is your age? ----------

3. What is your date of birth? ----------

4. Gender (a) Male (b) Female

SECTION B: HOW MATHEMATICS IS TAUGHT.

5. Do you learn mathematics? Yes [ ] No [ ]

6. If yes, what do you like about mathematics? ----------

7. If no, what don't you like about mathematics? ----------

8. Do you think mathematics is important? Yes [ ] NO [ ]

9. Explain your answer to question (8) above----------

10. How do you learn mathematics? ----------

----------11. How often do you have class activities?

Often [ ] Very often [ ] rarely [ ]

FACTORS THAT CONTRIBUTE TO LOW ACHIEVEMENT LEVELS

12. What teaching and learning materials do you use when learning mathematics?----------
---
---

13. How often do you use them? Often [ ] Very often [ ] rarely [ ]

14. How do you communicate with your teacher during mathematics lessons?

1. Sign language. 2. Lip reading. 3. Total communication. 4. Others please specify-----
---

15. How would you rate your performance in mathematics? Good [ ]
Bad [ ] Fair [ ]

16. Give reasons for your answer in the question above.----------
---17. Would you say deafness interferes with your ability to learn mathematics? Yes [ ] No [ ]

18. If yes, explain how deafness interferes with your learning?----------
---

19. What challenges do you encounter when learning mathematics? ----------
---

20. How do you overcome the challenges you encounter when learning mathematics----------
---

SECTION C: RECOMMENDATIONS FOR IMPROVEMENT OF MATHEMATICS

21. Do your teachers help you overcome the challenges you meet when learning mathematics?

Yes [ ] No [ ]

22. If yes, what support do you get from your teachers?----------
---
---

23. How best do you think you can learn mathematics? ----------
---
---

24. What do you think should be done to reduce the difficulties you face when learning mathematics? ----------
---

THANKYOU.

Appendix 2

Observation checklist for teachers

Sr.NO---------- DATE____/____/____

Bio data

1. Grade ----- 2. Gender (a) Male (b) Female

Characteristics to look for;

1. Look at the lesson plan and make observation on the following.

(a) Lesson preparation (b) Lesson objectives

(c) The method of teaching (d) Pupils' participation

2 Check for the availability of teaching aids

(a)What teaching aids is the teacher going to use?

(b)Do learners have learning aids to help them assimilate mathematical concepts?

3. In the absence of learning and teaching aids, what strategy is the teacher using to help learners grasp the concepts?

4. Is the strategy helping the learners to learn?

5. What approach has the teacher taken to teach the lesson?

6. Did the learners do any group and individual and group activity?

7. Have the objectives been attained?

Appendix 3

Group Discussion Guide for learners with hearing impairments

1. Do you learn mathematics?
2. Do you think mathematics is important?

3. How do you learn mathematics?

4. Are there any learning materials that you use when learning mathematics?

5. How often do you use these learning materials?

6. How would you rate your performance in mathematics?

7. Give reasons for answers in question 5?

8. Are there any challenges you face when learning mathematics?

9. How do you overcome these challenges?

10. How best do you think you can learn mathematics?

11. What do you think should be done to reduce the challenges you face when learning mathematics

12. Do you have anything else to say about the learning mathematics apart from what has been discussed?

Appendix 4

Questionnaire for teachers of mathematics to learners with hearing impairments

Dear respondent,

I am a post graduate student at the University of Zambia carrying out a research on low achievement levels for learners with hearing impairments. You have been selected to participate in this research. The information you will provide is purely for academic purposes and will be treated with the highest degree of confidentiality. You are therefore required to be as objective as possibly can in your responses. You need not to give the details of your identity.

Instructions

- Tick the appropriate answer and write in the space provided.
- Please try as much as possible to be specific. Your truthful and specific answers will be highly appreciated.

SECTION A: PERSONAL INFORMATION

1. What is your age range? 24 -30 years [ ] 31 -35 years [ ] 36 -40 years [ ]

   41 -45 years [ ] 46 -50 years [ ] 50 -55 years [ ]

2. What is your gender? Male [ ] Female [ ]

TEACHERS' QUALIFICATIONS

3. What is your highest level of Education? ----------

4. Are you familiar with sign language? (a)Yes ----- (b) No---- (c) a bit-----

5. Are you trained to teach mathematics to learners with HI?

   (a) Yes------ (b) No------ (c) just has a passion-------

6. How long have you been teaching mathematics to learners with HI?

(A). Less than a year. (b). 1 to 5 years (c). More than 5 years.

HOW MATHEMATICSCS IS TAUGHT TO LEARNERS WITH HI

7. How do you explain mathematical concepts to the learners using sign language?----------
---

---

8. Can learners with HI achieve as much as their hearing peers in mathematics?

(a).Yes ---- (b). No---- (c). Somehow----

9. Justify your answer in (4) above.----------

FACTORS THAT CONTRIBUTE TO LOW LEVELS OF ACHIEVEMENT

10. What challenges do learners with HI face when learning mathematics----------
---
---

11. Would you say the level of deafness contribute to low achievement levels in mathematics for learners with HI?----------
---

12.In your own view, what factors do you think contributes to low achievement levels in mathematics for learners with HI?----------
---
---

13. What is the nature of problems encountered by HI learners in learning mathematics? ----------
---
---

14. Do you have specific instructional materials for teaching mathematics to learners with hearing impairments?

(a) Yes ------- (b) No -------

15. List down the materials you use to teach mathematics.----------
---

---

16. How would you rate the availability of these materials?

(a)Very adequate (b) adequate (c) Not adequate

17. If there are no instructional and learning materials, explain how you teach mathematics to learners with hearing impairments.----------
---
---

18. What are some of the topics that you find challenging to teach?----------
---
---

19. What makes these topics you mentioned challenging?----------
---
---

20. Are there any other challenges you face when teaching mathematics to learners with hearing impairments? Yes [-----] No [-----]

MEASURES THAT CAN IMPROVE ACHIEVEMENT LEVELS AMONG LEARNERS WITH HI

21. What measures have you put in place to overcome these problems?----------
---
---

22. How best do you think mathematics should be taught to learners with hearing impairments?--
---

Thank you for your participation.