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THE USE OF ABACUSES

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Abstract

TEACHING OF MATHEMATICS TO THE VISUALLY IMPAIRED-USE OF ABACUSES

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One of the barriers to the education of learners with visual impairments (VI), appear to be the stigma attached to the presence of disabilities (Nganwa, 2017). This belief appeared to have adversely affected the curriculum of learners with VI. Some subjects such as Mathematics and Sciences were not being offered to them. This research however, was determined to reaffirm or negate such a theory. The extent to which persons with VI could be learning Mathematics was to be investigated through their teachers' capabilities. The guiding research question was: to what extent can teachers teach Mathematics to learners with VI? The study anchored so much on Howard Gardner's theory, which argued that 'some types of learning' (Kendra, 2023), appeared to be specific. That is, the traditional methods of using the chalk and blackboard could simply not work, instead, the tactile strategies needed to be exploited. The Abacus is the assistive devices highly recommended for teaching the LVI. This study was a mixed concurrent research design. It combined quasi-experiments and a survey. The sample population was 126, of which 100 was for the survey (60 teachers, 24 lecturers & 16 Ministry Officers), and 26 for the quasi-experiments (17 teachers, 3 lecturers & 6 LVI). The respondents were tested in Mathematics for elementary grades with the use of the Abacus. On average, they scored 20% and 69% at pre-test and post-test respectively, suggesting that Abacus methods could be greatly relied upon. The results suggests that it was the effective training of teachers that had been lacking, and not the VI disability in itself. The results also implied that LVI could also learn sciences, and other related subjects. The solution lied in Adapted Maths as a distinct specialised area. This shall attract more support.

Key Words: Abacus, Adapted Mathematics, barriers to education, visually impaired.

Declaration

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where stated otherwise by reference or acknowledgment, the work presented is entirely my own.

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Dedication

I dedicate my dissertation work to my family, friends and research supervisors. A special feeling of gratitude goes to my lovely wife, Ethel, whose words of encouragement always motivated me. My children: Justin, Mirriam, Likumbi and Donald were always in support, and their tenacity always tickled my ears.

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List of Abbreviations

ACBRAN	African Community Based Rehabilitation Africa Network
CCTV	Closed-circuit televisions
CDC	Curriculum Development Centre
CEC	Council for Exceptional Children
CPD	Continuing Professional Development
CSEN	Children with Special Educational Needs
CSO	Central Statistics Office
DCI	Development Cooperation Instrument
DFID	Department for International Development
DPO	Disability People's Organisation
ECZ	Examinations Council of Zambia
EU	European Union
HEA	Higher Education Authority
ICEVI	International Council for Education of People with Visual Impairment
ICT	Information and Communications Technology
LVI	Learners with VI
MHESSP	Ministry of Higher Education and Skills Sector Plan
MoCDMCH	Ministry of Community Development, Mother and Child Health
MoGE	Ministry of General Education
MoE	Ministry of Education
MoEC	Ministry of Education and Culture
OAU	Organisation of African Union

PWD	Persons with Disabilities
SADC	Southern African Development Community
SIDA	Swedish International Development Authority
SPRINT	School Programme of In-service for the Term
STEM	Science, Technology, Engineering and Mathematics
TESS	Teacher Education and Specialised Services
UN	United Nations
UNCRPD	United Nations Convention on the Rights for Persons with Disabilities
UREC	Unicaf University in Malawi Research Ethics Committee
VI	Visual Impairment/Visually Impairment
WHO	World Health Organisation
ZAMISE	Zambia Institute of Special Education
ZIEP	Zambia Inclusive Education Programme
8NDP	National Development Plan

CHAPTER 1: INTRODUCTION

This research was intended to contribute to the provision of quality education for persons with visual impairments (VI). The VI is one of the categories of people often classified as persons with disabilities. In order to carry out research on the abilities by teachers to teach Mathematics to learners with visual impairments (LVI), this research was organised around five chapters: Introduction, Literature Review, Research Methodologies, The Findings, and Interpretation of the Findings.

By LVI, the research was referring to visual disabilities in some pupils and students that could be interfering with learning in school (Nganwa, et al, 2017). All children were sent to school in order to learn. The society expects all the children, regardless of any disabilities, to succeed in their respective academic carriers. When children do not complete their school succesfully, Kelly, M. (1999) argued that the communities tend to doubt the education that was being provided. Schools were expected to be enrolling all children with differet abilities, regardless of whether they had challenges or not. Most of the learners without sight problems tended to fair quite well in school. However, those that did not have sight appeared to have been neglected. Their performance was simply far below the average (Jenkison, 1997). The education that was being offered to this category of disability seemed to have been compromised. In many countries, the school curriculum was designed for those that could see well. There appears to be less consideration of others with different learning needs. The LVI appears to be subjected to the same curriculum for the sighted, with very little adaptations to it. For such reasons, most of the LVI do not complete school successfully. This was as though they were just mere passengers who did not participate in the school's activities of their school journey. The outright consequence was the failure to complete school, and consequently being subjected to being vulnerable to many vices of life. They also become susceptible to vices such as high levels of poverty, illiteracy levels and high prevalence of diseases. Due to having various challenges, such children tended to be giving their parents and guardians a lot of stress (Nongola, 2015). When parents have a lot of stress, it may have a negative effect on their abilities to sending their children to school. It also suggests that the affected parents and guardians have to stay at home most of the time, to be like maids, in nursing their children.

Children who finish school successfully, were likely to get well-paying jobs later in life. Those that failed to do so, often failed to live independent lives. It could be argued that some of the problems people faced could be attributed to the inadequate education (Walmsley, & Hickman, 2007) they attained while they were in school. Without adequate education, nearly every sector of life can be a challenge. Most of the blind people found it hard to live independent lives. Challenges in life can come as a result of various factors. Some factors could be due to the natural calamities such as civil wars, family breakdown, droughts, poor education and many others. This research was intended to examine the education factors. Within the education sector, there were various factors that could interfere with the learning process. The factors included the appropriateness of instructural materials, the ethos in schools, attitudes of school managers, locality of the school, and so forth. This research focused on the sector of methodology or pedagogy.

Most schools tended to find it easier in teaching the VI Social Science disciplines such as Moral Education, History, English and local languages. However, they tend to have difficulties when it was in the areas of Mathematics and Sciences. A direct answer could be that most of the knowledge from social science subjects could be learnt through the sense of seeing. It was also easy to have such subjects transcribed into braille. Subjects that required teachers to write or draw on the blackboard have been proving to be difficult to teach to the VI. Instead of admitting that the teachers did not know how to teach Mathematics and Sciences to the learners, the tendency has been to shift the blame to the VI disability. Even for the social science subjects, LVI did not usually perform to the same degree as the sighted (Kelly, 1999). These were serious concerns that deserved to be investigated. The academic challenges faced by LVI were not clear considering the policies that were embraced by many countries. Many conventions and protocols under the education sector that have been asserted to by various countries appeared to be good. However, the implementation of such sound policies appears to have been the biggest challenge. For instance, the Ministry of Education (MoE) in its curriculum framework, postulated that:

> Learners with special educational needs will require an adapted curriculum and adapted technology relevant to their abilities … Learners who cannot benefit from the inclusive curriculum will have an alternative curriculum that suits their needs (CDC, 2013, p21).

From the above policy statement, it was expected that a few years thereafter, schools for LVI should have been provided with an adapted curriculum. The learners should have been passing in their school subjects with flying colours. Learners with VI should have been offered nearly the same subjects that the sighted did, as outlined in the school syllabuses. In addition to the Social Sciences, they should also have been learning the Natural Sciences disciplines. All learners needed to be enjoying their right to accessing any school subject of their choice. Apparently, this appeared to be a preserve only for the sighted. For LVI, the choice of subjects to be learning appeared to be a dream. The learners were dictated on what they should be learning. For reasons that were not clear, some felt that blindness interfered with learning (Pandey, 2018). Such fears however, appears not to have been proved. There appears to be no hope for the improvement of education for the blind learners.

However, the fact that many schools have been opening to them, suggested that there was progressive realisation for the provision of quality education to them. This could be noted from many nations that had made their education pronouncements inclusive (Nganwa, et al, 2017). They declared subjects such as Mathematics compulsory for all its younger generation attending school (CDC, 2013). Though this appeared to be the growing policy globally, the education being offered to LVI still appeared to be of less quality. Most schools appears to have challenges in teaching some subjects. In policy documents though, most of such subjects were compulsory for all learners, but practically, they were not. Some learners were being denied from learning the skills that were being offered to others. That was especially demotivating for learners who were learning side by side with the sighted from the same classes. Such schools were often referred to as inclusive schools (ICEVI, 2023). Mathematics was taught nearly every day, and it was usually given more hours (MoE, 1996) from the school curriculum. For those who did not learn the subject either had to stay idle or were made to do other things during the Mathematics periods.

Jay (2020) argued that Mathematics was considered by many educationists as a key subject in one's development. Because of its importance, all learners were expected to learn the subject from pre-grades, primary, and through to secondary school. This suggested that denying a learner the subject negatively impacted on their lives. It could also have led to stereotyping. Some could have thought that children with some disabilities should not be learning the subject. The lacking of certain subjects may also have negative impacted on how the learners progressed in their career. In many countries, there was a minimum number of subjects that a learner must pass in order to make a school certificate. Without attaining such a certificate, a learner may not qualify for further studies. The subjects learnt and passed whilst at school also seemed to determine the qualifications to certain disciplines in institutions of higher learning. To study natural science subjects, it was a requirement to pass in subjects such as Mathematics, Biology, Physics and Chemistry. The disciplines such as Economics, Agriculture, Medicine and Mining, all tended to demand competencies in Mathematics. The verification to such was done from the school certificate.

Additionally, the subjects that have been passed at school also tended to point towards the nature of jobs that could be accessed. Having competences in Mathematics appears to be opening to many opportunities in the job market. To get into well-paying jobs such as Engineering and Medicine, Mathematics had to be part of the certificate. This therefore, suggested that without learning the subject, it could be difficult to enter into any competitive jobs on the market. Most of the blind people have been limited to jobs related to cleaning the streets, being farm workers and being telephone operators.

According to the Stack Exchange (2023), there were several mathematicians who have made significant contributions to the field of Mathematics despite being blind or disabled. Some of them include Lev Pontryagin. He was a Soviet mathematician who lost his sight at 14 years due to a stove explosion. Another was Bernard Morin**,** a French mathematician, who was blind from a young age. He had a successful career in topology and was one of the first to exhibit a way to turn the sphere inside out. Oliv, and Anne (2019) also argued that students with VI without cognitive disabilities can follow through their grade level work in Mathematics.

It also became necessary to note that persons with disabilities (PWD) have families that needed to be taken care of. This implied that despite being blind, they also have the same responsibilities that everyone else has. They needed to be paying school fees of their siblings, pay for accommodation, electricity and water bills, as well as meet their transport costs. If they could not find descent jobs, life could be too hard for them.

It is in the light of these challenges that this research was undertaken. The focus was in the discipline of education. Globally, many countries appeared to have challenges with the provision of education to learners with special educational needs (Kelly, 1999). Schools in general tend to depend greatly on the use of the ‘chalk and blackboard’ as a methodology for teaching. The researcher felt that such a pedagogy may not be effective for this category of people. Other methodologies, therefore, needed to be sought. From the works by the International Council for Education of People with Visual Impairment (ICEVI), it could be noted that the Abacus was an effective tool for the teaching of Mathematics to the VI (D’Agostina, 2020). This research therefore, attempted to verify these assertions. Very little research appears to have been documented, especially in Zambia, on the effectiveness of the Abacus. To this effect, the guiding research question was: to what extent can teachers teach Mathematics to LVI?

The success of the study was thought to inevitably enhance the performance of the LVI not only in Mathematics but also in subjects whose concepts depended on it. This shall definitely make it possible for them to have access to many programmes in education, hence enabling them to widen their market scope for jobs that were competitive. The research was a mixed research concurrent design in the forms of quasi-experiments and survey. This section on ‘Introduction’ has been organised around the sub-titles: Statement of the Problem, Purpose of the Study, Research Objectives, Research Questions and Research Hypotheses, and the Nature and Significance of the Study.

Statement of the Problem

The Ministry of Education and Ministry of Higher Education and Skills Sector Plan (MHESSP) of 2017 – 2021 (MoGE, 2018) indicated that one of the barriers to education by persons with disabilities (PWD) was the presence of disabilities. This policy statement from the Republic of Zambia, suggested that they were very concerned with the welfare of PWD. The government seems to be concerned with the barriers that made it difficult for PWD to be leading descent lives. PWD were greatly affected by high poverty levels, inaccessible curriculum and infrastructure, long distances to schools, absenteeism, and examinations that were not well oriented to them, as well as stigma and discrimination in the society. These challenges appears to be persisting. It was like the Zambian government did not have answers to such concerns. This may insinuate that persons who were blind were to be living miserable lives perpetually. According to UNESCO (2019), the majority of children with disabilities do not go to school for various reasons. There appears to be a lot of education challenges that were encountered by PWD. Stigma for PWD, is a negative stereotype that appeared to be a global challenge (UNESCO, 2019). The author also argued that it was a mark of disgrace or unfair beliefs that the society may attach to them. When a person is stigmatized, the society may not support such ones. This is likely what some sections of society could have been doing to LVI. This could be likened to discrimination, which is an unfair treatment that often results from being stigmatized. Some members thought spending on such people was a waste of resources. They should just be trained to be telephone operators. The barriers and misgivings about the VI have greatly contributed to their wellbeing. Many universities and colleges of education with Special Education departments have mushroomed on the African continent, however, the training programmes being offered to trainee-teachers seemed to be inadequate. With the growing number of institutions of higher learning offering Special and Inclusive Education, it appears that the challenges to do with curriculum and pedagogy were not deliberate. There could be gaps somewhere. Research has shown that teachers simply did not know how to teach learners with disabilities (Kelly, 1999). The lack of sufficient research about pedagogical skills for teaching

Mathematics to LVI suggests that people who were blind were to forever not enjoy their right to education.

The Ministry of General Education (MoGE) often refers to education as an equaliser (MoGE, 2018). Learners that attended good schools, with well-equipped instructural materials, were supposed to be performing so well. This was also the case if they had well qualified teachers, Learners with disabilities were often taught by seemingly well qualified Special Education teachers. Education support materials also appeared to have been provided to Special Education Schools. In inclusive schools, regular classroom teachers, were often subject specialists in Mathematics. These were the ones that used to teach them Mathematics, hence it could be thought that inclusive education (IE) was effective. Additionally, the teachers and teacher-educators, appears to be well qualified. They had certificates that ranged from certificates to master's degree. In Zambia, and many other nations, these certificates were also offered to teachers of LVI. For schools to fail to produce competent learners in the areas of Mathematics, could suggest that there was a serious gap in their education delivery. This matter needed to be taken seriously not only in Mathematics, but also for the sake of saving resources from the training institutions. When learners do not perform so well in school, it could imply that resources that were being spent on their education were being wasted.

The workplaces and public transport could also have been inaccessible. There were also negative stereotypes and deep lying prejudices about their lack of abilities (Nganwa, et al, 2017). According to the United Nations (UN), some parents did not trust that their children with disabilities can succeed if taken to school. Others however, do think that inclusive education will result in poor performance, and that could affect others negatively (UN**,** 2023). The lacking of adequate information appears to be the source of misgivings that the VI could not manage this or that. That had negatively contributed to the enormous challenges the VI faced. Most of the LVI performed below average in schools. That was especially so in subjects that involved numbers. According to Mizunoya (2018), schools fail to make reasonable accommodation that can enable children with special educational needs (CSEN) and disabilities to learn. Stigma appeared to be shutting them out of the schools of their communities. The curriculum were designed for the sighted learners but were also subjected to learners who could not see. The use of sight appears to be the main pedagogy, and therefore, some subjects like Mathematics and Sciences could not be accessed by those who could not see. The Department for International Development (DFID) postulated that all children can learn (DFID, 2001), suggesting that when learners don't perform well, it should not be them to be blamed, but some gaps in the education systems.

The World Health Organisation (WHO)(2022) argues that 20% of any given population were PWD. For Zambia, which is about 19.47m, according to the Central Statistics Office (CSO) (CSO, 2022), this translates to about 2 - 4 million PWD. This is a large population that should not be allowed to be vulnerable to many vices. Fortunately, some organisations appeared to be miles ahead. The ICEVI (2023) embarked on a mission of developing assistive devices such as abacuses for supporting the teaching of Mathematics to the VI. The Abacus is a simple tool that can easily be used by the LVI for addition, subtraction, multiplication and division. Nearly every topic in Mathematics requires these basic skills. The discovery of Abacus for basic computation suggests that some of the barriers persons with VI have been facing, were not directly due to being blind (Nganwa, et al, 2017). In many cases, people did not just have sufficient information about their entitlements, ethical and economic opportunities for empowerment.

In Zambia, the Zambia Inclusive Education Programme (ZIEP) (2011-2013) implement the theory that all children can learn (DFID, 2001) by carrying out a project on inclusive education in

8 districts. The materials that were procured and developed included Perkins braillers, writing frames and embossers. There appears to have been a great impact in the sector of printing Braille Literacy books. It was thought that their education levels were going to improve so much. Unfortunately, not much seems to have been done in the area of Mathematics. It was therefore, imperative that this research is undertaken. Specific focus for this research was on the use of abacuses. There were several assistive devices that could have been used for computations. However, for this study, the Abacus was thought to be more effective, hence, it was the main tool of focus.

Purpose of the Study, Research Aims and Objectives

The purpose of this study was to investigate the ability by teachers to teach Mathematics to LVI. Many schools have been trying to teach the subject to this category of learners but with minimum achievement. Some institutions of higher learning have also been doing the same, but with very little progress (Higher Learning Institutions, 2021). The use of the 'blackboard and chalk' by teachers and lecturers seems not to have achieved much. This research unveiled the 'Abacus' as one of the effective assistive devices, and it tried to determine the extent to which the use of the tool could go. The research employed a mixed concurrent research design that employed quasi-experiments and a survey. Quasi-experiments are close to being true experiments, as they produced more authentic results (Kamal, 2015). By the nature of being an experiment, it was a quantitative research. The results of this research were mainly determined by the experimental approach. The qualitative and quantitative data that was collected through the survey, supplemented the experimental data. The teachers were to be pre-tested in Mathematics on work they were expected to be carrying out as a way of defining the situational analysis. The tasks were sampled from the primary school curriculum. The performance of the teachers at pre-test gave a status quo as to what was prevailing in the schools. The post-test results pointed towards the effectiveness or lack of it, by the use of the Abacus. Like a true experiment, quasi-experimental designs also aim at establishing a cause and effect relationship between the independent or predictor and the dependent or effector variable (Kamal, 2015). The predictor variable was the 'teachers existing knowledge' before the experiments. The dependent variable was the 'knowledge gained or lack of it' that was measured at post-test. Any significant difference between the pre- and post-test could be attributed to the Abacus methodologies. The learners, teachers and teacher-educators participated in the tests. Other than the teachers and lecturers, policy makers also participated in the survey. The researcher was the principal data collector during the experiments, hence, he was able to make well informed decisions during the observations when conducting the survey. Qualitative and quantitative data for the survey was collected through questionnaires and observation checklists.

The main research aim for this study was to determine the scope to which teachers could handle Mathematics for VI learners. As pointed out earlier, different organisations have been enrolling the VI in schools, but they were not being offered the entire curriculum. This raised many questions than answers. Why should they be enrolled in schools if they could not be taught key subjects? Did it mean that blindness interfered with the learning of Mathematics? To respond to some of these questions, the research participants were trained in the way that people who were blind could probably learn Mathematics. Hence, they were not to use pencils, pens and paper. Instead, they were to learn tactile skills on how to manipulate the Abacus. Ten basic Mathematics topics were tested on. They included problems on addition, subtraction, multiplication, division, fractions and decimal points. The main research aim was divided into four subsidiary objectives. These were:

1. To describe the challenges associated with the lacking of Mathematics by LVI.
2. To test the teachers on teaching strategies for the teaching of Mathematics to learners VI.
3. To experiment the use of abacuses to the teaching of Mathematics to LVI.
4. To compare the performance of teachers in Mathematics methodologies for LVI.

The first objective attempted to examine some of the challenges the learners were being subjected to for not learning Mathematics. The school subjects in a school curriculum tends to be complementing each other. The topic on Bearing in Mathematics for instance, has a relationship with the topic on Compass Directions from Geography. In History, there is a topic on Evolution, where there is knowledge of counting time in BC (or before Christ) and AD (after Christ). If one did not understand how to add or subtract in Mathematics, that person may also fail to apply the concepts in History. Mathematics was therefore, a key subject to the understanding of the application of various concepts. It followed therefore, that schools have no option but put emphasis in teaching the subject to the VI. The research question on challenges was explored with questions such as: please list some of the challenges persons with VI faced as a result of the lacking of Mathematics in their school curriculum.

The second objective examined the teaching strategies that could have been more effective for the handling of Mathematics for people who could not see. The purpose was to take note of any gaps in an effort to find interventions. The 2nd research objective was inquired through the survey questionnaires. It considered examining the teaching methodologies that were being used, including assistive devices, if at all, they were being used in schools, and the proficient by which the teachers were able to use them. Any strategies that were being applied were to be taken note of.

In another related question, the third research question, examined the extent to which the abacuses could be used in manipulations of numbers by blind learners. It was explored through questions such as: Assistive devices, have been known to be more effective in teaching Mathematics to the VI, what are some of these assistive devices? Do you have stocks of abacuses and other assistive devices in your institution? Does your training package for trainee-teachers include the use of abacuses? What assistive devices should be used during construction of shapes? The importance of examining such questions was to understand if teachers had sufficient knowledge in using the devices.

The fourth objective was concerned about the differences in knowledge and skills among teachers in the sector of Mathematics for the VI. This was because sometimes teachers came from different backgrounds. They could have been trained from different colleges and universities. It was therefore, possible that if some teachers were struggling to teach, others could be finding it relatively easy. This could also imply that some schools could be doing better than others. This objective was explored with the help of research analysis techniques such as the T – statistic and the ANOVA analysis. These values were computed from the means and standard deviations at pre- and post-test scores of different schools.

Nature and Significance of the Study

Nature of the Research

The nature of this research was that of a mixed research concurrent nested design. It combined both the quantitative and qualitative methods. The quantitative approach took the form of a quasi-experimental study. There was also a survey that collected data through both quantitative and qualitative designs. The survey collected data through questionnaires, with closed and open-ended questions. The quantitative study from the experiments collected data that was measured objectively through statistical (mean, standard deviation, etc.) and numerical values (discrete data, e.g. age, gender- finite). The experiments were both pre-tested and post-tested, in an effort to find out the relationship between knowledge (use of traditional methods), the independent variable and knowledge (arising from use of Abacus methods), the dependent. An experimental study aims at establishing causality (McLeod, 2023). The techniques on how to manipulate the Abacus were to act as the 'mechanism' for the proposed teaching methodology. The qualitative data from the survey was to bring out data that was descriptive in nature. This was in an effort to establish only associations between variables (McLeod, 2023). This type of data was meant to augment that which was collected through the quasi-experiments. To avoid being unethical, the human participants were not to be confined to specific rooms during the experiments. However, efforts were made such as closely monitoring the participant's behaviours during the experiments. The time for conducting the experiments was made much shorter, for about 5 days for each institution, to reduce on contact time with other factors. Some data was to be collected through Observation Protocols checklist. It was to include data of the participants' morale, willingness to adopt the use of the abacuses and management's efforts to support the programme. This data was coded on a three-interval scale: poor, good and very good. From the experimental approach, inductive reasoning was employed to confirm or negate the idea (hypothesis testing). The participants for the quasi-experiments and survey were selected through convenient and purposive sampling techniques as the population to be selected from was very limited. The results of the research were analysed through descriptive and inferential statistical methods. The descriptive methods included data that was presented in forms of pie charts and line graphs, while the inferential statistical methods involved calculations of standard deviations and hypothesis testing.

The Significance of the Study

The success of this research could be very significant for people with VI for living independent lives. Having the knowledge of manipulating numbers is very cardinal in improving the quality of daily life, particularly for people who cannot easily see. The African Community Based Rehabilitation Africa Network (ACBRAN, 2017) says that that was the wish of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD). The Ministry of General Education was also in support of offering Mathematics to the VI (MoGE, 2018). Therefore, the Ministry's dream for the provision of quality education for blind learners could be actualized through this research. The success in Mathematics could suggest that some of the persons with VI should be able to resolve most of their challenges in many aspects of their lives. It also implies that families of people with VI were to be living better lives.

According to Kelly (1999, p127), 'schools should be about student's success when they leave school for life in the society, and getting quality jobs. Jitka, & David (2016) also argued that the use of Mathematics was important for survival in nature. This research was intended to minimise the issue of always blaming the presence of disability on the inability by teachers in teaching PWD (Malungo, et al, 2018). It is argued that 'disability in itself was not an inability' (World Vision, 2020). The findings may also validate or negate Nganwa, et al's (2017) works where it was argued that some of the barriers persons with VI faced, were not directly due to being blind. Additionally, the government intervention that used to be channeled to welfare services, where it existed, could be invested into their education. This may help persons with VI manage themselves (Nganwa, et al, 2017). The inclusion of Mathematics to the curriculum for LVI, also suggested that it could enhance on their certification. This was because the number of school subjects they could be having access to, was to increase. The more the subjects one learnt, the better, as the Connection Theory ably put it: *individual neurons have very little power on their own*, however, when interconnected, could do great works (Edward, 2023).

The Ministry had a Continuing Professional Development (CPD) under the School Programme of In-service for the Term (SPRINT) framework programme (MoGE, 2018). The use of the Abacus was likely to be part of the SPRINT, hence, facilitating the Ministries' dream for offering the desired quality of education. The Ministries may have to produce or procure abacuses. It was also expected that the learners' progression rates from primary school to junior secondary, and from junior to senior secondary that was at 85% and 15% respectively, was to be greatly improved upon (MoGE, 2018). When parents discover that the quality of education for LVI has improved, they will also have confidence in the qualifications of Special Education teachers (Malungo, et al, 2018).

The methodology of using the Abacus may seem to be simple, but it was not. The success part of the study suggest that some institutions of higher learning could start appreciating the methodology, and even uphold it as a unique discipline. The introduction of Mathematics to LVI was also likely to expand their job market for people with VI. They were also to be seeking jobs that required passing in sciences and Mathematics. The positive results were to see some of the international conventions and protocols fulfilled. Some of them were the 1990 World Declaration on Education for All (UNESCO, 2014), and the Dakar Framework for Action of 2000 that demanded for the increased rights for all children (UNESCO, 2000). Others included the protocol to the African Charter on people's rights (African Union, 2020), the VISION 2030, the 8th National

Development Plan (8NDP) (Human Rights Commission, 2017), and the SADC Protocol on Education (SADC, 2015). The actualization of the results was likely to contribute to the notion of not leaving anyone behind in development (Human Rights Commission, 2017). The The world Blind Union (WBU) set its main priority for the promotion of full participation, equal opportunities, and protection of the human rights of persons who are blind or partially sighted (WBU, 2023). The WBU promotes braille literacy, lifelong learning, and independent living for blind and partially sighted persons in developing countries. Sightsavers, being one of the leading organisations in the promotion of education for persons with VI, may also support the scaling up of the successes. Several other Cooperating Partners have also been on board to support the teaching fraternity in this area of specialised discipline.

The evolution of effecting the new methodology for the VI, was likely to span more research into more effective ways of teaching Mathematics and Sciences. According to Jay (2020), success in Mathematics, opens the gate to Science. According to Mader (2017), subjects like History, Science, Mathematics and modern languages were appropriate for students with disabilities. Special education teachers are to be well-grounded enough around the adaptation of the school curriculum. The findings seems to also confirm the theory that the use of assistive devices was the way to go (Cook, 2023). Schools for the VI were to be equipped with a variety of real materials/objects as opposed to learning through abstract by the use of the 'blackboard and chalk'. This was to respond vividly to the 2nd research question, which inquired into the teaching strategies that were effective for teaching of Mathematics to LVI. Abacuses can locally be made; hence the technique was likely to be adopted for computations of figures when handling people with VI.

This study also appear to have confirmed the Gestalt theory by Fredrick Peris (Bustamante, 2023), which argued that the attributes of the *whole should not be deduced from analysis of the* *parts in isolation*. This implied that the education system should not be judging the performance of learners based on the presence of a disability. To be validated also was the theory that there were *specific types of learning* for certain disciplines (Loewenberg, et al, 2008). The knowledge of using assistive devices needed to be separated from the ordinary Mathematics curriculum so that it was recognised as a distinct learning area. The Ministries of Education were expected to have the more needed information for teaching Mathematics and sciences to LVI. The methodology shall inevitably aid Colleges of Education and Universities in developing courses for its teacher-trainees. The 3rd research question attempted to inquire into the effectiveness of using abacuses to the manipulations of numbers by LVI. By considering the significance of the study, as outlined in the previous paragraphs, this study appeared to be worth the attempt. According to Better Business Bureau (BBB) (2020), Mathematics and Sciences for teaching LVI, were being taught at Michigan State University, Georgia, and Indiana University and Akita University. The unique Adapted Mathematics knowledge were commonly known as ‘additional curriculum’ in the UK and ‘expanded core curriculum’ in the US (Willings, 2022).

According to Adelakun (2020), the Abacus cannot be used on all the topics in Mathematics curriculum. The author argued that other strategies should be used on other topics. The Nemeth Mathematical Braille, is a visual configuration technique (ICEVI, 2023). The method uses four types of codes: descriptions in English, writing number signs for figures such 1000 and 25, a script, and Mathematical operations such as = and x. Other than using the Abacus and the Nemeth Mathematical Braille, ICEVI (2023) also argued that to teach Mathematics successfully to the blind, there was need to be ‘creative’. This is in the sense that there were a lot of objects within our environments that could be used to explain certain properties, as well as being used as teaching and learning aids.

To teach Circle Geometry for instance, circle cut-outs could be made. The VI can be made to feel the shape's circumference, the diameter and radius. In the same vein, different cut-outs of triangles could be made and felt by the VI. The different types of triangles include isosceles, equilateral, right angled, and scalene triangles. The properties of Venn diagrams can also be explained in the same way. Several other topics such as probabilities, matrices, trigonometric functions, and simple interest can be explained to the VI through creativity and information giving. For topics that may require some computations, such may be carried out on the Abacus. Whereas the sighted may use pencils, the VI could use crayons that could be felt by their fingers (Adelakun, 2020). The holes that can be made by a tracing wheel can be felt by the LVI. It is the role of researchers therefore, to be exploring for solutions than always blaming the presence of a disability. Jay (2020) postulated that improvement in technology could help people with VI greatly. If the abacuses and enhanced technology were to be combined, learning could easily take place. A tape recorder for instance can be used to record the formulas of mathematical problems. These can then easily be memorised by LVI. Such formulas could include: Area of a Circle (A) $= \Pi\ ^{2}$, Circumference (C) $=2\Pi$, Area of a Rectangle = lb, and the Volume of a Cylinder ($V = \Pi\ ^{2}h$). The multiplication table should also be memorized by the VI. Without knowing how to multiple and getting answers to questions such as 6 x 7, 3 x 7, and 8 x 7 outright can make it hard to use the Abacus at higher grades. The major challenge therefore, seemed to do with the methodologies that teachers have been using in the classroom.

Research Questions and Research Hypotheses

In order to find answers to the objectives of the research, research questions were developed. According to Johnson, et al (2007), a research must have 2 to six research questions to guide a research paper, dissertation or thesis. The author went on to argue that research questions should be specific and researchable. They must also not directly be answerable as absolutely no or yes. That is, they should not be closed ended. When carrying out research through interviews or questionnaires, the research questions should be expanded into simpler several other questions in order to elicit much information (Yolanda, & Jennifer, 2021). The guidelines on how to write research questions were adapted from QuestionPro (2022) (see Appendix E). The adaptations were done by narrowing the generic tools to those specific to this research. It was explained that similar tones from the questionnaires should be summed up into themes and coded. The main research question was: To what extent can teachers teach Mathematics to LVI? The main research question (RQ) was further subdivided into four subsidiary questions. These were:

RQ1: What challenges, if any, could LVI encounter, if they did not learn Mathematics?

RQ2: What are some of the effective teaching strategies for the teaching of Mathematics to LVI?

RQ3: To what extent can teachers use assistive devices for teaching Mathematics to LVI?

RQ4: To what extent are the teachers' methodologies comparable for teaching Mathematics to LVI?

In order to strengthen the research questions, there were also comparative hypotheses that examined the expected relationship between the variables to be applied. A Hypothesis is a reasonable guess, and could be divided into Alternative (H_a) (hypothesis to be tested) and Null (H_o) (the opposite) (Prasko, 2015). It is a predictive statement about the relationship between two or more variables. Hypotheses can also be used to test the validity and reliability of a data set. According to Prasko (2015), hypothesis is an assumption that should be made at the beginning of a research. The research hypothesis are derived exactly from the corresponding research questions, as supported by Yolanda, & Jennifer (2021). The two (research questions and hypothesis) were therefore, somehow similar. The corresponding null hypotheses (H_o) and alternative hypotheses (H_a) to the main research hypothesis were:

Null hypotheses (H_o): Teachers cannot effectively teach Mathematics to LVI if not well trained.

Alternative hypotheses (H_a**):** Teachers can effectively teach Mathematics to LVI if well trained.

For each of the subsidiary research questions, corresponding hypotheses were also considered:

RQI H_o: There were no challenges associated with not learning Mathematics by LVI.

H_a: There were a lot of challenges associated with not learning Mathematics by LVI.

RQ2 H_o: Teachers were aware of effective teaching strategies for teaching Mathematics to LVI.

H_a: Teachers were not aware of effective teaching strategies for teaching of Mathematics to VI.

RQ3 H_o: There was no relationship between the use of Abacus and teaching of Mathematics to VI.

H_a**:** There was a positive relationship between the use of Abacus & teaching of Mathematics to VI.

RQ4 H_o: The teachers' methodologies for teaching of Mathematics to LVI shall not change if teachers were not well trained. Test: H_o: $\mu > 25\%$, and at Post-Test: H_o: $\mu > 80\%$)

H_a: The teachers' methodologies for teaching of Maths to LVI shall improve if teachers were well trained. (At Pre**-** Test: H_a: $\mu \leq 25\%$, and at Post-Test: H_a: $\mu \leq 80\%$)

The 4th hypothesis was also followed through test statistics. The researcher's assumption was that the teachers could not score more than 25% during the pre-test. This was because Adapted Mathematics for the Visually Impaired was not being taught in colleges and universities. Assistive devices were either inadequate, or not there, in schools for the VI. The general perception at pre-test, stated as null hypothesis was (H_o), $\mu > 25\%$. That is, the general belief was that teachers for the VI could score better than 25%. At Pre-test, the 25% was the pre-determined population mean. This means that the knowledge of teachers for the teaching of Mathematics to the VI was not better than 25%. This was the researcher's opinion. It was also generally thought that a well-trained teacher must score more than 80% on tasks at elementary grades after receiving quasi-experimental lessons. However, this was doubtful for it to happen. Some of the teachers did not learn Mathematics during their training period at institutions of higher learning. To use the Abacus effectively, one needed to have basics in Mathematics. Hence, the hypothesis at post-test were stated as follows: The null hypothesis, H_o: $\mu > 80\%$: that is, the knowledge of teachers for the teaching of Mathematics to the VI was better than 80%, where μ was the pre-determined population mean; and the alternative hypothesis, H_a: $\mu \leq 80\%$. That is, the knowledge of teachers for the teaching of Mathematics to the VI was not better than 80%. Researchers at times make assumptions or hypotheses in order to guide them in a study. In addition to collecting data based on the research questions, demographical data, that is, characteristic of respondent (age, gender, level of education, experience, and others) should also be collected and analysed.

CHAPTER 2: LITERATURE REVIEW

According to Elsevier Author Services (2022) Literature Review is the summary of previous research that is familiar to the study being conducted. The purpose of the Literature Review for this study was to explain the scope and direction (Wendy, 2004) for the teaching and learning of Mathematics for LVI. The themes for the sections were: Inclusion and Exclusion criteria, Persons with Visual Impairment, Policy and Legal Frameworks, Barriers and Misgivings, Leadership of Special and Inclusive Education, Mathematics and LVI, and Use of Assistive Devices.

Criteria for Selection of Literature

John (2023) says that there must be inclusion criteria for the elements that must be present in literature review. One of the criteria for inclusion for the literature for this study were studies that examined experiments and surveys related to the teaching of Mathematics to LVI. The research designs, methodologies, data analysis, research gaps and recommendations from former experimental studies were very important secondary sources. Additionally, the studies should have been related to the training of Special Education teachers. These were teachers trained to specifically handle CSEN. The studies should have also embraced the management of Special Education schools, as well as inclusive education schools where LVI learnt side by side with their fellow sighted peers in the same classes. Studies on the use of assistive devices, in particular, the Abacus, for teaching Mathematics to LVI were cardinal for this study. If there was an inclusion criteria for this study, it suggests that there should also have been an exclusion criteria to disqualify some elements.

One of the criteria for disqualifying some elements in the literature were studies that were not related to the teaching of CSEN. In addition, the studies related to the general training of ordinary teachers were excluded. These were basically studies that targeted learners that were sighted. This also suggests that studies related to CSENs who have other impairments other than sight challenges were also disqualified. For instance, the teaching of Mathematics to the deaf and learners with intellectual disabilities were not included. Studies on teaching and learning methodologies for learning Mathematics in ordinary schools were not of interest. This also implied that studies that were conducted in the sector of Mathematics in institutions of higher learning that did not offer Special Education training were also not embraced. Additionally, studies on the use of assistive devices that were not meant to aid in the teaching of Mathematics to LVI were disqualified. Some assistive devices helped the LVI in movements such as white canes, however, studies on such did not qualify to be part of this research.

Theoretical and Conceptual Frameworks

This unit of Chapter 2 has described the theories and the conceptual frameworks that have been used in the study. The sources the framework and the rationale for its choice have been provided. Efforts were made to ensure that the major propositions used have clearly been explained in the framework. There is a research based analysis of how the framework has been previously applied in ways similar to the current study. It has also described how and why the selected framework relates to the present study. The study’s theoretical, conceptual assumptions, principles and controversies in the field, have also been refereed to. The historical and current literature (at 87%) on the framework, with the aid of scholarly and peer-reviewed sources have been discussed.

There are two kinds of frameworks used when writing the background of a study: theoretical and conceptual (Creswell, et al, 2014). The author argued that theoretical framework is a widely accepted principle. A conceptual framework on the other hand is the decision made after analysing various theories (Elken, 2019). The subject under discussion was the ability of LVI to learn Mathematics. A number of theoretical frameworks were examined. These included the Gestalt theory (Bustamante, 2023), the Connection theory (Edward, 2023), the theory of Didactical Situation (Brousseau, 2022), the Cognitive Load Theory (Shibili, & West, 2017), Spiral Curriculum Theory (Music, 2020), the Behaviourism Theories (Kendra, 2022), Bloom's Taxonomy Theory (Shabatura, 2022), and Howard Gardner's Multiple Intelligence Theory (Kendra, 2023).

Howard Gardner's Multiple Intelligence Theory

This research mainly anchored on Howard Gardner's Multiple Intelligence Theory (Kendra, 2023). Howard Gardner in 1983 outlined different types of learning in his eight Multiple Intelligence Theory as body-kinesthetic-mathematical, visual spatial, linguistic-verbal, body-kinesthetic, musical, interpersonal, intrapersonal and naturalistic intelligence (Kendra, 2023). The rationale for working with the theory was that it recognised 'body-kinesthetic' which was closely related to the tactile methodology, which most researchers appeared to be familiar with when dealing with LVI.

The conceptual framework is that LVI do not see from the black board, hence they needed methodologies that exploited other senses. Body-kinesthetic type of intelligence appeared to be unique, and seemed not to have been widely exploited. The theory by Howard Gardner's seemed to suggest that some types of learning were specific to certain disciplines (Kendra, 2023). The field of Mathematics for the LVI was unique and required that teachers have specialised knowledge.

This was likely the main gap in most of our institutions of higher learning where teachers appeared not to be receiving adequate skills around the teaching of numbers to LVI. Since some renowned universities were offering Mathematics to trainee-teachers for the LVI, it was inevitable to learn from others to find out if such advances can also be extended to developing countries. Since the discipline appeared to be unique, it could definitely be a specialised discipline. This could be the likely reason the Adapted Mathematics was referred to as ‘Expanded Core Curriculum’ in the US (Willings, 2022). It was simply different from Ordinary Mathematics. It required specialised teachers such as those trained in Abacus methodologies.

Gestalt theory

According to the Gestalt theory by Fredrick Peris (Bustamante, 2023), the attributes of the *whole should not be deduced from analysis of the parts in isolation*. This theory was supported by the World Vision (2020) that purported that *a disability in itself was not an inability*. The World Vision successfully trained PWD, including persons with VI in various skills in Uganda. The conceptual framework is that certain fears were only myths. With concerted efforts, it is possible for LVI to perform to the society’s expectation.

The Connection theory

Another theory that was examined was the Connection Theory, that argued that *individual neurons have very little power on their own*, however, when interconnected, could do great works (Edward, 2023). The conceptual framework was that teachers from different disciplines needed to be collaborating effectively if they were to achieve greater heights, especially in the area of Mathematics for LVI.

The Theory of Didactical Situation

Another theory of interest was that of *didactical Situation*. This is the notion that when acquiring new knowledge, teaching should be consisting of setting up situations that encourage interactions for learners to be participating in (Brousseau, 2022). Many researchers appear to have applied this theory. Organisations such as the Akita University (Akita University, 2023) and the ICEVI (ICEVI, 2023) appeared to have benefited from this theory. These two institutions have been offering Mathematics and Sciences to those interested in teaching the subjects to LVI. With the use of abacuses, geoboards and other local initiatives, LVI could seek jobs such as being lawyers, medical, technicians and engineering jobs. The theory of didactical situation has resulted in changing the entire approach. Where teachers and learners may not understand, they may devise their own Braille codes. Many countries are now manufacturing abacuses, geoboards, tailor frames, and improvising objects from the environment in the teaching of Mathematics and Sciences to the LVI.

The Cognitive Load Theory

Another theory, the Cognitive Load Theory (Shibili, & West, 2017) was in support of the Gestalt theory (Bustamante, 2023), by proposing that *to learn a complex concept, it should be simplified into manageable units.* The curriculum was often designed in such a way that a topic at higher grades has preliminary topics at the lower grades. Definitely this was the case also for LVI as they have been using the same curriculum as for the so called normal. However, this strategy could perhaps not work for LVI as the teachers' methodologies were mainly the use of chalk and blackboard. However, for teachers that had learnt the Abacus methodologies, the teaching from simple to complex, or known to unknown was very useful.

Spiral Curriculum Theory

When teaching any type of learners, Jerome Brunner argued that challenging topics should be repeated several times in some kind of spiral (Spiral Curriculum Theory) for the topics to be easily mastered (Music, 2020). Implementation of the Spiral Curriculum Theory (Thomas, 2022) appeared to have been clear to many teachers even in the developing nations (CDC, 2013). Many curricula were designed in such a way that at some point, the work had to be repeated. Hence for the topic 'Reproduction', you may find it being taught at both elementary and upper grades. Sometimes you may find Reproduction appearing in many subjects such as Home Economics, Biology and Religious Education.

Just like for the Cognitive Load Theory, this strategy could perhaps not work for LVI as the teacher methodologies were mainly the use of chalk and blackboard. Once the teachers were conversant with the Abacus methodologies, repeating of the same topic could be made simple.

The Behaviourism Theories by B. F. Skinner

In addition to the theories discussed above, behaviourism theories were also examined. The Behaviourism Theories by B. F. Skinner (Kendra, 2022) argues that behaviour was a response to the external stimulus. The theory suggests that encouraging positive behaviour such as praise and rewards could enhance the student's academic performance. Either the teachers or the learners, or both may require some positive rewards to encourage them to be participating in problem-solving skills with the use of numbers.

The challenges with the theory were that even if teachers and parents encouraged the LVI to work hard in Mathematics, success was difficult as the learners were not learning. Their teachers had challenges in teaching them. Just like for the Cognitive Load Theory (Shibili, & West, 2017) and Spiral Curriculum Theory (Music, 2020), the Behaviourism Theories may only apply once the Howard Gardner's Multiple Intelligence Theory (Kendra, 2023) was first put in place.

Bloom's Taxonomy Theory (Shabatura, 2022)

A curriculum has different strata, with the lowest being at the bottom and the highest at the top. According to Bloom's Taxonomy Theory, coined by Benjamin Bloom, to learn something, one has to move from simple to complex (Shabatura, 2022). Bloom's hierarchical model was organised into six educational groups, namely knowledge, comprehension, application, analysis, synthesis and evaluation. The lowest level was comprehension and the highest being evaluation.

Thomas (2022) gave examples of how Bloom's Taxonomy of classifying knowledge has been applied in the education system. This theory was commonly applied in the school curriculum of many countries especially when setting questions for summative examinations (ECZ, 2016). The first questions were usually simpler, and they progressed into more difficult in latter questions. Like for the previous, Bloom's Taxonomy of classifying knowledge could not easily be applied as there was no adapted curriculum. In the sector of Mathematics for LVI, not much studies about the application of Bloom's Taxonomy appear to have been carried out. Bloom's Taxonomy Theory may only be helpful once Howard Gardner's Multiple Intelligence Theory was implemented (Kendra, 2023).

Maslow's Theory of Hierarchical Needs

Abraham Maslow argued that a person will be motivated when all his needs were fulfilled (Editorial Team, 2023). The Editorial Team (2023) argues that motivation for LVI and their teachers was necessary for encouraging them in dealing with educational challenges in their school journey.

Teacher motivation appears to be an essential component to enhancing classroom effectiveness (Carson, & Chase, 2022). Definitely, people sought jobs in order to seek satisfaction. They may not explain to management some of their inward feelings. Additionally, their dissatisfaction may resurface in various ways, such as learners not achieving their school objectives. Carson, & Chase (2022) further, went on to argue that for some teachers of physical education, motivation may be induced from a self-determination theoretical framework. Teachers in special and inclusive schools appear to be doing a lot of work that ranged from being a care giver, a teacher, to being an assistant teacher. They have to push the children's wheelchairs, and pick writing materials that fall off from the tables, because the LVI may not see them. Due to many challenges encountered during the teaching process, the theory of self-determination may not easily apply for the teachers. They definitely need to be motivated in some way. An allowance, for them to be getting a salary slightly above the others could be thought to be a motivating factor. From the Table, even if the salaries of teachers were doubled, it is doubtful if there were going to manage to teach Mathematics to LVI. However, if Howard Gardner's Multiple Intelligence Theory (Kendra, 2023) was implemented first, motivating of the teachers with better conditions of services may produce great results. Some of the useful theories referred and conceptual framework applied was summarised in Table 1**.**

Table 1

Key Theoretical and Conceptual Frameworks

Theoretical Framework	Conceptual Framework
Gestalt theory by Fredrick Peris. The whole should not be deduced from analysis of parts in isolation (Bustamante, 2023)	Look at a human being in totality, avoid focusing on loss of a sense organ.
The Connection Theory. Individual neurons have very little power on their own (Edward, 2023)	Encourage Special Education teachers to interact with teachers of Mathematics.
Multiple Intelligence Theory by Howard Gardner (Kendra, 2023). 'Body- -kinesthetic type of intelligence'.	For LVI, Assistive Devices should take the the centre stage when teaching Mathematics
Theory of didactical Situation, to acquire new knowledge, set up situations that encourage interactions for learners and teachers (Brousseau, 2022).	. Organisations (learners or teachers) were capable of constructing their own symbols or methods when they meet challenges.

In the light of the theories, it was found necessary to find linkages with issues that underpinned the disability movement. These included understanding who persons with Visual Impairments were.

Persons with Visual Impairments

There were two common ways of defining persons with VI: the legal and educational definitions. The former was the one commonly used by lay people and health professionals, while the latter was favoured by educationists (Adelakun, 2020). According to the legal definition, a person was legally blind if they had a visual acuity of 20/200 or less in the better eye even with correction, with say, sun glasses (Adelakun, 2020). The author went on to explain that a person who was legally blind may also have a field of vision of less than or not greater than 20 degrees in the better eye. For the sake of clarity, the ratio of 20/200 may be simplified to 1/10, implying that what someone with good vision could see say at 10 metres, the one with poor sight may need to get as close as 1 metre to see the object. Most persons with low vision have their visual acuity falling between 20/70 and 20/200. Definitions to do with visual acuity and field of vision may not be very useful to the teacher. These appear to be more to the medical disciplines. Teachers needed their own definitions that could help the LVI to learn, as learning has to do with the brain and not the eyes (Deborah, 1999). Adelakun (2020) argued that the educational definition should stress what was required by the LVI to learn. These included the use of braille, aural methods and abacuses (CSO, 2022). In many countries, this has led to LVI to learn how to read and write braille using the slate (writing frame) and the Perkins Brailler (Perkins School for the Blind, 2023). Since the VI cannot see, aural methods such as the use of tape recorders, radios, jaws or speech software could have been used to teach them. In one project, text-to-speech technology was used to present math word problems in audio format (Beal, & Shaw, 2009). They provided audio feedback to students about their answers. Results indicated that blind students' problem solving were comparable to that of the sighted students. Investment in the sector appear to have been inadequate.

As the study contemplates the provision of these assistive devices, it was important that it was guided by statistics of the learners being discussed. The World Bank (2022) estimated that more than 1 billion persons globally (about 15 percent of the world's population) had disabilities. The figures tallied with those by the UNESCO Institute for Statistics (2019). Many of the PWD were found to be living in low- and middle-income countries (LMIC). The author suggested that the number was expected to increase because the prevalence of disability was affected by a range of many factors. Such factors included aging, war and conflict, natural disasters, pandemics, climate change, and forced displacement (World Bank, 2022). The Central Statistics Office (CSO) population survey of 2022, indicated that Zambia had a population of 19.47 million (CSO, 2022). About half of the Zambian population was below the age of 24 years, and that could be estimated at 9.73 million. Fifteen (15%) of this figure translates to about 2.92 m children and youth with disabilities in Zambia. The 2018 Educational Statistics by the Ministry of General Education indicated that there were 137,502 CSEN in Zambian schools (MoGE, 2018). As a percentage (15%) of the 9.73 million population of the children and youth in Zambia, we note that only about 0.14% (1.5m) of the children disabilities were expected to be in school, including the tertiary institutions. Comparing this figure to the 137,505 CSEN, we note that the majority (1.5m less 137,505), likely about 90% were out of school, suggesting an infringement on their right to education.

Most estimates indicated that about 0.1 % of the population, was the prevalence of persons with VI (Sheila, 2019). In Zambia, this could translate to about 9,730 children and youth with VI that were in school. This was a relatively large number that needed the society‘s attention. Unfortunately, the 2018 Educational Statistics Bulletin (ESB) did not categorise learners with disabilities into their respective groups such as visual, hearing and intellectual disabilities. Hence it may be difficult to determine the actual numbers of the VI that were currently in schools and those that were not. However, when we compare 9,730 LVI as a fraction of 137,502 CSEN in Zambia (about 150,000 by 2022), we observe that the prevalence rate of the VI was at 0.06% (or 0.1%). This suggested that the Ministry statistics and those at global level were in tandem. (Please note that the CSO’s figures were for 2022, while those for the Ministry were for 2018. The figures for children with special educational needs (CSEN) in 2022 had not yet been computed).

According to the USC Roski Eye Institute (2023), studies conducted a few years ago at their clinic postulated that the prevalence of VI will not change for the better in the near future. The researcher argued that the number of people with different types of eye diseases and impairment issues was likely double in America by 2050. Therefore, the need for assistive technologies should only grow. This suggests that the world should not relent in finding solutions to the education of persons with VI. Modern technology should be encouraged to grow.

It may also be necessary to look at the progression rates of learners with disabilities in school. The 2018 ESB indicated that 113,698 (85%) and 23,804 (15%) of these learners were at primary and secondary levels respectively (MoGE, 2018). The readers of this thesis may be worried of these progression rates. Most of the learners that dropped off from school at primary level did not acquire sufficient knowledge and skills to be able to live independent lives. Compared to 2017, the total number of CSEN increased by 0.9%, and this was considered a marginal increase (MoGE, 2018). Further analysis also indicated that between 2015 and 2018, the higher share of the learners was at primary CSEN (averaging 83%) and 15% at secondary, this was explained by the Ministry as very low transition rates from primary to secondary education. Definitely a huge number of that population were children with disabilities. The Sightsavers International (2022) argued that about two point two billion people globally, had a near or distance vision impairment. This condition if not corrected interfered with the learning process. During the 2010 Census in Zambia, the national net value for out of school going children stood at 28.4% at primary and 54.5% at secondary (CSO, 2010). Definitely, the largest percentage of these children that were out of school were those with disabilities. In the 2016 ECZ final examinations, learners with disabilities were the least in performance (ECZ, 2016). In Eastern province, 90 schools were examined at Grade 12 level. The least in performance were special education schools. The trend was the same in Copperbelt and

Western Provinces. This was definitely a concern for researchers. The higher institutions of learning were entrusted with the responsibility of training teachers. It was expected that the knowledge gained from colleges was adequate to make learners learn. When the learners do not perform satisfactorily, the society may question the education systems in place (Nongola, 2015). Some learners with disabilities who completed secondary schools faced challenges of finding training institutions and/or jobs. The Ministry of Education and Culture (MoEC) (1996) argued that many college principals did not clearly understand how the deaf or blind could compute Mathematics or Science; hence many of them were denied access into institutions of higher learning (MoEC, 1996). The organisation argued that though a few PWD graduated with diplomas and degrees, many employers did not trust that they could perform to their satisfaction. The Ministry of Higher Education (2020) recognised that persons with disabilities were entitled to quality education. For this reason, between 1980s and 1990, there was an increase in the number of rehabilitation centres and employment opportunities in Zambia. This suggested that there was positive development in their favour. However, the period of economic restructuring of the Movement for Multi-Party Democracy in 1991 witnessed a significant decline in the provision of social services targeting PWD (MoEC, 1996). The reforms were somehow competitive, and appeared not to favour the underprivileged and marginalised.

Policy and Legal Frameworks

An attempt also was made to look at the policies guiding the education for PWD. Data from international conventions and protocols was provided. Additional policies, in particular those from the Ministry of Education in Zambia have been analysed to try to understand where we are as a nation. The reforms of the latest review of the curriculum by the Curriculum Development Centre

(CDC) in 2013 were also scrutinised. There were local and international frameworks that protected PWD. Globally there has been several conventions focused on the rights of children. These included the 1989 UN convention on the Rights of the child, World Declaration on Education for All of 1990, the UNESCO Salamanca and Framework for Action of 1994, Dakar Framework for Action in 2000, and United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) of 2006 (ACBRAN, 2017; UN, 2023). Though some of these conventions cited education as a right for children with disabilities, they did not clearly elaborate how the blind could learn the full curriculum. In many cases, the different categories of children with disabilities such as the deaf, deaf-blind, intellectual disabilities, were grouped as one, 'children with disabilities', yet the different categories have specific needs of education (Kendra, 2023). Additionally, assistive devices were found to be quite expensive to be made affordable by the poor developing countries. There were also no deliberate strategies on how reputable universities could be sharing their strategies with others, particularly with other institutions of higher learning in developing countries (Editorial Team, 2023).

At international level, the advocacy for the education of children with deferential abilities started in the late 1980s at the 1989 UN convention on the rights of the child (UNICEF, 2023). Though the convention did not clearly specify how to be educating these children, at least, it recognised the need for the development for every child in an atmosphere of happiness, love and understanding. The demand for the increased rights for all children was also strengthened at the 1990 World Declaration on Education for All in Jomtien, Thailand (UNESCO, 2014). It was argued that every person (child, youth and adult) needed to benefit from the educational opportunities designed for education institutions. However, like the UN convention on the Rights of the Child of 1989, the World Declaration on Education for All of 1990 appeared to have just given out general guidelines. It did not specifically touch on learners with disabilities (ACBRAN, 2017). The UNESCO Salamanca and Framework for Action of 1994 went further by advocating for all State Parties to accommodate all children regardless of their intellectual, linguistic or physical state, to be educated within the neighboured schools together with other learners (ACBRAN, 2017). They referred to such an education system as Inclusive Education (ICEVI, 2023). That conference appears to have been the first to specifically target learners with disabilities. In the United States, the Individuals with Disabilities Education Act (IDEA) defined inclusive education as the participation of students with disabilities alongside their peers without disabilities (Wendland, 2021). The Ministry could learn from the Act, IDEA (PL 94 – 142) that identified some areas for development such as proper identification strategies and full service at no cost. These appeared to be good policies that education providers could have taken advantage of. The students with disabilities were to be participating with their peers in academic settings, extracurricular and other school activities.

According to ACBRAN (2017), the 1994 Salamanca Statement called for inclusion to be the norm for students with disabilities. State Parties were to facilitate the full and equal participation in education, and in environments which maximised academic and social development. It was recognised that special education schools were few. Therefore, in order to achieve higher enrolment levels coupled with good quality education, it was necessary that all learners were schooled from the same schools, from the same classes, and all learners seated side by side. It was suggested that discrimination on the basis of disability, should not be allowed. However, there were few teachers and other stakeholders to handle inclusive schools, hence, this may have had a bearing on implementation.

Inclusive education advocates for reasonable accommodation, implying appropriate adjustments to the teaching and learning materials. According to the Sustainable Development Goals slogan, every child had the right to education (World Physiotherapy, 2019). This suggested that regardless of one's condition, such as presence of a severe disability or coming from a marginalised group, every child should have been embraced by the education system. The Ministries of Education in various countries were supposed to be employing the principles of 'reasonable accommodation' and 'universally design' (Rafael, 2016) when providing for all learners. The principle of reasonable accommodation suggested that education materials should have been accessible to all, such as buildings being built with ramps or slopes and rails. This could have allowed those with wheel chairs and other disabilities to be accessing them. The principle of universal design suggests that there should be a flexible curriculum that provided alternatives for students with differing abilities. That is, supports and scaffolds for all learners were supposed to be taken care of at the same time, to enable full participation to the curriculum. Apparently, planning of most curriculums for many countries has not been inclusive of all learners (Edyburn, 2006). It appeared accessibility for PWD has not been a priority in many countries (WHO, 2022).

At the Dakar Framework for Action in 2000, it was realised that State Parties had challenges of providing quality education. It was resolved that countries that were seriously committed to education should not be having challenges of the lack of resources (UNESCO, 2000). At the Flagship on Education for All conference, the UNESCO Institute for Statistics (2019) realised that there was need to have flagship indicators on education for all children in relation to the schooling and learning process. The indicators were yet to be determined particularly for learners with special educational needs (SEN). A review of Millennium Development Goals (MDGs) of the 1990s revealed a lot of challenges by various countries. New plans and ideas from the review of the MDGs were developed, and were termed as VISION 2030. Zambia asserted to the VISION 2030 for the provision of quality education for learners, and the Ministry of Finance and National Planning (2006) aspired to achieve many things (Human Rights Commission., 2017), however, again with very little reference to learners with disabilities. The VISION 2030 and the 7th National Development Plan (7NDP) argued that *no one should be left behind* in development. This implied that all school subjects needed to be made accessible to all learners. This was because research had shown that all learners could learn (DFID, 2001). The UNCRPD was the first legal rights instrument specific to PWD (Human Rights Commission, 2017). It promised full participation in economic, social, cultural and political life. Some terminologies were emphasised at the convention. Nations were to avoid 'discrimination' on the basis of disability by exclusion from enjoyment of human rights, on an equal basis with others. There should be 'reasonable accommodation' by creating necessary and appropriate modification where needed, to ensure PWD enjoyed or exercised their rights in full. There should be 'universal design' when planning for the teaching and learning materials and services to be used by all learners, to the greatest extent, without the need for adaptation or specialised design (Human Rights Commission, 2017). Definitely, this was a remarkable progress in policies guiding the education of persons with VI. However, when it came to implementation, there appeared to be a lot of challenges. The sector of special needs often came as an afterthought after many projects in schools have been completed. By the time they looked at PWD, the budget would have been depleted, hence budgets for special education could not easily be implemented.

On the continental level, efforts were also being done for enhancing the education standards for State Parties. In Africa, the 1997 Southern African Development Community (SADC) protocol on education and training, attempted to promote regional education and training that included education of vulnerable children and youth. The protocol to the African charter on the rights of PWD indicated that State Parties take appropriate steps to eliminate discrimination (African Union, 2020). It was argued that all children should have access to at least minimum levels of education (SADC, 2015). It was however, not very clear to what was termed as 'minimum' level of education. Efforts were also made at the Protocol to the African charter on Human and People's rights of 1998 that focused on establishing central courts. The challenge with this protocol was that it may have been difficult to enforce it as they did not have prescribed desired standards for teaching LVI. The responsibility for organising the Decade activities for the period 1999 – 2009 was given to the African Rehabilitation Institute (ARI), an agency of the Organisation for African Union (OAU), with headquarters in Harare, Zimbabwe, and the regional offices located in Dakar, Senegal (for Brazzaville, Congo (for Central Africa) and Harare (for Southern Africa) (The African Union, 2020). It appeared that the ARI activities were in many countries, particularly those in the Northern part of Africa. The roles of the ARI were particularly in mainstreaming priority action areas of the youth, women and children with disabilities and in the mobilisation of resources for disability inclusive development. The second mandate of ARI was the thematic area that dealt with statistics, research and evidence gathering on disabilities nationally. The third area concerned legislation matters in relation to exploitation and cruel treatment of PWD. ARI appeared to have concentrated more on putting up measures for protecting the parents, children and spouses closely related to the PWD (African Union, 2020). It did not clearly indicate how to deal with the school curriculum such as how to teach specific subjects like Mathematics and Science, hence there was a gap. However, like other previous cases, the education was usually defined for those without disabilities. The SADC needed to clearly set education goals for PWD.

One of the leading organisations in the promotion of education for persons with VI was Sightsavers. The organisation used to demonstrate to various governments on how to deliver certain education services to LVI (Sightsavers International, 2015). The report indicated that many nations were still having obstacles in meeting their obligations. Though many nations were usually represented at international conventions, most of the treaties agreed upon were rarely implemented. State Parties appeared to have been appending their signatures to the protocols without a clear understanding of the whole process. Eight two (82) countries signed the UN Convention of Persons with Disabilities (UN, 2023), but many PWD did not have access to quality education. Many nations ratified the convention on Inclusive Education that was held in France in 1994 (UNESCO, 1994), but to-date, most of the resolutions have not been implemented. This could suggest that many nations did not make wide consultation on the process of ratification. Treaties were instruments normally endorsed by State Parties. They were generally considered as sources of international law (UN, 2023). This implied that for a treaty to apply, State Parties were expected to sign the instruments. Thereafter, they were expected to ratify, accept or approve it.

The provision of general education in Zambia in terms of management, administration and financing of quality education, was in line with the Education Act No 23 of 2011 (National Assembly of Zambia, 2023). The 2011 Education Act classified schools in Zambia as Primary schools (grades 1 to 7), Basic Schools (grades 1 to 7, and 8 and 9 within the same school) and Upper Secondary School (grades 10 to 12). The Basic Schools have since been abolished, and replaced by Primary (grades 1 – 7) and Secondary Schools (grades 8 – 9 for junior, and 10 – 12 senior). The issues of quality assurance, national assessment and examination were guided by the ECZ Act No. 15 of 1983. Some of the challenges to reasonable were that LVI were examined on the same curriculum as for the sighted learners, without much adaptation (Kelly, M., 1999). There was also the Teaching Council of Zambia (TCZ) that was guided by the legal framework called the Teaching Profession Act No. 5 of 2013 (Parliament of Zambia, 2023), whose mandate was to improve the standards of qualification in the teaching profession and promote CPD amongst teachers. Another legal framework, the Zambia Qualifications Authority (ZAQA), was established under the ZAQA Act No. 13 of 2011, in order to protect the quality and standards of education (Parliament of Zambia, 2022). The Authority was established to ensure that standards of education and registered qualifications were internationally comparable. Another important legal document, was the Zambia National Commission for United Nations Educational, Science and Cultural Organisation Act No. 32 of 1966 [Ministry of Finance & National Planning (MFNP), 2022]. This Act mandated the commission to be providing professional advice to the Ministry of Education on matters related to the functions of UNESCO.

Other important policy documents included the Zambia's official education policy document 'Educating Our Future' of 1996, Vision 2030, and the Eighth National Development Plan (8NDP), covering the years 2017-2021 (MFNP, 2022). Despite having all these policy documents, there appeared to be no specific legal frameworks in the Ministry for taking care of pupils with disabilities.

Following the assertion of Zambia to the UNCRPD of 2006, the Zambian government was to facilitate the provision of special needs education for early childhood education, basic, high school, and tertiary levels for PWD. The need to improve education standards in Zambia was recognised by the Fifth National Development Plan (FNDP) (Human Rights Commission, 2012). The Ministry of Community Development and Social Services was mandated to coordinate the development of Disability Act and the Disability policy. The two documents were published in 2012 and 2015 respectively. The provision of education to CSEN was placed under the Ministry of

Education. The disability policy says that PWD should access an inclusive, quality primary, secondary and tertiary education (MoCDMCH, 2015).

One of the important elements in the provision of any service was legislation. By the time of conducting this study, the provision of special education by the Ministry of Education was unaccompanied by any piece of statutory instrument. There were only policies in place. One of the policy guidelines was that of ensuring that there was equality of educational opportunities for CSEN. The other one was that of providing education of relatively good quality to CSEN. Another one talked of providing and strengthening the supervision and management (MoE, 1996). The above policy guidelines sounded to be good; however, there was no guarantee for commitment of resources because they were not supported by any piece of legislation. Legislation of policies often goes with commitment by the government and other agencies. Once legislation was passed, education authorities were permitted (rather than requiring) to do so (Kelly, 1999).

In Zambia, the Educating our Future policy (MoE, 1996) argued that to the greatest extent possible, learners with SEN should be included in the mainstream classes. The statement implied that learners who could not be educated using conventional pedagogies required other strategies. Going by this statement, separate schools (Special Education Schools) were created for those with VI, hearing impaired, physically and intellectual disabled. Most of such schools were built far away from the children's communities. It was a fact that children with disabilities had already been devasted by their disabilities, hence sending them to distant places likely exacerbated their conditions (Nganwa, et al, 2017).

Under equity, the Ministry's intention was that of having flexible and inclusive education programmes that provided mechanisms for increasing equitable access to quality basic education for CSEN (Human Rights Commission, 2017). The strategies for achieving them were those of increasing accessibility, participation and retention in schools by CSEN. The Ministry appeared to have scored on accessibility as enrolment had generally increased from 1 – 5% (Human Rights Commission, 2017). However, there still appeared to be a challenge with participation and retention. According to the Human Rights Commission (2012), the Ministry of Education and Ministry of Higher Education and Skills Sector Plan needed to prepare a curricular that should facilitate human rights education in schools.

To continue learning about the education for LVI in Zambia, it became important also to talk about its history. Such an analysis could help to understand what worked in the past and what did not, as well as where we were at the moment. Their education has a long history which can be traced as far back as 1903, when the first school for the LVI was established at Magwero community in Eastern province. It was opened by the Dutch Reformed Church (Kalabula, 2007). Thereafter, other missionaries also started opening up schools in various parts of Zambia. The government of the Republic of Zambia officially became involved in the provision of Special Education in 1971 (Kalabula, 2007). Teachers started to be trained at the Zambia Institute of Special Education (ZAMISE). The Focus on Learning policy (GRZ, 1992), and thereafter, the Educating our Future policy documents (MoE, 1996) recognised the importance of providing education to learners with disabilities. The situation had gradually been changing where PWD were beginning to be viewed as partners in development. The government, through the Fifth National Development Plan (FNDP) of 2006 – 2010, was then becoming aware that dependency did little to empower PWD (Human Rights Commission, 2017). To make progress, there was need to ensure that PWD achieved equal opportunities. Their rights and needs needed to be included in all pieces of legislation and national development plans at all levels of society.

Between 1984 and 1989, the government received technical and financial support from the Swedish International Development Authority (SIDA) (Suya, et al, 1989). SIDA concentrated on the training of Special Education teachers and the establishment of a professional infrastructure to oversee the implementation of special education activities and practical research related to the teacher training. The centre for this was at ZAMISE. That led to many publications being developed and others procured. The SIDA believed that the handicapped children were a special case, therefore, there was supposed to be positive discrimination in their favour (Suya, et al, 1989, 46). The concentration for most of the institutions of learning, however, appeared to be more at lower primary. The secondary section therefore, appeared to have suffered a lot. This research shall attempt to make contributions to this sector of education as well.

With the coming to an end of the SIDA project in 1989, sustainability by the Zambian government became a challenge (MoE, 1997). This was made worse when Zambia moved from the philosophy of humanism to competitiveness under the Movement for Multi-Party Democracy (MMD) in 1991. Some institutions that depended on grants could not continue enrolling learners with disabilities to learn for free. The teaching and learning materials became scarce in schools for the LVI. From about 2005, there has been other projects such as by Sightsavers, except that they were not that big to cover all the schools in the country. There could also have been few other organisations that could have engaged into research in this area but were unnoticed. Since there wasn't much empirical research to rely on, most of the implementers relied on theories based on the 'so called sighted'. Due to inadequate research, most institutions of higher learning were still relying more on traditional pedagogies of the 'chalk and the blackboard'. The knowledge of the use of tactile methods most suitable for the blind appeared to be in their infancy. Zambia adopted the policy on Inclusive Education, and this was included in its latest review of the school curriculum in 2013.

The 2013 Revised Curriculum Framework by the CDC introduced a number of curriculum reforms (CDC, 2013). There were aims to standardise the curriculum for Early Childhood Education, Primary Education, Secondary Education, Adult Literacy, and Colleges of Education in order to have a smooth progression. Apparently, the standardisation of special education curriculum along with the given different levels of education was not done. The Ministry had also introduced a two-tier system or dual career pathways that attempted to embrace both the academic and vocational. The vocational pathway was thought to be more suitable for learners with disabilities. Apparently, the main focus for the Ministry were the mainstream schools. The Ministry, through the Curriculum Development Centre had also introduced Information and Communications Technology (ICT) at all levels. However, LVI could not effectively benefit from the ICT as the computers did not have speech software such as jaws, implying that, there was no universal design in the planning of the curriculum. Inclusive education was therefore, far from being realised in the country. There were also policy reforms in the pedagogical skills by Teacher Education and Specialised Services (TESS), under the Ministry (CDC, 2013). The TESS had two departments: Teacher Education and Specialised Services. The Teacher Education was responsible for general teacher training, while the Specialised Services was in charge of Guidance and Special Education. The Teacher Education Department used to work closely with several cooperating partners such as the Japan International Cooperation Agency (JICA), and the United States Agency for International Development (USAID – Read to Succeed, Time to Learn, and Step Up projects) (MFNP, 2007). UNICEF through Teacher Education, had also been capacity building teachers in Life Skills Education for professional growth at various levels of the education system (UNESCO, 2000).

Through such programmes, it was expected that serving teachers and teacher-educators could continue to acquire various forms of knowledge and skills aimed at improving their knowledge. Apparently, from the UNESCO report, (UNESCO, 2000), there was no mention of CPDs for helping learners with disabilities, again appearing to violate the principles of universal design. Cooperating partners needed to be practicing the universal design principle so that pedagogies and other innovations planned for the mainstream learners also befitted LVI.

The Department of Standards Officers in the Ministry was responsible for monitoring the provision of quality education. This was the evaluation function by Standards Officers that was overseeing to it that there was achievement and success of pupils, as set out from the various policies. When we talk about quality education, Kelly (1999, p127) argued that it was "about achievement of pupils, about student success when they leave school for further education, in getting jobs, and for productive work". The author went on to argue that teachers had often complained that some learners were not making progress, hence, had no place in the education system. However, the DFID (2001) argues that all learners can make some improvement. It followed that the high failure rate by those disadvantaged learners was due to the lack of good teaching strategies. Researchers have a mammoth task of coming up with good teaching methods. Standards Officers needed to be working closely with researchers and curriculum specialists so that teaching strategies were improved upon. This could inevitably correct the negative views of teachers. The advisory function required that Standards Officers give professional advice to teachers on how to teach learners with exceptional needs. The Standards Officers were looked upon as the ones that understood the expected education standards in the Ministry. In a nutshell, they were supposed to be disseminating good practices. The evaluation function of Standards Officers was summed up as:

> with assessing the quality of educational provision and effectiveness of actual educational provision in individual schools, and in the system as a whole and reporting on this to the appropriate authority (MoE, 1996, p155).

The Ministry of General Education (1997, p6) argues that that the "co-business of the Standards Department was that of ensuring that quality learning and teaching came first in all teaching institutions". Among those officers, there were Standards Officers in charge of Special Education. The Principal Education Standards Officer (PESO) was based at headquarters in Lusaka, and was responsible for ensuring that there were high education standards in all special education schools in the country. In each province, there was a Senior Education Standards Officer (SESO), who was in charge of special education activities. For every district, there was an Education Standards Officer (ESO) in charge of maintaining standards in special education schools at district level. Standards Officers collected information about schools and teachers in areas such as the school environment, teachers' qualifications and attitude towards work (MoE, 1996). The perpetual challenges in special and inclusive schools suggested that standards officers were not adequately performing their roles to the Ministry's satisfaction.

Umalusi (2008) compared the work of Standards Officer to that of supervisors. The organisation pointed out that their role was that of ensuring that everything in schools was done correctly and safely. This view was supported by Kelly (1999) who argued that schools were expected to perform according to the set standards by higher authorities. However, to manage schools may not that easy. The demands by Standards Officers were often not the priority by the teachers. Teachers may have other problems including personal ones such as inadequate accommodation which were rarely discussed during inspection or monitoring, and this could negatively be contributing to their effectiveness.

Kelly (1999, p27) says ‘schools did not respond physically to the needs of CSEN, as they did not know how to care for them’. Schools that did not meet the expected standards of education were supposed to be assisted by the inspectors of schools. Monitoring of schools was an important aspect of ensuring that set standards were maintained and achieved. All schools, including special education schools for learners with exceptional needs were supposed to be inspected (Adelakun, 2020). Standards Officers have the role in ensuring that all these aspects were taken into consideration during their visits to special education schools.

Most teachers tended to expect the same performance from every pupil (Adelakun, 2020). Some did not understand that some learners had body parts either missing or not functioning well. The effects of losing sight were different from those of losing the sense of smell or that of losing limbs. It followed that even the education needs for each disability were different. The needs for learners with sensory impairments may differ from those of learners with physical impairments. A learner with sensory impairments may require modifications in curriculum such as the use of Braille for the VI or use of sign language for hearing impaired learners. Learners with physical impairments may need environments that allow easy movements of wheel chairs and other supportive devices. Learners with behavioural problems may benefit from self-management approaches such as self-evaluation programmes (Adelakun, 2020). Special education also required the provision of special facilities such as wheel chairs, speech mirrors, audio meters, and physiotherapy equipment. An effective school will normally have such equipment (Kelly, 1999, p199). The Ministry says that the provision of these services to LSEN should not be considered as a sense of sympathy, but as a moral obligation. One of the issues an inspector of schools needed to be concerned with was whether schools for CSEN had access to appropriate teaching and learning resources or not. Apparently, what was termed appropriate on the Zambian inspection tool was not defined (Kalabula, 2007). Internationally, there was the Bridging the Gap project to spearehead inclusive education (Observer Research Foundation, 2021).

Globally, the Bridging the Gap was a project funded by the EU under the Development Cooperation Instrument (DCI) that aimed at carrying out actions aimed at increasing the inclusion of PWD at both the international and country level (Observer Research Foundation, 2021). This role was an obligation for the EU and Member States as parties to the UN Convention on the Rights of Persons with Disabilities (UNCRPD). The Bridging the Gap projects were implemented in two countries: Sri Lanka and Coimbatore, India. The project was divided into two parts: In phase 1 (Observer Research Foundation, 2021), the theme was on ‘Communication using sign language’. Other than Sri Lanka and India, five countries were also included in the consultations and validation of the tools, namely Ethiopia, Jordan, Moldova, Nepal and Paraguay. In addition, within the included countries, the government disability focal point persons, national statistics office, national human rights institution and organisations representing PWD (the Disability People’s Organisations - DPOs) were all included in the process. The developments from these consultations were yet to be realised in Zambia. Their report did not clearly spell out the sectors of Mathematics and Sciences for CSEN. There was urgent need to share the outcomes of the Bridging the Gap I explicitly (EU, 2021).

The theme of Bridging the Gap-II was ‘Inclusive Education’ (EU, 2021). The component was implemented in India and in five partner countries (Burkina Faso, Ecuador, Ethiopia, Paraguay and Sudan). It focused on human rights and mainstreaming of disability matters in international cooperation. The European Union (2021) indictated that there were challenges with respect to the universal accessibility, gender and social sustainable. If such international organisations had some challenges, what more with developing nations?

A success story however, was that of a blind person learning Mathematics in Gambia (Luo, 2021). That was a case study in which a blind learner in an inclusive class was successfully taught Mathematics by an adult blind student on a one to one basis. That happened within a regular classroom. The success story had ultimately carried a message of hope that not only can blind students learn mathematics but also become teachers to other blind persons. It also indicated that LVI could benefit from an inclusive education set up. This suggests that when carrying out research in this sector, LVI should not be left out.

It is argued that teachers have the responsibility to educate all learners in their classes (Sightsavers, 2015) but often they did not always have the skills and knowledge to cater for those with special needs. DFID (2001) argues that schools were supposed to ensure access and inclusion of all children, and to change their attitudes to disability. However, there were no clear-cut strategies for helping learners with disabilities access school.

It is postulated by the United Nations (2023) that quality inclusive education must provide PWD with preparation for work by providing them with skills necessary in an open, inclusive and accessible work environment. It was argued that inclusive education should aim at promoting mutual respect and value for all persons. Additionally, the curriculum itself, needed to reflect on the value of diversity. The Ministry, in its Educating our Future policy (MoE, 1996) recognised this responsibility of providing education to learners with disabilities. However, it is argued that unless the barriers that include high poverty levels among PWD, coupled with inaccessible school curriculum were removed, inclusive education was not going to be effective. Other factors that needed consideration included were school infrastructure, long distances to schools, stigma and discrimination. UNESCO (2019) argued that the blind and partially sighted students must be provided with opportunities to learn Braille, alternative script, augmentative and alternative modes, as well as orientation and mobility skills. Organisations such as the Gerald Dirks Scholarship Selection Committee awards one or more scholarships annually, the sum of US Dollars 1000 each, to eligible visually impaired women and men between the ages of 18 – 35 years from a developing country, with preference given to the Africa region (WBUa, 2023). This appears to be very progressing. States parties should therefore, continue lobbying for the inclusion of PWD, though they could be facing challenges on addressing the diversity of learning needs. With concerted efforts, they will definitely get somewhere. The focus should be on the provision of education that was more productive as it was presumed to be one of the keys to empowerment. Education was known to raise self-esteem and lift people out of poverty (House, 2007). Early intervention also holds significant promise in assisting students who were struggling with learning (Jitka, and David, 2016).

In 2007, Inclusive Education was piloted in 3 schools in Kalulushi by the Ministry with support from DANIDA (MoGE, 1997). The evaluation of the project showed some signs of success of the project, and plans were put in place to scale up the project to other districts in Zambia. Many schools, including the pilot schools, did not believe that learners with SEN could learn side by side with those without disabilities within the same classroom. In Gambia, however, Alieu, a blind child used to get the highest marks in Mathematics test from an inclusive class (Sightsavers International, 2022). The inclusive education and special education guidelines (MoE, 1996) indicated that the curriculum for learners with educational needs (LSEN) shall as much as possible follow the Zambian Education Curriculum Framework, which was the curriculum followed by learners in the mainstream schools. The policy went on to say that LSEN who did not benefit from the academic curriculum by virtue of their disabling condition, should have been offered a curriculum that emphasised functional and vocational skills. The curriculum needed to include Braille as a teaching subject for those with VI. The policy however, did not elaborate on the content to be offered in the Braille subject, for this reason, the policy was still far from being realised. Additionally, the policy also stated that the teaching and learning materials should have been adapted to suit the different needs of learners with SEN (MoGE, 1997). The term 'adaptation' tended to be broadly applied. There was need for researchers and policy holders to have elaborated on how the work should have been adapted. The researcher felt that the method of adapting History must be different from that of adapting Science. Even within Science, there are various topics, to adapt a topic 'Environment' may differ with the techniques of adapting the topic 'Density'. The Ministry of Higher Education and Social Sector Plan (2022) argue that they were aware of barriers that tended to hinder the education of persons with VI. The two Ministries proposed specific strategic plans for removing such barriers. Their strategies included adapting the assessment of CSEN, integrating CSEN in early Childhood Education (ECE), providing Alternative Modes of Education Provision (AMEP), construction of CSEN user friendly schools and providing facilities for CSEN at already existing schools (MHESSP, 2022). The programmes by the two Ministries ran up to 2021. The Ministries did not raise the issue of adapting the curriculum for CSEN, suggesting that Zambia is a long way in introducing Mathematics to LVI. The failure to give attention to learners with SEN suggests that their families were being subjected to untold hardships. According to Nongola (2015), parents with children with disabilities suffer a double tragedy, they have lower expectations from their child and by staying at home nursing their disabled child, end up not having enough time for economic ventures. That implied that their families will ever be poor.

The discussion on the search for quality learning for LVI cannot be concluded without looking at assessment. In Zambia, the Examinations Council of Zambia (ECZ) did issue guidelines for the administration of examinations. The proposed 'access arrangements' for learners with disabilities included an increase in the time for writing exams, introducing breaks and having user friendly examinations (CDC, 2013). It was in black and white that it was the role of Ministries of Education to be constantly carrying out research for making all topics accessible to all learners. Nganwa, et al (2017) argues that the guidelines for training teachers for taking charge of children with disabilities were clear, hence there was no need to reinvent the wheel. For Mathematics, English and Science (CDC, 2013) to be declared compulsory subjects by the Ministry, they must have known how to be making access arrangements for all learners to be taking all the subjects. It was not clear how the Ministry provided national examinations for LVI, in the absence of a national adapted curriculum. This appeared to be the trend in many countries (Kelly, 1999). It is not clearly understood why many states did not make efforts to be doing their morale obligations.

Barriers and Misgivings about the Visually Impaired

The University of Illinois (2010) argued that there was a great deal that society could do to reduce, and to ultimately remove some of the disabling barriers. They argued that it was the responsibility of the society to remove the barriers rather than blaming PWD. A recent review of the Ministry's Sector Plan of 2017 – 2021 suggested that one of the barriers to their education was the presence of disabilities. According to UNESCO (2019), the majority of children with impairments do not attend school for various reasons. The barriers included high poverty levels, inaccessible school curriculum and school infrastructure, long distances to schools, examinations and curriculum not well oriented, stigma and discrimination in the society. Stigma is a negative stereotype, a mark of disgrace or unfair belief that the society may attach to a group of people (World Bank, 2022**)**. When a person is stigmatized, she or he may not be supported by the society. Such barriers and misgivings about the VI had greatly contributed to their wellbeing. It was therefore, important that a flexible structure that responded to the needs of PWD was put in place.

The World Bank (2022) had also noticed that PWD encountered attitudinal and environmental barriers that hindered their full and effective participation in society on an equal basis with others. The organisation further argued that disability-inclusive development should be seen as a universal objective to which States were bound. This was according to treaties State Parties had ratified and the international agreements they had adopted. It was argued that participation, non-discrimination and accessibility were prerequisites for fostering social inclusion (World Bank, 2020). Without access to school, proper transport, communication, and information, a person's participation and full inclusion cannot be guaranteed. Hence, PWD will remain unable to fully benefit from developmental investments of many organisations. This World Bank found that children with disabilities continued to face significant gaps in obtaining an inclusive learning experience. They did not have access to reading and learning materials in adapted formats. Personal assistance related to their disability-needs, especially at school were also a challenge. The study further indicated that access to, and the use of assistive devices remained low among children with disabilities. Additionally, it was found that nongovernmental organizations (NGOs) and families were the ones that were the key providers and financers (World Bank, 2020). The World Bank report found that social protection programs played a significant role in reducing the high costs that families with children with disabilities faced. It was also discovered that the lack of assistive devices in schools was due to their high cost and lack of financial support. Teachers did not have the skills for maintaining assistive devices. This suggests that for low-income countries, even the few assistive devices that were procured do not work for a long time. The society therefore, does not fully benefit from the funds spent on them. In short, there was a high need but low uptake of assistive technology by the users. In a research carried out by Nongola (2011), it was found out that some learners with SEN were not performing so well in school due to inadequate food supplements in schools, poor transport to schools, and too much absenteeism. Some teachers explained that most of the learners with SEN were coming from poor families. That applied to learners in both day and residential schools. The children were rarely given some funds by parents to buy foods whilst at school. Parents also rarely visited their children, particularly those in residential schools. The children had to entirely depend on government funding, which in most cases was erratic. Such factors could have contributed to the high poverty levels among PWD, hence making them more vulnerable to many vices. Attitudinal factors also appeared to have been at play, where parents fail to take care of their young ones.

There were also personal Challenges. Pandey (2018) argued that the existence of blindness limited perception and cognition in three ways. It appeared to have reduced the scope and variety of experiences, the orientation to get about, as well as to be able to be in the control of the environment. Some of the barriers people with VI faced, however, may not be directly due to being blind (Nganwa, et al, 2017). In many cases, people did not appear to have accurate information about their rights and opportunities available to them. The workplaces and public transport may also be inaccessible. There could be negative stereotypes and deep lying prejudices about their lack of abilities (Nganwa, et al, 2017). Additionally, some parents did not trust that their children with disabilities could succeed if taken to school, while others thought that inclusive education can cause a deterioration in the quality of education, or otherwise impact negatively on others (UN, 2023). Lack of adequate information appeared to be a source of misgivings that the VI may not manage this or that, and that appear to have negatively contributed to the enormous challenges the people faced.

There was also a challenge to do with getting into meaningful employment. The lack of adequate opportunities for employment among PWD should be of great concern among researchers. The lack of descent employment could have been contributing to some of them leading abject poverty, as they did not have earnings or income to take care of themselves. This suggests that the entire family may suffer economically. The high economic stress may put someone into stress and health problems. People who are unemployed, especially the youth, were likely to be frustrated and have the feelings of social discrimination and inequalities (Jenkison, 1997). They may eventually resort to criminalities and social instabilities.

Persons with disabilities have not been immune to the effects of globalisation. In the world, Pandey (2018) says that globalisation forces have generally changed the shape of trade and business. The new shape, driven by the ever-increasing transnational businesses, free trade, free markets, rapid technological developments, and the ever-changing competitive business environment had largely contributed to the high unemployment rates of PWD (Pandey, 2018). In Europe for instance, it was possible that some of the big companies had laid off some of its employees due to emerging technologies (House, 2007). In order to alleviate the problems affected by PWD, it could have been necessary to put in place austerity policies that could have tried to create a balance between the haves and have-nots. This could mean a review of the university and college curriculum in order to give more priority to the skills and technology requirements by persons with disability in the labour market. Additionally, companies should have been given more incentives for employing PWD, such as tax rebase. Schools for children with disabilities also tended to suffer from lack of adequate teachers.

Before this research was undertaken, many learners with disabilities in Zambia were not performing well in national examinations (ECZ, 2016). This was despite the fact that they were taught by well qualified teachers who had bachelors and master's degrees. Additionally, attrition rates of teachers from special schools to inclusive and mainstream schools had often been too high. In Zambia, the training of teachers in Special Education started with the establishment of the ZAMISE in 1971. ZAMISE was offering certificates and diplomas in Special Education. To be accepted for training at ZAMISE, one needed to be a teacher first. He or she should have already been trained from the general colleges of education as a primary or secondary school teacher. ZAMISE was an in-service institution. It offered a certificate and diploma in Special Education. To learn any of these special education programmes from the institution, it took an additional 1 and 2 years for a certificate and diploma respectively. This was in addition to the years spent in the general colleges of education. This implied that a certificate in Special Education was at least 2 years (1 year for General Education and another year for Special Education). For the diploma, it was 4 years (2 years for General and another 2 years for Special Education). Graduates at ZAMISE at that time were considered to be well-seasoned (Kelly, 1999).

The first Bachelor's degree in Special Education at the University of Zambia was introduced in the early 1990s. Entry to the programme by in-service students was at 3rd year, and one needed to have a diploma in Special Education. Most of the first graduates were employed. But later on many of them had challenges in finding jobs. The demand for employment by the Ministry was mainly based on the teaching subject, which most of the special education officers did not have. These challenges led to the introduction of teaching subjects to trainee-teachers undertaking Special Education. In the late 2020s, ZAMISE also introduced teaching subjects such as Mathematics, Sciences and Computer Studies.

The ordinary diploma from colleges of education for a major, say in Mathematics, took about 3 years. (CDC, 2013). ZAMISE was offering a diploma that had components of both Special Education and the teaching subjects within the same 3 years. The same scenario was followed at the University of Zambia where the degree programme took 4 years. The programme included both Special Education courses and the teaching subject (see appendix C). This is suggesting that some of the contents needed to be reduced from the teaching subject in order to create space for the Special Education courses. The model could also imply that the trainee-teachers for Special Education were not completing the curriculum for both the Special Education and the teaching subject.

Different countries appeared to be following different curriculum models. A few institutions had their curriculum examined. These included the Akita University, Michigan State University, University of Georgia and Akita University. At Indiana University for instance, students taking a Bachelor in Secondary Special Education, allowed students to choose English, Mathematics or Science as a content specialised area, proving that all learners can learn any subject (BBB, 2020). At Michigan State University and University of Georgia, the Special Education programme took about 5 years. The higher number of university training appeared to allow students to engage in rigorous internship experience (BBB, 2020). It also allowed the inclusion of specialised courses commonly known as ‘additional curriculum’ in the UK and ‘expanded core curriculum’ in the US (Willings, 2022).

The guidelines by Jenkison (1997) were that trainee-teachers for learners with special educational needs needed to be adequately trained in the subject matter and also in Special Education. Most institutions of Special Education were only producing Special Education teachers. Such teachers were grounded in areas such as Psychology, neuropsychology, Sociology and

Counselling. The trend had changed to combining psychological courses with a teaching subject such as Geography, History, Social Studies, Mathematics, Sciences and Information Computer Technology (ICT) (see appendices B and C). Such guidelines have also been followed in the Zambia Education Curriculum framework (CDC, 2013). The introduction of teaching subject areas to the curriculum in institutions of higher learning that offered Special Education (CDC, 2013) appeared to have come with challenges. Despite these seemingly good reforms, the graduating teachers still had the challenge on how to adapt Mathematics and Sciences. From the ongoing discussion, if a student was to study both the special education and teaching subjects, it suggested that the trainee-teachers may graduate without completing the two syllabuses. It can also be noticed from the courses in appendices B and C that there were no courses on Adapted Mathematics for the VI. At Michigan State University, they had added additional years to allow for the adaptation of the teaching subject (BBB, 2020).

In Kenya, they had offered regular curriculum subjects such as plus braille, typing and mobility training (Hwang, & Taylor, 2016). It was pointed out that they could not expect learners with disabilities to get into engineering courses. They also expressed challenges to do with inappropriate examinations, markers, and syllabuses not being completed. In Africa, inclusive education has been demonstrated at the primary level and has been improving at the secondary level. However, inclusion is yet to be fully realized in employment and entrepreneurship. The few persons with special needs who have experienced inclusion have demonstrated success, yet some communities are not ready to give them opportunity and support their needs. In Kenya, there also cases of Siminyo, Akinyi, and Bulimi who exceptionally served as role models to persons with disabilities and society. The purpose of this study was to establish the impact of inclusion of persons with disabilities in mainstream society in Kenya in terms of employment and entrepreneurship. The objective was to demonstrate how inclusion practices enhanced acceptance and improved the lifestyle of persons with disabilities. A case study methodology was implemented with people with three different types of disabilities. The study identified the importance of inclusion practices in society. The results established that if persons with disabilities are integrated early enough in life, they can live a fulfilling life in their communities without depending on other people.

There was a growing demand for effectively preparing high-quality special education teachers, and adhering to accreditation standards. Institutions of higher learning in Zambia were regulated by Higher Education Authority (HEA)(HEA, 2018). The institution developed and regulated the legal frameworks governing the provision of higher education in Zambia. The HEA was established by Act number 4 of 2013 in order to set Standards for higher education institutions, quality assurance, as well as registration and accreditation of private higher institutions (HEA, 2018). The University Act of 1999 was repealed and replaced by the HEA. The role of the HEA was to advise the Minister on all matters of higher education, and to establish a coordinated higher education system which promoted corporate governance. It also provided for harmonising of university programmes, regulating higher education institutions and coordinating the development of higher education programmes. It was also formed to promote quality assurance in higher education for auditing the quality assurance mechanisms. The institution was also to restructure and transform higher education institutions and programmes to be responsive to the human resource, economic and developmental needs of the republic. Some underperforming institutions of higher learning were at one time deregistered (HEA, 2018). It is not clearly understood why they did not monitor institutions offering education to learners with disabilities. The other concern was that the teachers themselves were inadequate in schools for learners with disabilities. In Zambia, many special education teachers were offloaded on the market each year. However, there were few teachers in the special education schools. One of the reasons for this imbalance was the fact that the trainers' teaching methodologies appeared to have targeted the sighted learners. These were ones that often benefitted from the blackboard. Upon being deployed, most of the special education teachers failed to offer subjects like Mathematics and Sciences. The LVI needed other methodologies, likely tactile in nature. Some of the teachers therefore, just taught for a few months to years, and thereafter got transfers to the mainstream schools on the pretext of offering inclusive education. This appeared to have caused an artificial lack of teachers in schools for learners with disabilities.

The other challenges were to do with reduced learning time and lack of opportunities after leaving school. The lack of an Adapted Mathematics (CDC, 2013) for LVI in Zambia appears to have impacted negatively on their lives. It is hard for them to have the minimum number of subjects required for a school certificate. Malungo (2018) argues that more than 75% of learners with disabilities performed substantially below their typical peers. They performed below the mean achievement levels. This also suggests that LVI had challenges in accessing higher institutions of learning as well as finding competitive jobs. This implied having challenges in manipulating day-to-day tasks that required knowledge of Numeracy. Hwang, & Taylor (2016) found that STEM disciplines were not being offered to students with disabilities. He argued that these subjects were very important in improving lives in general, particularly for the underprivileged. According to Mader (2017), subjects like History, Science, Mathematics and modern languages were appropriate for students with disabilities. He went on to say that these learners with disabilities were entitled to learning these subjects, and by learning the same curriculum. It was seen as minimising differences between students. The teaching and learning resources ought to have been adapted to give learners with disabilities access to common curriculum opportunities and environmental experiences.

House (2007) pointed out that to enhance the education for CSEN, educators needed to have the skills of adapting the school curriculum. This suggests that institutions of higher learning and curriculum departments should be striving to have enough knowledge for the development of large print materials for the partially sighted. They should also have Braille and/or audio format for blind learners. Definitely, more detailed information needed to be provided to guide the institutions. Special education teachers needed to be well-grounded enough around the adaptation of the school curriculum (Walmsley, et al, 2007). The basic instructional material that was often sought in many schools for LVI was the Braille paper. This can merely be compared to an ordinary exercise book. In fact, even Braille paper has not been highly exploited in its use. Other than just being used for writing in, textbooks, graphics, and several other models can also be made from the paper. Often it was taken for granted that lecturers and teachers were all knowing. There was need to be concerned with the welfare of the learners. The educational sector for learners with special educational needs may seem to be trivial, however, it was very important that the best type of education was provided to the sector. The World Bank (2020) argues that accessibility to quality learning can break a vicious cycle of exclusion. It can therefore, be argued that learners with disabilities did not have access to some subjects not because they did not need them, but because the subjects were not made accessible to them.

Additionally, constraints such as transportation or inaccessible urban environment, had not been made available to them. With accessibility factors put in place, the World Bank (2020) argued that it was possible for PWD to work. If they did so, they would rely less on national allowances. And if they could work and earn a salary, they could definitely become consumers. If their salaries were reasonable, they could contribute to national development through paying of taxes. It was therefore, important that capacity development of all relevant stakeholders was done. Persons with disabilities should not just be empowered. The development of competencies is an essential step in practical implementation of their skills. The Ministry of Community Development, Mother and Child Health (MoCDMCH) (2015) noted that the existing learning institutions in Zambia did not have adequate facilities to cater for learners with disabilities. Most of the schools had insufficient number of materials in braille, and other teaching and learning aids. The UN (2016) also postulated that there were often inappropriate and inadequate funding mechanisms for providing incentives and reasonable accommodations for students with disabilities. Some government Ministries were often discouraged from providing instructural materials for learners with disabilities, because they were perceived to be costly. The limited availability of resources hampered full implementation of policy intentions to supporting the provision of quality education (MoGE, 2018). If the government thought it was a costly venture, it implied that they were not seeing any potential in PWD (Malungo, et al, 2018).

Evidence was suggesting that nations should have invested in the timely development of resources in digital formats (House, 2007). Apparently, the use of digital formals was somehow limited in developing countries whose sources of electricity were inadequate. Computer viruses and inadequate technical staff when they broke, also limited their use. However, it was argued that investment in appropriate technology can facilitate the learning process (Deborah, 1999). It could make certain concepts much easier to learn. The author went on to say that they should also have considered developing standards and guidelines for the conversion of printed material into accessible formats and languages. The barriers faced by PWD were also examined in terms of the type(s) of model followed by some nations.

The social model approach argues that when a child succeeds, it was due to the efforts put in place by the society (Nongola, 2015). The social model advocates towards putting in everything that can be done to help the child. They do not put blame on the child's disability, but focus so much on helping the marginalized in society. States such as Osaka – Japan, followed the social model approach for the implementation of inclusive education. Osaka had a unique programme called "Living Together and Learning Together", where learners with disabilities learnt side by side with those without disabilities (Nongola, 2015). They did not have segregated or special education schools, where learners with special educational needs learned on their own. They strongly believed that those that had succeeded in life, it was because of efforts that had been made by their government, communities and/or parents. Inclusive education required the support and resource system for teachers in educational institutions at all levels. This might have required partnerships between neighbouring education institutions, including universities.

Alkhattabi (2020), however, found that there were students with disabilities that historically followed a segregated medical model in Saudi Arabia. From the study by Alkhattabi (2020), students with disabilities were being educated in the general education classrooms (i.e., inclusive education). The purpose of the survey study was to examine the level of preparedness of general education teachers. It also investigated if there were significant differences in the beliefs of general and special education teachers based on educational background. The results indicated the differences in attitudes between general and special education teachers. Though there were differences in teacher attitudes, the results for both sets of teachers indicated a strong preference for students with disabilities receiving services in segregated settings. Additionally, collaborative practices, team teaching, and study groups appeared to produce fruits (UN, 2023).

There was also the Human Rights based Model, where it was believed that education was a right for all (UN, 2023). According to the organisation, PWD should be given an opportunity to realise their rights to the fullest. Educating learners went beyond just enrolling them in school. They needed to be progressing to higher levels of education. Also related to the Human Rights based Model, was the idea behind the phenomenological approach. This is the idea that each person was ‘unique’. Phenomenology is a philosophical discipline that focused on human experience (Courtenay, 2010). According to the author, the idea of phenomenology is that human beings differed in their experience as well as their interactions with the environment, and with each other. If we approached PWD as individuals, many of them could likely develop their potential to the fullest.

From the above models, it could be concluded that the medical and social models of disability viewed disability and society as a ‘problem’ respectively. The medical condition of a child may be important during the initial days of reporting for school, particularly during assessment. However, the society may need to help the learner in whatever way they could such as the provision of assistive devices. Schools needed resources in order to run effectively. The learners also may require walking aids. Following the social model ensured that the required materials for learning were put in place. Depending on the severity of a problem, patients were often characterized as mild, moderate, severe and profound (Editorial Team, 2023; MoE, 1996)**,** and such definitions have frequently been used by educationists. It followed that if one was a wheelchair bound and had challenges in moving upstairs, the blame was likely put on the use of wheelchairs and not the lacking of accessible facilities. Such communities may not put in much to help children with disabilities. The Human Rights based model was also very important. Learners may be allowed to attend school but if the school was not universally accessible, some learners may be discouraged to learn from it. The phenomenology model seems to be very important in responding to learners' individual efforts. Hence, all the four models were important. In the researcher's view, however, the social model and human rights models needed to be greatly emphasised as they came with commitments from governments and other stakeholders.

The issue of inadequate Special Education teachers for PWD was not only in Zambia but in many countries (Malungo, et al, 2018). Additionally, learners with SEN were usually educated from different classes or units. According to Malungo, et al (2018), teachers sent to such small and far away classes tended to feel marginalised. Such harsh conditions could have probably contributed to the high attrition rates from the Special Education centres. With such a challenge, what then was the rationale for sending the children to schools? It was necessary that infrastructure development and teaching methodologies reasonably accommodated all, including persons with VI. There was also supposed to be universal designs in the planning of the curriculum (DFID, 2001). The World Bank (2022) argues that accessibility should not just be applicable to the built environment; but also, to the written communication. Most of the schools for the VI did not usually have enough library materials in form of books, newspapers and leaflets (DFID, 2001). They also did not provide accessibility to graphics communication in the forms of banners, posters and directions. The posters were rarely in Sign language nor in Braille. The curriculum for the VI was therefore, simply narrow.

The World Bank (2022) recommended that barriers that prevented access to existing facilities and other education services be removed gradually in a systematic and continuously monitored manner, for the sake of achieving full accessibility. The ideal goal of achieving full accessibility lied in the application of the seven principles of universal design: equitable use, flexibility in use, simple and intuitive, perceptible information, tolerance and error, low physical effort, sise and space (World Bank, 2020). Researchers needed to be encouraging States to be implementing universal design and reasonable accommodation for PWD. Universal designs therefore, appears to be the design of products, environments, programs, and services that can be used by all people (DFID, 2001). To the greatest extent possible, they should be usable without the need for adaptation or specialized design. On the other hand, reasonable accommodation generally did not require a significant economic cost or complicated construction activities (DFID, 2001). Some examples could be allowing of more time for students with disabilities during examinations. They should also provide alternative arrangements for exam taking. Oral exams for instance, can be used to help address different learning needs. According to the World Bank (2020), more accessible environments put PWD in a better position to fully reach their potential as human beings. Accessibility also contributed to reducing the level of inequality that may have existed in a country. For example, with universal accessibility, PWD will be able to exercise their right to education and be able to work, therefore, reducing the social gaps.

There also appeared to be barriers to do with stigmatisation and discrimination in the society. Many people tended to see the disability and not the ability. Many families, including educationists were unable to see the potential (Malungo, 2018) that lied within a child with a disability. For the above reason, some children were stigmatised. This may explain why some families fear that their children will catch a disability from children with disabilities while in school (Nganwa, et al, 2017). The blame was put on their disability, even though the fault could be lying with the learning environment (Malungo, et al, 2018). The other challenge seemed to be the misunderstanding of brain development in relation to the visual loss. It was generally believed that distinct areas of the brain carried out certain functions. However, according to Deborah (1999) such a belief was ludicrous. He argues that the brain is adaptive, and in all mammalian brains, destruction of the thalamus results in a loss of consciousness. This is because it controlled the flow of sensory information into the various higher order regions. The scholar further explained that if you connected the visual organs to the traditional auditory regions during development, that brain area grew into a visual processing center instead of an auditory one. Even though the angular was thought to be the Mathematical areas in the brain, the Federal Communications Commission (2022) says that we should not be assuming that all Mathematics was processed in the same way. This was because the brain can shift functions from one area to another. These studies were suggesting that most of the brains of blind people start to channel extra processing through other senses. The author further elaborated that, if we turned off our lights in our room at night, we immediately start to rely on these additional senses to give us cues. That is, our brains were still getting visual data. Upon realizing that the brain was not getting data through sight, the blind man's brain definitely has to start adapting.

Deborah (1999) further argues that the brain was not born preprogrammed. It evolved during development, from conception to adulthood, and gradually adapted to its environment. She further elaborated that the brain doesn't just have a math center. It appears each type of Mathematics was coordinated from a different region. This suggests that Geometry and Algebra may be induced from different centres. It also suggests that if you were good in Algebra, you may not necessarily be good also in Arithmetic. The Mathematics Educators (2020) also say that people who go blind after having seen before retained the ability for visual imagination. It followed that they can still dream visually and presumably do other things like spatial rotation. This may not be true for those who were born blind. Dreaming things they have never seen may be a problem. The Federal Communications Commission (2022) argue that when teaching, it was best to target all senses. We should make efforts to convert a teaching methodology into another modality that may require the use of another sense. This suggests that when trained well, someone with VI could even perform better that the sighted. Many people have seen many persons with VI working in reputable organisations, suggesting that the society played its part in helping them attend quality education (World Vision, 2020). The World Blind Union committed itself to the promotion of full participation, equal opportunities, and protection of the human rights of persons who are blind or partially sighted (WBU, 2023). The do this by promoting braille literacy, lifelong learning, and independent living for blind and partially sighted persons in developing countries.

The list of barriers cannot be complete without mentioning the devastating effects of Covid 19 on the education of PWD. The Center for Disease Control (CDC) (2021) argues that PWD were at the greatest risk for Covid 19 related diseases. When they compared adults with and those without disabilities, it was found that those without disabilities had a higher chance of not having been vaccinated. It was argued that PWD had a lot of challenges in receiving vaccinations. Coronavirus disease (Covid 19) was a new strain that was discovered in 2019. It was from a large family of viruses that caused illnesses ranging from the common cold to more severe diseases. The European Human Rights Report on the impact of Covid 19 of 2021 on PWD, postulated that even prior to the pandemic, PWD experienced widespread discrimination and exclusion (International Disability Alliance, 2022). Covid 19 had merely exacerbated the existing inequalities that resulted in PWD dying at higher rates. This pushed them further into extreme poverty and exclusion from pandemic response measures. The European Human Rights Report postulated that discriminatory medical protocols resulted in PWD being infected in huge numbers with Covid 19. In order to improve the health for PWD, it was recommended that national legislation and policies on health care should be line with the UNCRPD. Obstacles and barriers needed to be identified and eliminated. The health-care personnel on disability also needed to be trained on disability matters. PWD were expected to be empowered so that they can take control over their own health on the basis of informed consent. Since 18th March 2020 when Zambia recorded the first case of COVID-19 (International Disability Alliance, 2022), the education for more than 4.4 million children and adolescents got disrupted. This potentially regressing progress made in attaining Sustainable Development Goal number 4, including the attainment of high-quality primary and secondary education. Children's routines were also not the same, resulting in unprecedented stress among many.

Zambia recorded the first case of Covid 19 on 18th March 2020 (World Vision – Zambia, 2020). That potentially regressed the progress that had been made in attaining Sustainable Development Goal number 4, which considered the need for high-quality primary and secondary education. In June 2021, the Ministry of Health (MOH) announced that the country had entered its third wave of Covid 19, and that vaccinations were to be intensified. The Centre for Disease Control and the Zambian public health officials focused on encouraging people to get vaccinated. The MOH encouraged everyone to follow Five Golden Rules: masking up in public places, maintaining physical distance, washing hands frequently or using hand sanitizer, avoiding crowded places and staying home, and to seek medical treatment early if one had symptoms. According to Iradukunda, & Ananda (2021), there was a suspension of physical learning of schools, colleges, institutions and universities. Virtual learning for schools was introduced on some platforms on televisions. Unfortunately, the lessons were not translated into sign language for the benefit of deaf learners, nor were they in braille for the VI. This suggests that PWD were hit most from lack of information on Covid 19, and from school subjects. Apparently there appears to be sufficient literature for the sighted in the teaching of subjects considered difficult such as Mathematics and Sciences. However, there appears to be inadequate research related to the pedagogy of manipulation of numbers for

LVI. In Zambia, there were Braille Mathematics Notation' booklets by Braille Authority of the United Kingdom (2005). They had content that could be used to teach Mathematics to the VI. Apparently, the books appeared to be difficult for the teachers, the teachers required some training, hence they were just shelved. Schools needed to take time to do some research in order to add value to the services they offered.

Leadership of Special and Inclusive Education

Sometimes it could be difficult to effect change because of the leadership styles that could be in place. Northouse (2016) argues that leaders should be the saviours and heroes for organisations in crisis. He supported the idea that every organisation should have a leader. There were many leadership styles. Masters and PhD students needed to be acquainted with them. It was found sensible to reflect and critically assess the "Path-Goal Theory" in terms of usage and effectiveness in the sector of teaching Mathematics to LVI. Northouse (2016) produced a video of "Steve Jobs Leadership Examples" that explained why some paths were effective, and while others were not. Steve jobs began by trying to make a distinction between leaders and managers. Over the years, leaders have been using different titles. Some were called managers while others called themselves leaders. For head teachers and principals in institutions of higher learning, it was often difficult to make a clear distinction between management and leadership. It appears leadership is an old phenomenon that pre-existed prior to the use of the term management. The modern managers have to go to school and attain specialised papers in specific management fields. In the 21st century, technology has greatly changed. Diversity has increased due to globalisation. Leaders therefore, needed to understand how to adapt to new leadership styles. The overall topmost position in most organisations was being referred to as Chief Executive Officer (Hayes, 2023). Most of the head teachers and college principals have been teachers and lecturers respectively, before they ascended to those top positions. This suggests that they were men and women with vast experience in their professions. Northouse (2016) argues that these leaders could also be categorised according to their leadership styles. These were Autocratic or Authoritarian, Democratic (participative leadership) and Laissez –faire. Laissez-faire suggests that the team members were free to set deadlines and have enough freedom to decide the possible course of actions. In a study that was conducted on effectiveness of leadership styles, it was shown that there was a direct relationship among all the leadership styles with job satisfaction (Northouse, 2016). The failure to introduce Mathematics among the VI appeared to have a bearing among the leadership styles that were practiced in schools.

In the 20th century, the autocratic leadership style appeared to be the most preferred model for most organizations (Northouse, 2016). The author argued that the autocratic leadership style was the trait theory, or the 'Great Man Theory of Leadership' where it was believed that great leaders were born that way. We needed such leaders even then, to be initiating programmes that others thought were impossible and irrelevant. Some senior officers from the government, with positions of influence, needed to be opening up all school subjects to PWD. The trend now was to be more collaborative, and that has given birth to democratic leadership. It was also pointed out by Northouse (2016) that this was a new approach of the modern leadership often known as 'leading followers by goal setting'. This process was based on Path-Goal Theory that argued that leaders should be providing their followers with a clear vision. Democracy has been there for years, with little effect on the curriculum for PWD. House (2007) developed the path-goal theory. It mainly focused on followers' satisfaction and motivation. The theory was premised on four common propositions. Firstly, the juniors at work will and only admit a leader's behaviour if it was a direct cause of satisfaction. Secondly, a leader's behaviour may raise satisfaction if it created the desire for efficient performance through training, support and direction. Thirdly, a leader's job was to increase the followers' emotional and mental condition towards the job satisfaction. Fourthly, the leader needed to decide by the situation over which behaviour should be adopted to increase motivation. By following on such well-focused path ways may likely help our leaders implement some programmes that may reduce the challenges among PWD. According to the path-goal theory, the role of a leader was to give direction, explain the goals to followers, and make the path easy. The followers need to understand reasons for offering Mathematics who cannot see. They need to be acquainted with methodologies for handling the subject.

There were ways in which a leader could perform his or her job (House, 2007). These included identifying the followers' desires and raising their personal payoffs. The leader could also provide direction, train his/her followers, and assist in clarifying expectancies. The leader should also reduce hurdles and increase the chances for personal satisfaction. Leaders that managed schools needed to have this knowledge. There is also Directive leadership style where the head teacher can initiate and give directions to employees and tell them what they have to do and how it should be done (Northouse, 2016). Additionally, Supportive leadership showed concern for followers' welfare and personal needs. Such leaders were friendly, open-minded and created pleasant work environments. Participative leadership style appears to be including followers in decision making process**.** Additionally**,** achievement-oriented leadership includes challenging the followers to perform at their best level. Northouse (2016) explored leadership approaches for possible positive and negative aspects of leader-follower dynamics. These are Transformational Leadership, Charismatic Leadership, Transactional Leadership, and Situational Leadership. Transformational Leadership is thought that through adequate training, managers can learn the necessary techniques and qualities to make them proficient to become transformational leaders.

Charismatic leaders acted in a unique way with their followers based on personal characteristics and specific types of behaviour, such as strong role models for the adoption of beliefs and values in followers. Transactional leadership worked on a contingent reward system with more of a positive reinforcement for employees that performed well, and punishment based on poor performance. Situational leaders evaluate and assess employees based on competence and commitment to perform tasks. Depending on the situation and employee's motivation, leaders will change the degree in which they are supported in meeting the changing needs of employees.

The Apple CEO Tim Cook 2019, outlined 10 rules of success in following the Path-Goal Leadership (Cook, 2023). According to him, you need People, Strategy and Execution. Some people may have skills that you do not have, they are functional experts. As a leader, you should have confidence in yourself. You should be striving for perfection. You should write your own rules on how to achieve success. Additionally, you should stay focused even if circumstances changed. You have got to love your work. You should listen to your gut (feelings, fears). You should not get distracted by life’s potholes. You learn from others, collaborate, argue and debate issues, and respect and trust others. You should stay with the North Star (i.e. your goal) no matter how things try to change. Steve Jobs 1997 also outlined some leadership qualities that can be borrowed when attempting to make change in an organisation. Leadership (House, 2007). Defending his commitment to Apple, and leading followers by a Goal setting, Steve explained to his followers that they needed to be risk takers. They needed to consider everything at work and in the environment as pressing issues. Each leader or worker should be sharing their vision with others. The followers were told not to be making things in the same way all the time, they should strive for improvement. Competition was considered an important element in improving things. He emphasized that what they needed was not necessarily finances, but a plan, distribution strategies and commitment. He advised them that when you invest into the business, change did not happen overnight. He also encouraged firing non-performing officers.

To attempt to implement programmes such as the teaching of Mathematics and Sciences to a category of people highly stereotyped, requires leaders with traits such as those of Steve Jobs 1997. (Watch the video of Steve Jobs 1997 from https://www.youtube.com/watch?v=4RYKtfr-87E). From the video, it can be noted that though his strategies appeared to be very effective, they did not succeed as he proposed. Some of the reasons could be that he never listened to suggestions from the peoples. Additionally, he wanted things to change overnight. Officers may also require further training to understand certain concepts. He fired those that opposed his ideas, instead of trying to learn from their thoughts. The tenets of Steve Jobs's management style could also apply in Special Education. The structure of Special Education in countries like Zambia appear to be weak. There was less representation of Special Education officers in top management. In many cases, big decisions were made on behalf of implementers. Top management may think that they know it well when in fact not. They may go to the extent of buying Braille paper and writing frames, only to discover later that they bought the wrong sizes and types. In many cases, Special Education teachers were the ones that were blamed (Nganwa, et al, 2017) when CSEN did not perform well, when in fact not. Engaging the teachers or democratic type of leadership should be encouraged before major decisions are made. The teachers may appear to be too junior to be consulted, but that should not be the case for this sector. Programmes such as retraining of the teachers the way the managers so it fit were very important.

Being Transparent is another new concept that has arisen in the modern philosophy of leadership (House, 2007). Leaders in modern industry have started to realise that transparency with employees is a critical factor of success. Another new concept that had arisen in the modern philosophy of leadership in the 21st Century was the 'inspiration over direction'. A successful way of leading others was through inspiration over careful direction. House (2007) says that ethical leadership had to do with values, traits and behaviours such as being honest, trustworthy, altruistic and fairness. Another early conception of ethical leadership built on examples of "servant leadership" found in the New Testament. Servant leadership at the workplace was about helping others to accomplish shared objectives by facilitating behaviour consistent with the long-term welfare of followers (House, 2007). Authentic leadership emphasized the value of consistency in their words, actions, and values. It primarily described an ideal leader for organisations. There was also Crisis management, that is, the management required when there was a crisis in a school (House, 2007). Public relations officers were important in the provision of the Ministry's roles before and after whenever there was a crisis. School administrators needed to have this cardinal information. Good governance could therefore, suggest that leadership was clear, and ethics and integrity were observed. It also suggests that the top management may not have experts in the discipline, hence most of those engaged to run the Special Education departments may not easily understand how to be managing it.

The education sector had experienced many challenges that had probably led to the lower standards of education. Among the challenges, was the seemingly rigid structure of the Standards Department under the Ministry of Education (Kelly, 1999). The number of officers was the same at all provincial and district levels regardless of the number of the schools under the provinces or districts. In provinces where the number of schools was too high, enforcement of standards tended to be a challenge. The long distances to districts and schools, coupled with inadequate transport could have made routine visits a challenge. As teachers, the issue of being blind should not have been their major concern because the brain was able to shift the angular brain's function to the auditory side. They needed to be concerned with changing pedagogical skills from the visual senses to tactile ones.

Mathematics and the Visually Impaired

The research also examined reasons why almost all the nations that offered Mathematics to its learners justified the inclusion of LVI to the subject. Despite acknowledging that the subject was of utmost importance, globally, the learners' performance has not been impressive. This study has examined factors that could have been leading to the low levels of Mathematics skills proficiency among the learners, both in the developed and developing countries. The curriculum in institutions of higher learning was also examined to ascertain why trained teachers had challenges in offering the skills of manipulating numbers to learners who were blind.

It is argued that Mathematics was the study of measurements, numbers and space (The Scientific World, 2018). These were aspects that were required on daily basis. The authors explained why the subject was one of the first sciences that humans worked to develop. Mathematics appears to play a vital role in all aspects of life such as time, driving, farming, cooking, accounting, finance, banking and building. These skills required a strong mathematical background. There should therefore, be no discrimination to learning them. Everyone in life was required to solve some problems. We all need to develop the ability to think, to use money to buy things and ensure that we have been given the correct change. This suggests that Mathematics was the pillar of our lives. Without manipulation of numbers, it was thought that we may not resolve many issues in our daily lives (Bogdan, 2019). It entails that in the absence of wages, prices of goods, claims, measurements, taxes, etc., we have to face confusion and chaos. The Scientific World (2018) argues that Mathematics was a powerful tool for global understanding and communication, as it helped to organise people’s lives and prevent chaos. It was believed in helping us understand the world and provide effective ways of building mental discipline. Jitka, and David (2016) argues that Mathematics was a subject that encouraged logical reasoning, critical thinking, problem-solving ability, and even effective communication skills. The authors further pointed out that contemporary life demanded the requirement to have good Mathematical knowledge. It is often said that Mathematics is a language for description of the real world (Hansen, & Gray, 2010 in Bogdan, 2019). This suggests that it plays an important role in our everyday life through our interactions with nature and others. The subject appears to be very important in supporting life and all-round personal development. It significantly influenced learners’ education both in academics and in terms of moral education. These facts elaborate the fact that persons with VI needed to be part and parcel of the benefits of having Mathematical knowledge. After a rich and long-lasting experience in teaching “didactics of kindergarten math activities", Bogdan (2019) observed that Mathematics was a complex activity that was very little talked about in the field of academic research at the university level, yet many disciplines depended on it.

Many sectors in government and in the private seemed to be depending a lot on Mathematics. It was often said that the formulas used in Mathematics were the ones relied upon in nature, technology, architecture, building industry, and in research (Jitka, & David, 2016). Other interesting applications appeared to be in genetics of hypothesis testing. Mathematics was relied upon when creating statistical analysis of quantitative data. When research was processed, it was definitely true that, one needed to have knowledge of arithmetic mean, scattering, standard deviation, etc. It appears, Mathematics was the basis for research methods. Jitka, & David (2016) argues that the use of Mathematics in human life was not only in technical fields but could also be applied in nature. Many at times, we want to use the shortest route to save on fuel, or plan our food so that it lasts us longer. Since it was required for application in the nature, it followed that we should develop pupils' interest in the subject. This was because Mathematics was part of their daily routine. The amount of knowledge of the subject influenced the quality of their life and their professional orientation. It was also postulated that Mathematics was a gate and key of the Science subjects, and according to the famous Philosopher Kant, a Science is exact only if it employed Mathematics (Jay, 2020). This therefore, follows that all scientific education which did not commence with Mathematics could be said to be defective. He further postulated that the neglect of Mathematics could be seen as working towards injuring to all knowledge. It also followed that if one was ignorant of the subject, one could not understand many things in the World. She or he may be unable to understand even their own ignorance, and may not want to seek any remedy. Mathematics appeared to have played a pivotal role in perfecting all Science. In almost every country, there was a growing demand for growth in Science and Technology. Emphasis appears to be given to Science subjects such as Chemistry, Physics and Biology. For one to specialise in all these Science subjects, one needed to have at least basic Mathematics knowledge. Therefore, it was aptly remarked that Mathematics was a Science of all Sciences and art of all arts (Jay, 2020). But how easy is the subject of numbers? Such questions, particularly for LVI required more readings.

The foregoing discussion has demonstrated that Mathematics was very essential in our daily lives. In Zambia, the *1996 Educating our Future policy* (MoE, 1996) recognised Mathematics as a key subject and declared it a compulsory subject for all learners. The Ministry through its 2013 Zambia Curriculum Framework reiterated the same view. It was therefore, made a compulsory subject for all learners at both primary and secondary schools, including colleges of education (CDC, 2013). Apparently, the policy just appears to be on paper as implementation did not include planning for all the learners. Learners with SEN, particularly those with VI were not being offered

Mathematics at secondary level. This could be due to the teachers' lack of skills to handling the subject in accessible formants for the learners. According to Bojuwoye (2020), the disconnect between policy provisions and school practices on special and inclusive education also happened in Nigeria. In-depth individual interviews were conducted with 80 high school teachers. The results revealed teachers' limited knowledge of pupils with disabilities and their special education needs. The participants expressed limited capacities to assess pupils' special education needs. Schools were also reported to be lacking adequate resources to support pupils with special education needs and for inclusive education. The challenges appeared to be global.

Though Mathematics was an important subject, teacher educators, administrators, as well as parents and the public had become increasingly alarmed by the low level of Mathematics skills proficiency among students throughout the United States (Jay, 2020). Many learners did not enjoy Mathematics because it was relatively hard. However, because of its important role in people's lives, it was imperative that the subject was taught to all learners. Many strategies were designed to help learners pass the subject. Early intervention was observed to hold significant promise in adjusting students who were struggling with numbers. The results established that if persons with disabilities were integrated early enough in life, they can live a fulfilling life in their communities without depending on other people (Sichari, et al, 2020). Another scholarly article by Jitka, & David, (2016), carried out a research on the importance of Mathematics in our life. Working for Palacký University in Czech Republic, they sent out questionnaires to selected schools to fourth and eighth grade pupils. Different nations participated in the research. In the Czech Republic, the relationship of the pupils to individual subjects was examined in order to determine the popularity of the subject. It was found that Mathematics ranked last in terms of popularity. Most learners did not like it. In terms of the pupils' marks, the general performance was poor. It was also designated as the second most difficult subject. In terms of importance, however, it was ranked third. It was also argued that we could not entirely make deductions from the pupils' observations without focusing on the teachers' abilities and pedagogies (Wijethunga, & Chandrasena, 2019). In the modern world where employment has become hard to find, there were many teachers who have been employed but were unable to compute numbers, hence contributing to inadequacies by learners.

At Palacký University in Olomouc, in the years 2006 to 2007, a project called Playful Mathematics was carried out, to find out the relationship of pupils to Mathematics (Wijethunga, & Chandrasena, 2019). They also examined whether pupils realised that they would need Mathematics and Natural Sciences in real life. Additionally, they also tried to identify the interest of pupils and students in the sector of technical fields. The guiding questions were as follows: What do you imagine when you hear the word Mathematics? Is Mathematics among your favourite subjects? Which Mathematical topics did you like? Do you solve tasks at school which you might encounter in practice? The questionnaire included both closed and open questions. In the closed questions, the pupils and students could choose Yes or No. In other questions, they chose one response from Excellent, Commendable, Good, Sufficient and Insufficient. Some of the findings were as follows: Primary-school pupils had most difficulties with Geometry. It was observed that Mathematics was not a popular subject in primary schools. It was only a favourite subject to 31% of the primary-school respondents. In comparing the performances of girls and boys, it was found out that the popularity of the subject was more or less the same with both genders (Wijethunga, & Chandrasena, 2019). In terms of specific topics, most of the students had challenges with Geometry, Combinatorics and all topics. Easy topics were found to be Trigonometric functions, Vectors and Roots. In addition, about 69% of all the primary-school respondents stated that Mathematics helped them in solving practical tasks. A prominent area where they applied the subject was when shopping and seconded by economy. The pupils also mentioned that the knowledge of numbers was important for teachers of Mathematics, Biology, Physics and Chemistry, as well as builders and bankers. These were very important jobs that were needed in order to survive. With regards the difficult in the topics, it was explained that it depended on the quality of the teachers, the availability of instructional materials and how the materials were organised (Kendra, 2022). There were also other challenges to the offering of Mathematics to students with VI.

In Nigeria, Oyebanji, and Ubong (2021) postulated that the development of skills and comprehension of many topics depended on their spatial sense. Spatial sense was defined in terms of the mental understanding of shapes, size, distance, orientation, and location. Other topics that dependent on spatial sense were fractions, measurement, estimation, the number line and map reading. Oyebanji, and Ubong (2021) argued that the ability to understand such topics provided background for understanding advanced topics such as algebra, trigonometry, sets, matrices, probability and calculus. In a related study, the Americans with Disabilities Act (ADA) mandated U.S. institutions of higher education to provide reasonable accommodations to students with disabilities, to ensure that was equality of educational opportunities (Holt, et al, 2019). However, the U.S. institutions only had limited resources that existed for the teaching of physics to students who were blind or with VI. This was despite the fact that Physics played a pivotal role as a gateway to STEM subjects.

According to Adelakun (2020), many school subjects taught in schools used diagrams, more especially in Science and Mathematics. Accessing such diagrams in an inclusive classroom was identified to be one of the problematic issues for blind students. Teachers tended to omit most of the diagrams leaving the blind people to access only portions of education received by their peers.

In the same vain, some questions with diagrams were treated as bonus for blind students in some countries which was seen as not being fair to them. According to Carole, & Erin (2009), the future lied in providing the blind student with access to information conveyed in graphics such as maps, figures, charts and graphs. Yesilada, et al (2004) in Carole, & Erin (2009) argue that this type of graphic did not lend itself particularly well to audio description due to the spatial nature of the information. The researchers pointed out that though most of the spatial information to the blind was being given in the form of tactile graphics, using embossed paper to represent lines, shapes and other forms, audio descriptions were also important. Although tactile graphics were extremely valuable for the blind user, Adelakun (2020) says it can be difficult to include enough information on the page due to physical space constraints. There was also a study that explored the efficacy of STEM Kit diagrams on participation and inclusion of blind students in science lessons in two case schools in Nigeria (Adelakun, 2020). It collected data through classroom observations, and from teacher and student interviews. It was found that there were diagrams in the STEM Kit that were accessible to LVI. The findings of this study suggested that it was possible to make adequate accessibility of diagrams to blind students in inclusive settings. D'Agostino (2022) also argues that symbolic and spatial, though important for comprehending and learning physical and natural sciences, were not readily accessible to blind students in the diploma and undergraduate Chemistry classroom and Physics laboratories. Such types of lessons created a disadvantageous and inequitable situation. Researchers have a task of finding appropriate instructional methods for enhancing the learning outcomes of a diverse student classroom. By considering the teaching methodologies and universal design pedagogies, learners who are blind could be transformed from a passive experience to active ones.

Yingkang (2022) carried out a research in the area of teaching aids necessary for teaching Mathematics. The research postulated that good teaching aids made learning become joyful. The main research questions that were followed were: How are the designs of the application of the teaching aids for children with disabilities? What were the results of such designs? The objectives of the research were that of fostering imaginative mathematical thinking in the students. They also intended to test whether the design of teaching aids was suitable for children with disabilities at Extraordinary School. The findings were that imaginative skills had begun to grow following the use of well-designed teaching and learning aids. Learning was also found to be joyful. Institutions of learning needed to be making their education induce imaginative thinking in the learners. They should also be very motivating and exciting.

It was also argued that the knowledge and skills that Mathematics teacher educators needed to have, was a fundamental issue for influencing the learners' preparation and development (Yingkang, & Cai, 2022). From the findings, the interviewees generally agreed on the importance of school teaching experience. They identified various aspects of school teaching experience that were related to the knowledge, competency, and disposition needed for teaching Mathematics. However, they also found that the school teaching experience did not connect so well with educational theories and research. The study further suggested that though teaching experience was necessary, it was insufficient on its own for teaching. The study emphasised that teachers needed to be well trained.

Oyebanji, and Idiong (2021) investigated the challenges of teaching Mathematics to VI students in a school of the blind. This was a case study of some selected schools for the VI. Questionnaires and interviews were used for data collection from the respondents. The hypotheses in the study were tested using t-test with significance level of 0.05. The study followed a cross-section survey design and involved 80 respondents that included VI students, 10 Mathematics teachers, 10 special Mathematics teachers, 40 low vision and non-VI students. A close analysis shows that the sample sise was almost the same as for this study. The findings revealed that the VI students were receiving bursaries from the government and non-government organization. They were also given meals, accommodation, and few scholarly materials. Extra time was given during Mathematics classes. There were examination supports. However, there were constraining limitations in the method of instruction and assessments. One of the recommendations the study had proposed was that of encouraging the LVI to continue pursuing Mathematics. The study also encouraged the employment of Special Mathematics teachers. Simalalo, M., & Hambulo, F. (2019). Definitely without employing the teachers, would-be teachers may not be encouraged to join the profession.

The studies by Kohanová (2007) postulated that there were special high schools for VI students in Slovakia. However, the students were mainly oriented on music and some handicrafts. The author further pointed out that there was a growing demand for learning Mathematics even in Special Education schools. In Slovakia, the teachers were noted not to be specially educated in this field as they were using "trial and error" methods. The LVI lacked educational materials and limited Braille notation for learning Mathematics. The VI students at the level of secondary education mastered the basic mathematical operations of addition, subtraction, multiplication and division. However, challenges were noted as the knowledge or topics became difficult to teach and learn, with limited Mathematics braille codes. The scale of mathematical knowledge increased very sharply in all fields in advanced grades. This was in the disciplines of Algebra, Probability and Geometry. Hence, they needed to overcome a lot of other new challenges, especially with Braille notation of all new symbols. Kohanová (2007) argued that the scenario was the same in several

European countries. They had challenges with rules for notation of mathematical text. Since, the education systems did not put in sufficient rules, the VI students had been creating their own particular mathematical language they could make sense from. This is the idea behind the *theory of didactical situation*, where new knowledge could be acquired through setting up active learning situations that allowed learners to carry out interactions on their own (Brousseau, 2022).

The Federal Communications Commission (2022) argued that the source of weaknesses in learning Mathematics was students with VI's mastery of the basic concepts. Failure to master the basic skills was thought to be influencing the achievement and proficiency of pupils in mathematics at a higher level. Strategies for improvement were proposed in the areas of accommodation, adaptation and having a parallel curriculum. In the area of accommodation, the LVI were to be using books of audio format, braille books, large-print books and closed-circuit television. The curriculum was also required to be adapted by adding extra effort and time. By Parallel Curriculum (parallel instruction), that meant having a curriculum that was highly enriched. The author was however, not explicit in the explanation. The Federal Communications Commission (2022) says that the Mathematics curriculum for blind students should be the same content areas as for the sighted students. The instructional materials and methodologies, however, could be different. It is gratifying to note that Jenkison (1997) had given examples on how the VI could learn Coordinates in Mathematics. This could be done by printing out a tactile grid, or using braille, or puff paint, and then using push pins and rubber bands for the lines.

The mastering of Mathematics skills was one of the key abilities for understanding subject (Salamonczyk, 2020). The presentation of information graphically was found not to be easy for common pupils. Topics such as graphs of functions and geometric shapes, were mainly presented in the forms of graphs. The article on mastering of Mathematics examined one of the approaches for using aural interface in the presentation of graphs to blind students. The method was presumed to be especially important for the recognition of graphics by the blind. It was based on two steps of Mathematics graphic recognition. The first step was the general recognition of graphs using synthetic speech. The second step was the conversion of a graph data to sound waves with different attributes. Seven students were examined. It turned out that the use of mathematical graphics in a tactile way, interfaced with aural, and gave quick and good results. This methodology appeared to be effective, hence more research was needed to be conducted in this discipline in order to remove some of the impediments to learning the subject. In the modern world, there seems to be several methodologies that were emerging. In the United States, the Council for Exceptional Children (CEC) (2023) argued that special education teachers needed to undergo many years of training than the general education training. This was consistent with ICEVI (2007) that argued that student teachers must be a General Education teacher first, and a Special Educator later. The additional specialised courses demanded that additional years were to be added. The CEC (2023) also supported this view. They pointed out that special education trainee-teachers needed to be spending the last years of training on an internship in a classroom under supervision. Some institutions appeared to have made some head way. ICEVI (2023), in its book, ‘Mathematics Made Easy for Children with Visual Impairment’, explained how to teach almost all topics in Mathematics to LVI. They have explored how various assistive technology devices such as the Abacus can be used in computation. According to Nongola (2015), learners with disabilities in Osaka-Japan performed competitively in almost all subjects. The policy of ‘living and learning together’ in inclusive education, appeared to have been a good formula. They worked so hard and were committed to meeting the education needs of each child. Shinde (2021) had an interview with an educator with experience in classrooms in both Japan and the U.S. The study was conducted based on a theoretical framework. The results from the case study revealed that culture and legal structure were key components in the outcome of the nature of inclusion practices (Wendland, 2021). Hence different countries could be applying it differently as long as the objectives were achieved.

Use of Assistive Devices

The study by DePountis, et al (2015) investigated the abilities by teachers to using assistive technology purported to be effective for teaching numeracy skills to students with VI. The authors discovered that schools positively responded to this theory and were procuring assisting devises for the learners. Teachers were also being trained on how to use the devices. The students appear to have benefited a lot as they were able to take many subjects in school, hence they could compete favourable with their sighted peers. By taking many subjects, it gave them more opportunities for selection for further training and better jobs. DePountis, et al (2015), however, did not mention the extent to which the assistive devices were aiding in the teaching of the subject. Mathematics has a lot of topics, and it was necessary to also explain how each of the topics could have been handled. Additionally, were the assistive devises readily available? Can a teacher who is blind also teach Mathematics to another blind person? These questions demanded further research. It was also thought that having co-teaching between a regular Mathematics teacher and a Special Education teacher served students with special needs much better (Walmsley, & Hickman, 2007). The researchers definitely found weaknesses in teaching the VI by either of the parties acting alone. The two types of teachers appeared to have different skills, with the Mathematics teacher having the content of the subject. On the other hand, the special education teacher had tactile skills. If the two worked together, the results could have been quite impressive. Managers needed to be encouraging such innovations by allocating more resources for research.

Another interesting topic was how the emergency of digital technology in Numeracy had rapidly developed in our time. The technology had not left out learners with disabilities. The study went on to find out how much information could be accessed by LVI with access to enhanced technology. It has also looked at simple low technology adaptations for students with mild VI. Additionally, it has also researched on places where assistive devices could be procured. It was also thought that it should examine the quality of education control mechanisms in the Ministry of Education.

Of particular importance in this research was the knowledge behind the use of the Abacus for enhancing the learners' skills**.** Efforts were also made to explain the Abacus and other assistive devices. Before getting into these various subjects in detail, it was important that the reader was familiarised with the purpose of this research. Most of the people learnt Mathematics visually, but the VI or blind learners largely learnt it through non-visually. This suggests that the methods ought to be used to teach the blind people should be different from those with sight. Kendra (2023) aptly argued that some fields were highly specialized. The emerging generations therefore, needed to acquire more knowledge and skills on how to be using such technologies, not only in their school life, but also for independent life (Jitka, et al, 2020). Developing countries such as Zambia, have started embracing Computer Studies as one of the learning subjects in the school curriculum. In the Czech Republic, Jitka, et al (2020), says that existing curricular documents at the national level were being reviewed to accommodate digital literacy. The focus in the area of Mathematics was both the development of Mathematical literacy and digital literacy. There appears to be a difference between the two terminologies. Mathematical literacy is the individual's capacity for formulating and interpreting Mathematics in a variety of contexts, where as digital literacy was the ability to use digital technology by evaluating and creating information (Jitka, et al, 2020). From the ongoing discussion, it can be seen that one needed to understand both digital and mathematical literacy. It also suggests that the goal of teaching Mathematics in the modern world should be in both areas. Digital literacy referred to the use of digital technologies such as smart phones, lap tops, iPads, desk tops etc. To effectively use these devices, each learner needed to have their own personal appliance. However, the cost of the devices was not to the reach of many families. Additionally, with attitudinal challenges towards LVI, it was likely to take too long for nations to realise that they also needed similar innovations. The lacking of alternative materials can be improved upon by investing in digital tactile graphic inputs. In the case of digital tactile graphics, the ICEVI (2023) says that they should be simplified according to the characteristics of tactile discrimination. The author further said that there should be a variety of alternative learning materials to help LVI to be accessing information independently. With the campaign by the UN not to leave anyone behind, digital literacy in curricular reforms should be one of the main objectives for all learners. The subject of Mathematics, being primarily visual in nature, could have been presented to VI students with many challenges (Oyebanji, et al, 2021). It was therefore, imperative that teachers implemented certain methodologies to provide LVI with an effective Mathematics education. The traditional pen and paper methods for learning purposes were not good enough. They needed something different. In this section, the role of assistive technology to the teaching of Mathematics to LVI has been discussed.

It is argued that assistive technology can level the playing field (Yolanda, & Jennifer, 2021). For students with VI to access the same educational opportunities as others, they definitely needed the technology. Technology was ever and ever becoming more sophisticated. This suggests that educational opportunities for students with VI must also be in abundance. Both high- and low-tech devices take barriers away from students. This therefore, helped them to read, write, solve maths, and other academic tasks, as well as participate in classroom activities and projects with their peers. Assistive technology could include any device that aids in a student's learning. Although assistive technology should not give students a due advantage (Yolanda, & Jennifer, 2021). The authors argue that they should provide LVI with the least restrictive environment to promote independence and academic progression. Thanks to technology, there appears to be a possibility to develop a wide range of tools, devices, and strategies that can be helping the learners with everyday tasks. Such an approach allowed them to accomplish tasks that would otherwise require the help of other people. Assistive technologies may include software and hardware. These can help people with different types of disabilities to break the barriers and reach better results in education and other spheres of life. To teach the LVI, teachers needed to have skills of how to modify their teaching strategy. According to Oyebanji, et al (2021), you can start with the use of regular objects to teach a number of important basic Mathematics concepts to LVI. We therefore, need to be a little innovative. This sounds to be an easy step as simple teaching and learning materials were everywhere in our environment. With a little bit of more improvisation, basic arithmetic operations such as addition and subtraction should be taught with easy. The use of containers may appear absurd to some teachers, but it is a known matter that children enjoy hands-on learning experiences (Aydın, et al, 2020), hence combining it with Mathematics could be extremely satisfying from the learner’s point of view. It is argued that teachers should be allowing the use of visual aids and assistive technology (Federal Communications Commission, 2022). The organisation indicated that when presenting visual aids to LVI, they should be clearly described. For example, if one was showing a picture of an Abacus to emphasise a point, he or she should also describe its features. To the contrary, ICEVI (2023) argues that the picture should be given to the learners in advance to allow for familialisation before the lesson begins. The types of assistive devices exemplified in the

National Disability Survey for the LVI (CSO, 2018) were magnifying glasses, telescopic lenses/glasses, enlarged print and braille. It appears that Zambian schools were not using assistive devices such as abacuses and geo-boards. It was often said that the education outcomes should be the same for all learners (Akita University, 2023). Teachers therefore, needed to ensure that all of their learners had an equal opportunity to succeed in their subjects.

Salend (1998) identified a number of strategies as a way to promote Science and Mathematics literacy for learners with disabilities. It was argued that instructional materials should be organised around big ideas and interdisciplinary themes. Students should be engaged in cooperative learning groups. In addition, adaptations, and accommodations in Science literacy could involve teacher demonstrations, pupil-led investigations, as well as extended time. Since Mathematics was often taught using a lot of visualization in helping the blind, wikiHow (2019) postulates that one should also get into the habit of dictating what you are writing on the whiteboard. With careful oral instructions, this allowed learners who were unable to see on the board to follow along. When it came to seeking the teacher's attention during class, wikiHow (2019) says that you should replace visual cues with audio cues by asking students to clap when asking a question. The traditional way was to ask learners to raise their hand if they wanted to speak during a lesson, but the LVI or blind students may not notice when their peers raised their hands. The ICEVI (2023) argues that a complete course for teaching the blind should comprise of Braille Maths Code, Creativity & Use of Assistive Devices. Mathematics Braille codes should either be RNIB or Nemeth system. It was argued that the growing preference was for the latter, as the symbols appeared to be easier to memorise. The use of assistive devices such as the Abacus, and Creativity and Innovation (Oyebanji, et al, 2021) in handling various topics were greatly encouraged. Mathematics, like any other subjects, is made up of various topics and sub-topics. One of them was Algebra, which was about finding the unknown or about putting real life problems into equations and then solving them (Cook, 2023). Algebraic problems could be in the form of addition, subtraction, multiplication and division. Such problems can also be computed using the Abacus. However, when the learner wanted to write in the book or one needed to read the question, the work needed to be in braille. This suggests that LVI should also have the knowledge of reading and writing in Braille. Jenkinson (2020) went on to say that to enhance the cognitive level of learners, we should use a variety of real materials/objects related to the topic. Whereas the sighted may require various methods that involved the use of the blackboard, the blind should use the use abacuses and the Nemeth code (ICEVI, 2022). For solving algebraic equations however, he further postulated that blind learners should be using the Nemeth code as it was difficult to recall all the steps and not lose your place when using the Abacus. There was an important thing to understand when it came to the cognitive development of LVI. It was argued that the majority of LVI did not have any cognitive impairments (MaxiAids, 2020). This therefore, implied that there was no need to develop sophisticated learning programs to increase their ability to get educated. With the help of technology, these students should be able to learn and perform just like any other learner. By applying different practices, teachers can help LVI to use various tools to participate in the curriculum with a high level of independence. Such an approach will enable students to acquire the skills required for independent living and getting higher education. The society can help the learners by changing the depth of information and the way this information was presented. Since each student was unique, assistive technology should take many forms. Having discovered that the blind can learn Mathematics using assistive devices, several organisations went into research for the manufacturing of devices. According to a particular situation, MaxiAids (2020), says a technological solution can be pretty simple or quite complex. Handheld magnifiers, refreshable braille displays or custom eLearning services were examples of assistive technology tools. Other devises were screen magnifiers, auditory-based technologies, web and desktop applications, web and desktop applications, geoboards and the Abacus.

Figure 1

Some Graphics Aids for Mathematics

. Geoboard MathTrax

Adapted from the Understood Team (2020)

To teach the basic arithmetic operations of addition, subtraction, multiplication and division to the VI, many experts recommended the use of Geoboards and the Abacus. According to D'Agostina (2020), the Abacus is an ancient calculating device invented centuries ago. However, that may not make it less important. According to Dick, & Kubiak (1997), many interesting activities that can be done on geoboards. They included exploring properties of polygons in order to determine the relationship between a polygon's number of sides and the sum of its interior angles. Such software programs as The Geometer's Sketchpad (Dick, & Kubiak, 1997) can also be helpful in exploring these and even more sophisticated geometric relationships.

Geoboards are also perfect tools of providing hands-on effective geometry and shapes lessons to LVI (D'Agostina, 2020). They were thought to be effective on hands-on lessons on geometric topics like: shapes, rotation, reflection, translation, similarity, co-ordination, right angles, counting shapes and figures, patterns, congruency, area, perimeter, scaling, classification and position (Oyebanji, et al, 2021). There were also several other devices. Some of those that have been found to be beneficial for teaching Mathematics include braille meter stick, the Analog model clock and the tactile thermometer (Study.com, 2020). A Braille meter stick has raised lines for every centimeter and meters. Students having VI can use the meter stick for measurement purposes. The Analog model clock has raised markings for effective hands-on math lessons related to time. It was recommended for use for students with VI. The tactile thermometer can be used to teach various temperature-related problems to students. Definitely, several other key materials are available on the market that can serve the purpose of teaching Mathematics effectively. The products can easily be accessed online. This was proof enough that somewhere in the world, LVI effectively learnt Mathematics.

Other scholars also needed to find out how they could implement the similar programme in their respective countries. The Understood Team (2020) argues that the main source was online. The organization also stated that most desktop and laptop computers have built-in AT options like calculators. They may also have some software programs to help kids with math. Mobile devices (like tablets and smartphones) have built-in AT. We are also advised to add math tools to our mobile devices with apps. Chrome browsers on any device were also known to have some built-in AT, too. Chrome apps and extensions can be used to find specific tools to help with math. In this study, so far, examples of organisations where such tools can be sourced has been given. They include the International Council for Education of People with VI, Bright Hub Education, The Understood Team and MaxiAids. The vision by these companies for manufacturing these devices implies that Mathematics was possible by LVI.

Bright Hub Education (2022) argues that if teachers, occupational therapists and other professionals were to work as a team, it could be relatively easier to meet the student's needs for assistive technologies. The officers were from different disciplines, hence, augment each other in terms of knowledge. According to the author, discussions were required around special adaptations, procurement of materials and sourcing of support staff. The author argued that students who attended schools that had specialised services for the VI may have opportunities to use more advanced technologies. They may also have access to a teaching team that works in collaboration.

The Understood Team (2020) also exerted their energies into developing assistive technology (AT) that could be of big help for people who struggle with Mathematics (Understood Team, 2020). The company manufactured various Mathematics tools. Among them were calculators. Others tools were digital graphing tools. There were also various kinds of calculators for the LVI that ranged from graphing calculators to computer apps. Some of them could even solve equations with variables. E.g. for equations $x = -b \pm \sqrt{}(b^2 - 4ac)/2a$. and $y = x^2$. Learners with VI who took algebra or calculus could use these tools to solve graphing problems. Drawing tools helped with drawing lines, shapes, angles, and other geometric features. According to The Understood Team (2020), embossed tools like rulers, stencils, and protractors can help with drawing for LVI. There were also specific computer programs for drawing. According to ICEVI (2023), learners who were sighted can insert pencils into the compasses to draw, but the LVI can use crayons, as well as tracing wheels. There were also manipulatives. According to the Understood Team (2020), manipulatives were objects that can solve Mathematics problems in alternative ways. Classic examples such as the Abacus can be used to compute problems by moving beads in front and backwards.

The researcher argues that with the Abacus, you will be able to provide your learners with a number of math lessons such as counting, adding and division. It was also a hands-on form of education which appeared to be immensely beneficial for LVI. The Abacus has columns each with 10 beads. From the right most, the columns were classified as units, tens, hundred, thousands etc. Engaging with the abacus, was however, not that easy as it required one to have good knowledge of multiplication. It also requires time and practice. Graphics of abacuses are shown in figure 2.

Figure 2

Types of Abacuses

Illustrations adapted from ICEVI (2023)

Summary of Literature Review

The research purpose was mainly to find out if it was possible to introduce Mathematics to LVI. It was meant to find out the possibility of empowering teachers and lecturers with knowledge, and its counter effects on the blind learner. It focused on ensuring that LVI received their right to quality education (UNESCO, 2014). It also hoped to validate the assertion that the 'Abacus' was an effective assistive device for teaching Mathematics to LVI (Jenkison, 1997).

The literature review examined various theories in an effort to understand the issue at hand. Some of the key theories that helped to shape this study included the Connection Theory (Edward, 2023) which suggested that individual neurons had very little power on their own, but when interconnected, could do great works. This theory implies that the special education teachers persee may not manage to teach Mathematics to LVI effectively. They may need to be working closely with technocrats of the subject 'teachers of Mathematics'. The Gestalt theory (Bustamante, 2023) also reiterated that educationists should not be making judgements based on the loss of a sense organ, but look at the senses in totality. According to Nganwa, et al (2017), these were negative stereotypes and deep lying prejudices that have not been proven. According to Deborah (1999), the brain circuits were able to shift from the virtual cortex to other regions such as the auditory areas. This implies that a person who is blind may still be able to learn using the remaining senses. There is also the *theory of didactical Situation* (Brousseau, 2022), that has widely been referred to. This theory indicated that the education system should be setting up situations that should allow for topics to be rigorously discussed by teachers as well as by learners. In case of some challenges on their way, the teachers and learners may find their own solutions. This is to say that sometimes the receipients (learners or teachers) were capable of constructing their own symbols or methods when they meet challenges.

A more interesting theory was that of Howard Gardner's *multiple intelligence theory* (Kendra, 2023) which argued that there were different types of learning. If some of them were exploited, LVI could greatly benefit in the learning of Mathematics. The multiple intelligence categories such as logic-mathematical, visual spatial and body-kinesthetic if well harnessed could reduce the challenges of teaching Mathematics. Some disciplines were quite specific. Mathematics for LVI appear to be a specialised area. The sector needed to be recognised as a specialised area, in order to attract investment. Howard Gardner's theory was supported by Johan, and Hans (2020) who investigated the effect of an intervention on the braille readers' performance in reading and comprehending mathematical expressions. They also looked at the braille readers' ability to make well-founded choices for the use of the braille display (Pel, & Steen, 2020). A pre- and post-test were administered. For mathematical braille reading skills, the percentage of correct answers increased from 22% to 41%, while for speech comprehension, the percentage of correct answers just increased slightly, from 56% to 59%. The results suggested that improving mathematical braille reading skills was the key to better mathematical performance. The use of Braille or tactile strategies were quite unique, and needed to be promoted.

As a way of appreciating Howard Gardner's theory (Kendra, 2023), a conceptual framework was developed. To proceed from the analysis of theories, some factors were considered very important for review. These included understanding who the people with VI were. It was also important to discuss the policy and legal frameworks that guided their education. Additionally, the leadership styles that were being applied in Inclusive and Special Education schools were also to be looked at. Furthermore, the matter of barriers and misgivings for persons with VI appeared to be of great concern. The importance of Mathematics and LVI also needed to be discussed. Since the use of Assistive Devices for teaching Mathematics was noted to be bearing fruits in some countries (Willings, 2022), it was found prudent that more details on the subject were made available. The Abacus, in particular, was the key among the assistive devices. There was need to learn more about the tool. The cons and pros about the tool also needed to be made available to the readers.

The educational definition must stress what was required for the LVI to learn (Adelakun, 2020). These strategies included the use of braille, aural methods and abacuses. According Sheila (2019), the prevalence of persons with VI was about 0.1 % of the population. In the national examinations, these learners, being part of learners with disabilities have been fairing quite below average (ECZ, 2016). The Ministry of Education and Culture (MoEC) argued that many college principals did not clearly understand how the deaf or blind could learn Mathematics or Science (MoEC, 1996). These learners therefore, did not appear to be enjoying their right to quality education. Besides understanding who persons with VI were, some policies were examined in relation to their education. These included the 1989 UN convention on the Rights of the child, the World Declaration on Education for All of 1990, the UNESCO Salamanca and Framework for Action of 1994, the Dakar Framework for Action in 2000, and United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) of 2006 (ACBRAN, 2017; UN, 2023). Zambia enacted the 2012 Disability Act and domesticated the UNCRPD of 2006 2015 into the Disability Policy of 2015. Good policies appears to have been framed, however, the education that was being provided to LVI was still far below the desired standards of education. Another factor that needed attention was the consideration of disabling barriers.

The societies just needed to reduce, and to ultimately remove some of the disabling barriers. Some of them included high poverty levels, inaccessible school curriculum and examinations. Learners with disabilities did not appear to be doing well, partly because of the seemingly rigid curriculum (World Bank, 2022**)**. Stigma and discrimination in the society just needed to be dealt with. Such measures could have definitely improved their wellbeing. The conceptual framework also identified 'leadership styles' as a factor that needed attention. According to Northouse (2016), leaders should aim to be the heroes for organisations. There were many leadership styles. These included the Autocratic or Authoritarian, Democratic (participative leadership) and Laissez –faire. In the 21st Century skills, democratic principles appears to be the preferred leadership style. Whatever the style, some paths have been effective while others have not (Northouse, 2016). Some organisations such as the ICEVI (2022), Michigan State University and Akita University (BBB, 2020), appears to have succeeded in introducing Mathematics to LVI. Any organisation with the 'will' should be able to make it.

The conceptual framework also examined whether Mathematics was really essential for persons with VI. According to The Scientific World (2018), globally, learners' performance in Mathematics has not been impressive. However, Jitka, & David (2016) argued that despite its difficult, the subject was important for supporting life and all-round personal development. It was a subject that significantly influenced learners' education both in academics and in moral education. It was argued that most of the formulas used in Mathematics were the ones relied upon in nature, building industry and research (Jitka, & David, 2016). From the foregoing discussion, because of the seemingly importance of the subject, it was declared a compulsory subject for all learners (MoE, 1996). By learning the subject, that was likely to give them more opportunities for further training and better jobs.

Kendra (2023) aptly argued that some fields were highly specialized. For students with VI to access the same educational opportunities as others, they definitely needed methods such as the use of assistive technology (Yolanda, & Jennifer, 2021). Through research, organisations such as the ICEVI (2023) and Understood Team (2020) have developed classic assistive devices such as the Abacus for computing Mathematical problems. The Abacus could be used to add, subtract, multiply and divide by LVI. It appeared to be a good tool as the mentioned basic operations were required on nearly every topic in Mathematics. Whether it was fractions, probability, linear programming or matrices, the basic operations of addition, subtraction, multiplication and division were always there.

CHAPTER 3: RESEARCH METHODS

In an effort to determine the effectiveness of using assistive devices in teaching Mathematics, the ‘Research Methods and Data Collection’ chapter has been divided into the following sub-chapters: ‘Introduction to the Section, the Population and Sample of the research Study, Materials/Instrumentation of research tools, Operational Definition of Variables, Study Procedures and Ethical Assurances, and Data Collection and Analysis’. The main purpose of this research study was to find out if the use of assistive or adaptive devices, in particular, abacuses could aid to the teaching of Mathematics to people with VI. This category of people has challenges with sight, and belong to the large group of people often identified as children with disabilities (Adelakun, 2020). The lack of Mathematics, sciences and engineering disciplines in most curriculum for the VI in secondary schools and institutions of higher learning was considered for research because the existing curriculum appeared to be disadvantaging them to many educational opportunities (University of Illinois, 2010). This category of learners did not appear to have been fully enjoying their right to quality education. The Understood Team (2020), however, argued that various areas of Mathematics could be adapted for the benefit of these learners. Several universities such as Akita University (2023) supported this view and had been engaged in adapting Mathematics for LVI. This suggests that sooner or later, the innovation by Akita University and other organisations shall reach many other lands.

In many developing countries, Zambia inclusive, the major methodology of teaching Mathematics was the use of the blackboard and chalk. This pedagogy appears to have been disadvantaging LVI. It was often argued that schools had challenges in teaching learners with SEN (Kelly, 1999; Derrick, 2012; MoEC, 1996). This entails that more research especially in developing countries needed to be conducted in order to enhance teachers' methodologies. The research study by Simalalo (2012) found that teachers' attitudes and the lack of instructional materials were the major contributing factors to the inadequate performance by teachers for LVI in Mathematics. The study, however, did not specify the type of methodology that was lacking, and could have likely helped scholars to intervene in the matter. Additionally, examples of the exact effective teaching and learning materials were not explained. This study has filled-in some of the gaps in the previous studies. This study has found that the challenges being faced by teachers in handling Mathematics for LVI were far much bigger and required efforts by researchers and education providers. Though there appeared to be many causes, a few were singled out. The researcher assumed that the issue had to do with teaching methodologies.

Without conducting empirical research, it may not be easy to convince stakeholders that a particular methodology was an effective intervention strategy. It called for the evaluation of teaching strategies that were being used the world over. The methodologies of dividing learners into groups, working as individuals, brainstorming, lecturing and use of assistive technologies needed to all be explored. The Abacus was intensively used in the early 1960s and 1970s in learning how to count. They were used by all learners in elementary grades. They were not specifically for LVI. Different types of abacuses have appeared on the global market. They varied in the shapes and number of columns. They could have 2 or 5 columns, while others had up to 15. Abacuses for beginners tended to be much simpler. Research was instituted in an effort to find out how the Abacus worked and, and also to determine how far it could go. It started with intensive research on internet. After learning the skills, presentations were made by the researcher at both local and international conferences. There was great appreciation of the use of the Abacus at such fora. The innovation was noted to be adding value to some of the former studies, particularly where it was thought that the lack of teaching materials was the main cause. It was becoming clearer that it was not just any type of teaching materials, but it was specific assistive devices that were lacking.

The other factor that was commonly blamed upon was that of insufficient specialised teachers. That could however, not make much sense in Zambia as the Ministry employed many Special Education and Mathematics teachers every year. Adequate research appears to have been lacking. Though some officers at the Ministry were good at pronouncing the adage, 'disability was not an inability', in reality, they seemed to be the barriers for effective research. Funds for disability programmes were being released but with very little improvement to the quality of education. Most of the policies appears to have been concerned with the removal of social and economic barriers, with less effects to the sector of Mathematics and Sciences for the VI.

Research Approach and Design

The research approach and design sub-heading examined the following areas: mixed research designs, research questions, research hypotheses, experimental quantitative approach, survey design, philosophical worldview assumptions, piloting of the study, and typology of the mixed research design. This study was a mixed research concurrent design. There were two basic research approaches and designs for this study, namely quasi-experimental design and survey. Each of these studies also has other approaches.

The Quasi-Experimental Design

The experimental approach was the major part for this study. Experiments could be classified as true or quasi designs. According to Paul (2021), true experimental designs were where participants are confined and not allowed to mix with others. Due to ethical or practical reasons, true experiments could not be applied for this study. Where true experiments may not easily be applied, Lauren (2021) says quasi-experimental designs, where participants may not be confined can be used. True experiments may involve control groups for the sake of comparing groups of participants that partake in the experiment and those that do not. The quasi-experimental approach could therefore, be engaged for measuring the degree of change as a result of the treatments arising from the new methodology. Additionally, this study did not involve control participants due to the limited numbers of teachers of Mathematics and Special Education in schools for the VI. For comparisons sake, pre-tests and post-tests were conducted. Like a true experiment, however, quasi-experimental designs aimed at establishing a cause and effect relationship between an independent/predictor and dependent/effect variable (Kamal, 2015). It was assumed that for any seemingly significant difference between the pre- and post-test results could be attributed to the use of the Abacus methodologies.

Research from other lands reported some progress on the use of the Abacus. It was imperative that research was conducted so that some challenges could be identified. The researcher took some time to examine how the Abacus worked from free source online pages. After studying by himself, it was thought that there was need to try the methodologies learnt, to see if they could be adapted for Zambia and other neighbouring countries. This study hoped to move scholars away from the traditional methodologies that emphasised the use of the blackboard even to people who could not see. This study was unique and original, because it tried to reach the cause of the problem by interacting with the teachers during the experiments. As indicated earlier, the quasi-experiment was the major approach, as it responded to the title of the research directly. The survey study nested on it. The quasi-experiment was exploited through the use of the Abacus, which is an assistive device for computing problems through tactile procedures. The computations were on ten basic

Mathematics topics, namely Addition, Subtraction, Multiplication, Division, Addition of Decimals, Subtraction of Decimals, Addition of Fractions, Subtraction of Fractions, Multiplication of Fractions, Division of Fractions, and Abacus computations of Decimal Numbers. The Mathematical computations were at the elementary level, of Grades 2 to 7. The assumption was that if teachers could manage to compute the problems at that level, they should be able to teach learners at that level too. And if they managed to solve the problems at elementary level, the pre-test items were to be adjusted to an advanced level of junior secondary, and later even at senior secondary.

The failure to compute problems at a lower level could mean that the teachers and teacher-educators had serious challenges. It also implied that they could not manage to teach the subject at a higher level. Therefore, the performance of the teachers at pre-test acted as a guide in measuring the level at which the teachers were able to function in relation to the use of assistive devices. The reader is also informed that the findings of a study do not always turn out as designed (Kamal, 2015). Quasi-experimental research, however, has the limitation of not being able to control and manipulate the variables, therefore, creating challenges to do with internal and external validity (Luo, 2021). As the question on the ability of the Abacus was being investigated, the researcher was also interested to know how the school environment and teachers' conditions contributed to the challenges of offering Mathematics to LVI. To investigate this factor, Observation Protocols were considered because of their abilities to measure the teachers' behaviours on the following indices or scales: teachers' morale, willingness to adopt the abacus methodology, and support from management. This was important for enriching the data. It is argued that observation checklists offer better ways of collecting data about specific behaviours, knowledge and skills (Formlus, 2021). The observations also can aid in formulating hypothesis. It is postulated that data collection through observations has the advantage of being more accurate (Formlus, 2021). Both the observation protocols and responses from the survey were to complement each other in the data analysis, as to the extent to which the Abacus could be used as a mechanism for Mathematics calculations for LVI.

The Survey Design

This research has also included the use of survey designs. The Centre for Disease Control (2022**)** says that survey research were measurement procedures that engaged in asking questions to research participants. The survey was originally designed to collect data through interviews, but because of the onset of Covid 19, the data was collected through questionnaires. This could have impacted negatively on the quality of data collected. The Centre for Disease Control (2022) postulated that there were different types of surveys that varied depending on the span of time for conducting the study. There were cross-sectional surveys that focused on a specific population over a short time, unlike in a longitudinal study where similar data was collected from the same population repeatedly over a long time. Both were known to collect quantitative data that was non-experimental (Hudelson, 1994). Since this research collected data at once, it fitted well under cross-sectional survey. The questionnaires had collected both quantitative and qualitative data. They had both free-answer and guided response types, where respondents were restricted to selecting from multiple-choice answers.

The survey design for any study is often determined by the nature of the research questions. It is argued that research questions should be open-ended, general, neutral and exploratory. They were known to change during a study (Mengshoel, 2012). The Survey research questions were designed to generate and discover or understand phenomena. They were also designed to collect data as guided by the research questions. The main research question focused on the extent to which LVI could learn Mathematics? This question was divided into four subsidiary questions as follows: What challenges, if any, could LVI encounter, if they did not learn Mathematics? What are some of the effective teaching strategies for the teaching of Mathematics to LVI? To what extent can teachers use assistive devices for teaching Mathematics to LVI? To what extent do the teachers' methodologies comparable for teaching Mathematics to LVI? The responses to such survey research questions were intended to either validate or disapprove the notion that the lack of learning Mathematics by blind learners was as a result of schools lacking instructural materials (Simalalo, 2012).

It was in the public domain that at times Special Education Schools were well funded but the challenge of teaching Mathematics still persisted. Teachers had various certificates, ranging from certificates to masters, and even doctorates have found themselves teaching in institutions offering special and/or inclusive education. However, answers on how to teach Mathematics to LVI was still farfetched. It is for such reasons that the Ministry of Education and Culture (1996) and Kelly (1999) pointed out that there was a challenge with regards the taking of certain subjects by CSEN. Teachers appeared to have challenges especially in the areas of Mathematics and Sciences. The survey questions collected data to respond to most of the issues that had been raised under the Literature review and Introduction Chapters. The targets for the question on the use of the Abacus were the lecturers and teachers. Through the analysis of data from these various multi-sectorial departments, the status quo for the education for the VI in the nation was established. Since the questionnaires had both qualitative and quantitative type of questions, the survey study alone could also be appropriately referred to as a mixed research design (Kamal, 2015).

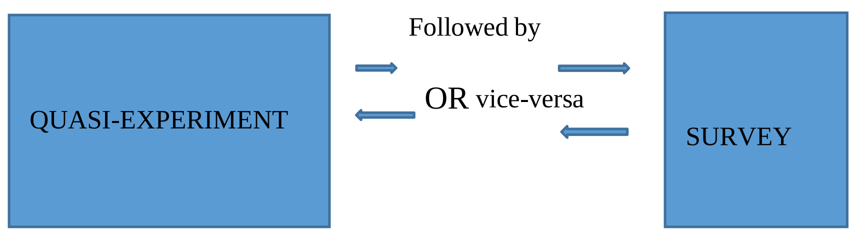
Unlike the major research question that was studied through quasi-experimental designs, data collected from the subsidiary questions was collected through non-experimental designs, to be specific, through the cross - sectional survey. One such a question from the questionnaires was: One of the assistive devices for teaching Mathematics to LVI was the Abacus, list down the topics in the Mathematics curriculum you think the Abacus may be used for in computations? The intention was to determine the status quo as pronounced in policy guidelines, as well as collecting data to determine the challenges teachers and lecturers have been encountering in the provision of Mathematics to LVI.

Typology of Research Designs

Depending on the sequence of the research designs, mixed research designs are often categorized into two main categories: sequential and concurrent mixed methods (Creswell, et al, 2014). Sequential implies happening after the other while concurrent suggests taking place almost at the same time. For this research, experimental quantitative data and survey data were collected at the same time. However, it involved carrying them out one after the other. The order as to which type of research method should start first was not very important, either the experiment or the survey could be administered earlier. Such a research design therefore, could appropriately be referred to as a mixed research concurrent design (Creswell, et al, 2014).

Figure 3

The Typology of the Two Research Designs

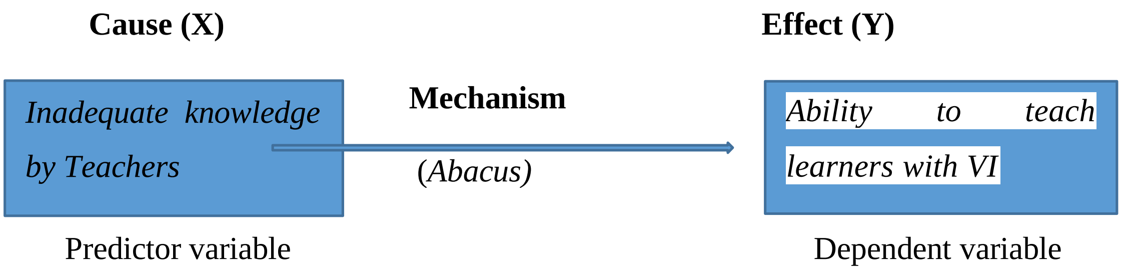


Quantitative Data only Both Quantitative & Qualitative data

Adapted from Nancy, 2007.

Despite the use of research questions, this study has also used research hypotheses. Before carrying out an experiment, a researcher needs to have a tentative answer or a reasonable guess to the research problem. Such an assumption is often referred to as a hypothesis (Prasko, 2015). The author further went on to classify research hypothesis into null hypothesis (H_a) and alternative hypothesis (H_a). The alterative or working hypothesis is a hypothesis to be tested by the data. A null hypothesis (H_o) is the direct opposite of the alternative hypothesis, and could occur because of chance errors, and are therefore not significant. For this research, the assumed cause of poor quality of education among LVI was the inadequate knowledge by teachers. As a researcher, the 'mechanisms' (Ingo, 2018) proposed for the intervention was the Abacus. The cause and effect relationship, and the proposed mechanisms could be summed up as in figure 4.

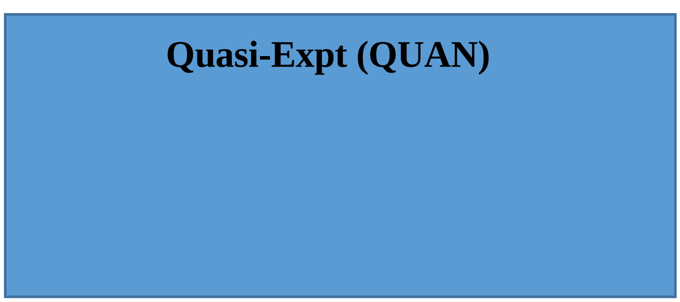
Figure 4: **Experimental Cause and Effect Relationship**



According to Prasko (2015), a hypothesis should be stated in the form of declarative statements, and it should consist of statements with at least two variables that are related. A hypothesis should also be testable. For this study, the alternative hypothesis was that there was a relationship between the use of abacuses and the ability by teachers to teach Mathematics effectively to LVI. The null hypothesis was that there was no relationship between the use of abacuses and teacher effectiveness in teaching Mathematics to LVI. Data was collected and processed to test if the principles of alternative hypothesis (H_a) was to be satisfied. With the help of Microsoft Excel 2013, the results were presented in this report for either rejection or acceptance. The experimental quantitative data were analysed numerically with data derived from using Microsoft Excel 2013 software. This is supported by Bryman (2016), who argued that quantitative research designs in the form of experiments were often analysed descriptively. The mechanisms were the lessons on how to use the Abacus, and altogether, they were 10 lessons or treatments, that could be labelled as X_1, X_2, X_3, X_4 … X_{10}. After undergoing the lessons, the participants were re-examined. Any significant positive results was considered to be due to the mechanisms that had been put in place. The study started with a mini pilot study in an effort to authenticate the tools. After correcting the tools, a pre-test was administered. The pre-test or baseline findings suggested the existing knowledge that the teachers had. That explained how the teaching and learning had been going on in the schools and colleges. Paul (2021) pointed out that a pre-test is a test you give before any form of training is given so as to establish the knowledge and skills that respondents have prior to the experiment. During the administration, some corrections were made to test questions that were not very clear.

At the end of the experiments, the same or similar tests were administered to determine if there was any progress or its lack of. Such a test is often referred to as post-test (Kamal, 2015). The performance for each participant and the average per school were measured during analysis. Questionnaires were also administered to teachers and school administrators. During the survey, numerical quantitative data was collected through closed responses such as YES or NO. This is important when it comes to generalising concepts more widely, and for predicting future results, as well as investigating causal relationships (Mengshoel, 2012). The quantitative data collected was computed through the use of computer software, the Microsoft Excel 2013. Qualitative data that was collected through the surveys could be related to data collection through phenomenology, grounded theory, narrative research, ethnographies and case study. A narrative research design (Ntinda, 2019) is where a researcher is focused on someone who is willing to tell their story, and this could not be applied due to the effects of Covid 19. This research was also not phenomenological (Vinay, 2023) which attempts to study the lived experiences of a group around a specific phenomenon. It is also not ethnographic that studies different cultures sharing patterns of behaviour, beliefs and language (Creswell, et al, 2014). The study was a survey because it collected information from different schools, with different locations within Zambia, and of respondents of the same characteristics of interest (Linda, 2002). In a mixed research, the approach that tries to respond to the major research question may be appropriately abbreviated in capital letters. In this thesis, the study was divided into two, with the quasi experimental research being the one that directly responded to the main research question. The quantitative data from the experiment, being the major approach could be abbreviated as QUAN, and the minor approach (survey) that collected quantitative and qualitative could be represented as ‘quan’ and ‘qual’ respectively in small letters (Jennie, 2013). This is the principle behind the nesting of an approach on another. As indicated before, the quan and qual nested on the QUAN. The responses to do with policy direction or challenges expressed by respondents were the ‘quan and qual’. Institutions of higher learning were somehow autonomous and enjoyed academic freedom, hence it was also necessary to find out why their Mathematics curriculum did not take care of people who were blind. These institutions were free to carry out research, and it is their responsibility to be doing so. For various reasons, the research recognised that it may not be easy to engage the lecturers in quasi-experiments. Hence, the ‘quan and quan’ questions were administered as a questionnaire to them. Survey data was equally important, as it was to fill up the gaps from the experimental quantitative tools. In figure 5, the illustration shows that data from the quan and qual was embedded or nested on the QUAN. This data was to fill up the gaps in QUAN. Such a mixed research where one approach is a lesser one compared to the other, could be illustrated as shown in figure 5.

Figure 5: Typology showing Survey Nesting on Quasi-Experiment



Adapted from Jennie, 2013.

From figure 5, the Survey (quan + qual) nests on Quasi (QUAN). With the QUAN, the participant cannot easily lie in an experiment. Either they know it or not. From whatever they know, the quasi-experiments seeks explanations for the status quo. There were also observations that were taken note of during the experiments. However, in a questionnaire, sometimes respondents may not tell the truth. The researcher may also not be able to control the responses in quan. The collection of data using many approaches can greatly enhance the findings. Data from the two approaches were triangulated in many ways such as in the creation of themes for similar content. A summary of the research methods adopted for this study could be summed up as shown in Table 2.

Table 2

A Summary of Research Methods

MIXED CONCURRENT NESTED RESEARCH DESIGN	
QUASI EXPERIMENT	SURVEY
Data Tools: Pre & Post- Maths Test.	Data Tools: Questionnaires
Observation Protocols.	Observation Checklists

Table 2 is demonstrating that the research designs for this study could be classified into Quasi-Experiment (Quantitative) and Survey (Quantitative & Qualitative). It can be noted that the quasi-experiments started with a Pilot Study. This was followed by Pre-Test, then Experimental tests and finally a Post-Test. The QUAN was the quasi-experiments and survey took the forms of quan and qual. Such was the typology of the Mixed Research Concurrent Nested research, where the survey nested on the quasi-experiment.

Population and Sampling

The topic on research designs and approaches in research is often followed by a theme on 'Population and Sampling' of the Research Study. This unit comprised of the following sub-topics: demographics of the representative population, population sampling for quasi-experiments, population sampling for the survey, and procedure of data collection.

Demographics of the Sample

The demographics that were considered for the study included the names of the respondents' institutions/schools (see Appendix K), status of their institutions/schools (Early Childhood Education, Primary, College or University, etc.). Additionally, the schools were classified as to whether they were Special Education Schools or mainstream schools. The universities were also classified according to their departments (Special Education, Natural Sciences, Or Mathematics and Statistics). Demographics also included the participants' job titles, gender, age, qualifications and years of experience. Dominic (2010) postulated that understanding demographics forces can aid in better preparation for the challenges caused by the world's fast changing population. The characteristics of the population and how a sample was selected mattered in a study. Sometimes the differences in gender and age may bring in other ideas.

Population of the Research

Bryman (2016) postulates that the population in a research is the total number of people in the group that one is trying to study. Zambia is divided into ten provinces, and most of them had special education schools or units for the VI. The population comprised nine provinces. The 9 provinces were Lusaka, Western, Eastern, Copperbelt, Luapula, Northern, Southern, North

Western and Central provinces. However, only few districts in each province that had schools officially recognised as having LVI were engaged. The participants needed to be teachers and lecturers from the Special Education and Mathematics departments. These needed to be from primary and secondary levels of education. In addition, school administrators that included head teachers, deputy heads, heads of departments and senior teachers of Special Education Schools and units were also part and parcel of the population. Also included were officers at the Ministry headquarters, provinces and districts that were responsible for the provision of Special Education and Mathematics. These Departments were Standards and Curriculum, Teacher Education, and the Examinations Council of Zambia. To make the study a little more meaningful, it was thought that the trainers of teachers or lecturers from institutions of higher learning, belonging to the Departments of Special Education and Mathematics be included.

In terms of statistics, there were about 26 Special Education schools for the VI in the country. Each school had about 4 special education teachers that were biased to Mathematics and Sciences (bringing the total to 104 teachers). Additionally, only primary and secondary schools officially known to have at least 4 LVI were purposively selected. Additionally, there were about 18 inclusive education schools (about two in every province). Each of the 18 schools had about 6 Mathematics teachers, giving a total of 108 teachers. The total population for teachers was 212 (104 + 108). Universities with departments of Education and colleges of education were engaged. Both the public and private universities were involved. The five institutions of higher learning that were involved were University of Zambia, Nkwame Nkrumar University, Zambia Open University, ZAMISE and Rockview University. In terms of numbers of lecturers, on average, the ones that taught the course 'Teaching Methodologies' for the VI in the public universities formed the population. In total, they were about 10 (2 by 5) from the Special Education faculties. For those from the Mathematics faculty, they were on average about 3 per university, hence, from the universities, the total was estimated at 15 (5 by 3) Mathematics lecturers. Included to the population of lecturers were six colleges of education for the VI. From each of them, on average there were 2 lecturers for teaching methodologies for the VI, hence bringing the number to 12. The total number of lecturers could be summed up to 10 (from Special Education, 15 from universities and 12 from colleges of education), bringing the total to a population of 37.

From the Ministry Headquarters, the participants were drawn from 4 departments (CDC, TESS, ECZ, Standards and Evaluation). Each of them had about 3 officers on average, in charge of Special Education and Mathematics, hence there were about 12 officers. In the Ministry, there were also 9 Senior Education Standards Officers at Provincial level (apart from Muchinga that did not have a school for LVI). In each of the provinces, there were about 2 districts that had a school for LVI. The Special Education schools in the districts were managed by Education Standards Officers (Special Education). Multiplying 9 provinces by 2 districts gives 18 districts. Additionally, each of the 26 schools for the VI had an administrator. Hence, the total population for Ministry of Education officers was 12 at headquarters, 9 from provinces, 18 from districts and 26 head teachers, bringing the total to 65. As a summary, the population was: 163 Ministry of Education officers, 37 lecturers, 212 teachers and 260 learners.

Population Sampling

The response rate for the total questionnaires for the survey and Mathematics tests for the quasi-experiments were as follows: 24 was the desired number of participants for the quasi-experiments. The study only managed to find 20 participants, which was about 83.3% turn up. This was a good representation. Eight LVI were targeted for the video, but only six participated, a response rate of 75%. The survey had targeted 102 respondents and 100 questionnaires were collected, representing a 98% response rate. In total, for both the quasi-experiment and the survey, the study had targeted 134 participants, and it collected data from 126 of them. This is equal to 94%, which was a good response rate.

A good sample is often referred to as ‘power analysis’ (Jones, 2023). It ensures that the population is well represented by the sample. To come up with the minimum number of the respondents for the quasi-experiment, the principle of power analysis was followed, by engaging institutions of learning that appeared to have more data. The population sample for the survey comprised all the nine provinces in Zambia. Initially 2 provinces were planned for, but fortunately enough, the study took advantage of a workshop in Lusaka that attracted teachers for the VI. The quasi-experiments were set to be in 2 provinces: 1 rural and 1 urban. For urban provinces, Lusaka was selected purposeful and conveniently. It had more schools, colleges and universities, centrally located, and hosted most of the Ministry officers, from its various departments (CDC, Standards and Evaluation, ECZ and TESS). Lusaka competed with the following two provinces from the urban setting: Copperbelt and Central. Lusaka was selected purposeful and convenient because it was endowed with a lot of schools for the VI. Being the capital city, it also had many universities and Ministry officers. From the rural setting that had 6 provinces, namely Eastern, Western, Southern. North Western, Luapula and Northern, Western was selected through *simple random probability* by drawing a paper from a hat, with names of all the six provinces. From the 5 experimental schools (3 from Lusaka & 2 schools from Western), 20 teachers were selected purposefully.

A Special Education college was also selected through purposeful sampling. The schools were a private and public schools. A university college was also selected purposefully. For the

Survey, 100 participants were selected [60 out of teachers 212 (28.3%), 24 out of 54 lecturers (44.4%) and 16 out 158 Ministry Officers (10.1%)]. The special education teachers were selected purposeful and convenient, whereas simple random sampling was used for teachers of Mathematics, through simple random sampling, by drawing a paper from a hat. The 60 teachers were shared as: 30 from special education and 30 from Mathematics. From the schools, the special education teachers needed to have qualifications of Braille, Mathematics and related subjects. Stratified sampling was also involved in that the teachers were divided, with administrators sampled differently. The two schools that were selected purposefully in Western Province had a long history of offering education to LVI. One was a special education school that catered for LVI only from primary to secondary school, while the other was an inclusive school where learners with sight and those without learnt together in the same classroom. It was a secondary school with both junior and senior classes. The two schools were in proximity to each other, hence were conveniently sampled. Six (6) pupils were also sampled purposefully, and were made to take part in a video on how to calculate Mathematics using the Abacus. In percentage, 6 out of 10 learners is 60%. This was a video, therefore, it could accommodate many learners. Fortunately, two schools were involved. It is important to know that two private universities were also engaged. Efforts were made by ensuring that half of the participants were drawn from the Special Education department, and the other half from the Mathematics Department. Special education lecturers, being few were drawn purposefully. The Mathematics lecturers on the hand were drawn by a simple random sampling. The ZAMISE, the only college in the country that was typically for student-teachers for learners with SEN, had to be purposefully selected for the quasi-experiment. Also sampled were 16 out 163 (about 9.9%) Ministry of Education officers. These included school administrators and colleges principals. The inclusive and exclusive criteria for the quasi-experiment was summarised in Table 3.

Table 3

Inclusive and Exclusive Criteria for Quasi-Experiment

Inclusive factors	Exclusive Factors
A teacher who teaches LVI	A teacher who does not teach LVI
A Special Education Teacher	An ordinary classroom teacher
A teacher in a Special Education School	A teacher in a an ordinary School
A Maths teacher in an Inclusive School with LVI	None Maths teachers in Inclusive Schools with LVI
Teachers of subjects related to Maths such as Geography & Sciences	Teachers for Social Sciences such as Religious Education & Social Studies.
A primary or secondary school with LVI	A primary or secondary school without LVI
Lecturer from the Departments of Special Education & Mathematics	A Lecturer from the Department of Social Sciences, e.g History
A lecturer from the VI Department for the VI (e.g. Braille, Assistive Devices, Psychology, Sociology, Counseling)	A lecturer that did not offer Methodologies for LVI (e.g lecturer in Department of the Deaf, Intellectual Disability)
A learner with VI for the Video	A learner without VI disability
A learner with VI to be less than 16 years	A learner with VI more than 16 years
A learner with VI at primary school	A learner with VI at secondary school
A learner with VI in grades 5 to 7	A learner with VI not in grades 5 to 7

Table 4

Population Sise for the Quasi-Experiment

Teachers of VI Learners		Special Education College Lecturers		Learners with Visual Impairments
Special Ed	Inclusive Sch	1 College		Quasi-Experimental Schools
16 Schools	6 Schools	Dept of Special Ed	Dept of Maths	LVI trained by the trained teachers
64 teachers	36 teachers	5 Lecturers for LVI	3 Maths Teachers	20 Learners
100 Teachers		8 Lecturers		

The population for the quasi experiments was about 100 teachers, 8 lecturers and 20 LVI. The population sample for the quasi experiments was as in Table 5:

Table 5

Population Sample for the Quasi-Experiment

Targeted:	24 teachers	4 lecturers	10 Learners
Sample found:	20 teachers	3 lecturers	6 LVI
Sample/Target	83.3%	75%	60 %
Sample/Population	20%	37.5%	30%

Eighty-three (83.3%), 75% and 60% of the targerted teachers, lecturers and learners respectively were found. These were higher percentages and could be relied upon. The inclusive and exclusive criteria for the survey was summarised in Table 6.

Table 6

Inclusive and Exclusive Criteria for Survey

Inclusive factors	Exclusive Factors
A teacher who teaches LVI	A teacher who does not teach LVI
The teacher offers any subject to LVI.	The teacher does not teach LVI
A Special Education Teacher	An ordinary classroom teacher
A teacher in a Special Education School	A teacher in a an ordinary School
A teacher in an Inclusive School	A teacher in a an ordinary School
Teachers of subjects related to Maths such as Geography & Sciences	Teachers for Social Sciences such as Religious Education & Social Studies.
A primary or secondary school with LVI	A primary or secondary school without LVI.
Lecturer from the Departments of Special Education & Mathematics	A Lecturer from the Department of Social Sciences, e.g History
A lecturer for methodologies for LVI (e.g. Braille, Assistive Devices)	A lecturer that did not offer Methodologies for LVI
Ministry of Education (MoE) Officers in Departments with Special Education responsibilities	MoE officers in Departments that did not have officers with Special Education responsibilities
Head teachers and their Deputies in charge of Special Education Schools	Head teachers and their Deputies in charge of ordinary schools

It was also found necessary to clearly define the population of the study. The population sise and sample are shown in Table 7 and 8 respectively:

Table 7

Population Sise for the Survey

Teachers		Lecturers			Ministry Education Officers
Special Ed	Maths	Special Ed		Maths	Special Education Department
26 Schools	18 Inclusive Sch	5 Universities + 6 Colleges			CDC, TESS, ECZ, Standards, Head Teachers
104 teachers	108 teachers	10 Sp Ed	15Maths	12 Sp Ed	65 Ministry Senior Officers
212 Teachers		37 Lecturers			

Altogether the population for teachers for the survey was 212 teachers, 37 lecturers and 65 Ministry Senior Officers.. The population sample for the survey was selected as shown in Table 8:

Table 8

Population Sample for the Survey

Targeted:	65 teachers	20 lecturers	20 Ministry Officers
Sample found	60 teachers	16 lecturers	16 Ministry Officers
Sample/Target	92.3%	80%	80%
Sample/Population	28.3%	43.2%	25%

Ninty-two point three (92.3%), 80% and 80% of the targerted teachers, lecturers and Ministry of Education officers respectively were found. These were higher percentages, hence the data can be relied upon.

Procedures of Data Collection

The Data collection tools (questionnaires and Mathematics tests) were initially tested in a pre-survey. Participants' scores were measured in percentages. By conducting a preliminary study, it could be able to save a lot of effort and cost including information on their origin, reliability, and validity. According to Prasko (2015), it is advisable that authenticated and validated tools were used or adapted to one's research. Authority was sought to adapt research tools (questionnaires and test items) from ICEVI tools and from QuestionPro (2022). The letters of authority have been attached as appendices D and E respectively. Data collection had taken about two months, excluding the period for the pilot study that lasted for two weeks. The experiments used to take about 5 days for each school, depending on circumstances in `the different institutions. The data collection process was not smooth as it was the time when national examinations were being conducted in schools. Plans were put in place in case of disruptions by extending the period for the collection of data. Data could also be collected during lunch breaks if the participants so wished. Instructions for teachers during the pilot study, pre-test and post-tests were as follows: please solve the following mathematical problems. You are not to use pens, pencils, calculators and phones when solving the problems. Use any tactile methodology such as assistive devices (Taylor frames, cubarithm boards, slates and styluses, geo-boards, abacuses, etc.), that is, methods used by LVI to learn. Take about 30 Minutes to calculate the 10 problems. The study shall now look at some of the test items in order to examine if it met the facet of internal validity. In a test, each question is often referred to as an item (ECZ, 2016). These tests or instruments were used at pre-test and post-test. A sample test on Basic Mathematics that was developed is shown in Table 9.

Table 9

Sample of a Pre- and Post-Test Quasi-Experimental Test

Solve the following using any assistive device.
1. 5 + 7
2. 37 + 45
3. 73 - 18
4. 54 x 67
5. 54 x 67
6. 28.2 + 7.57
7. 43.002 – 8.35
8. 348 x 785
9. 0.021 x 1.4
10. 5 6/7 + 7 4/5

The questions were from ten different topics, from grades one to seven. The questions were initially piloted to the teachers to determine if it was an appropriate test at primary school level according to the Mathematics school curriculum. Nearly all of them agreed to all the test questions. Internal validity of the test questions was therefore, guaranteed.

Prasko (2015) argued that external validity was the ability to generalise the findings to the target population. Most of the teachers in Zambia were trained from local colleges and universities. This suggests that they had similar knowledge on how to computing problems related to numbers. If the teachers were subjected to some experiments on calculations, it was expected that they may score similar marks. If they had learnt how to be using the Abacus, as it was perceived in the null hypothesis related to the third research question, they were also going to score higher marks. However, it was also possible that some teachers had been trained abroad, from institutions where the use of the Abacus was taught. In such a case, there were going to be wide differences in performance, more especially at the pre-test. Since the quasi-experiments were conducted in many schools across different provinces, it could be said that the results obtained could be generalised even to the other provinces.

In quantitative research, McLeod (2023) the trustworthiness of data should also focus on its reliability. The researcher stated that a research should be reliable by addressing the overall consistency of the study's measurement instruments. This was explained as a test-retest, meaning that the results should be the same if the test was carried out on a group of similar respondents. Reliability of data was an important aspect that could be measured by testing an instrument on a group of people of the same characteristics (Scheman, & et al, 2011**)**. If the scores obtained were similar, then the tools were reliable. The quantitative tools for computation should compare with similar studies in the discipline (LibGuides, 2023). The process should make research questions more researchable and meaningful to most of the respondents, and to avoid embarrassing respondents as Adelakun (2020) put it. A research may be carried out in one town, however, the results should be able to apply to other cities, and even in other countries. This also suggests that the findings from a few participants that have been involved should also apply to others that did not participate in the research. It also entails that if the method of measuring was accurate, then re-asking the same question in a different way should still produce accurate results. For instance, some of the questions that were asked were as follows: What is 53 x 4? Asked differently, 53 dogs have how many legs? The first question was in figures, and the second was in words, but were both conveying the same massage. There was also other strategies for testing the credibility. According to Hudelson, P (1994), this can be done through re-asking a question or concept in a similar way and be able to produce the same results. For instance, 24 + 76 can be used to replace 34 + 57, and 75 x 8 with 78 x 7.

It is also important to note that quasi-experiments were not true experiments. Despite having this disadvantage, they have the potential to establish associations or correlations between the variables (McLeod, 2023). The use of abacuses as a mechanism for intervention can be assessed as to whether the lack of adequate knowledge was the cause for their challenges to teach Mathematics to LVI. All the stages of the quasi-experiments needed to be consistent with scientific research. This should include a clear background statement and research problem, including research questions and data analyses. Furthermore, the researcher was the principal data collector in the experiments, which was better, as not all experiments can be conducted by any researcher. This ensured that primary data was collected efficiently and appropriately. Unforeseen errors (McLeod, 2023) such as teachers trying to mentally calculate problems instead of using assistive devices were immediately rectified by changing direct questions to slightly harder ones that could not allow for mental calculations but required the use of assistive devices. Example, substituting 7 + 5 with 25 + 97. The participants' behaviours were also observed throughout the period of the experiment on a quantitative standardised form that had indices or codes interpreted as 1 for Poor, 2 for Good, and 3 for Very Good. The tool for measuring the teachers' behaviours was adapted from resources by Osthoff, et al (2009), hence could be trusted. The observation protocols also added to the insights of understanding the challenges and successes.

There were also Observation Protocols that focused on the teachers' behaviours as well as any other critical roles necessary for improving the teaching and learning processes. Observation protocols of participants' behaviour were noted with regards the commitment of teachers and lecturers to the subject under study. Additionally, there was also a survey that included structured observations of the schools' environment on a standardised procedure. The study was administered by the researcher, and the major tool or mechanism that was used was the Abacus. By having pre-tests and post-tests, it was hypothesised that the use of the Abacus, as the mechanism, could bring about enhancement of teachers' knowledge, resulting into a positive significant difference between the two tests. Questionnaires were used to collect data for similar questions. They collected both qualitative and quantitative data. This study has justified how the representative samples were drawn from the population sampling. The sample populations were drawn from schools, institutions of higher learning, and policy makers from various departments of the Ministry. Data from the several tools: Mathematics pre- and post – tests, questionnaires, observation protocols and observation checklists were to be triangulated.

Materials/Instrumentation of Research Tools

Materials as Research Tools

According to Creswell, et al (2014), the collection of data that is accurate and systematic is critical to conducting scientific research. There were a lot of materials that were referred when writing this study report. These included scholarly publications, peer-reviewed articles from journals**,** and popular sources such as news, magazines and books. Others were conference proceedings, government documents, book chapters, thesis and dissertation (Prasko, 2015). Sources of materials could be classified into primary and secondary data. This research collected empirical data through observations (primary) to allow for the prediction of the data. To understand some of the techniques for drafting data collection instruments, it is recommended that researchers read peer-reviewed articles. There were plenty of such articles from Online Journals and Databases that undergo a rigorous and critical review process. Other important reference materials were Scholarly journals. Alibina (2023) argues that these journals carried detailed citations, footnotes, endnotes and bibliographies. They are written by experts from particular disciplines. There were also empirical research articles that reported on primary research (Victor Valley College Library, 2023), based on observations or experiments related to my field of study. Such were a valuable resource when drafting instrumentation of research tools. This study has referred to a lot of articles, that included studies on the use of assistive devices, the VI disability and Mathematics. It is postulated that a good research must gather data suitable for testing hypothesis and/or answer proposed research questions that are under investigation (Hudelson, 1994). The Likert Scale type of rating was adapted and used to measure respondent's knowledge, attitudes and opinions, where respondents were rated on a scale of 3 or more (Alibina, 2023). Instruments of research tools are measurement devices that are used for collecting data for a research (Prasko, 2015).

For any research, there must be data collecting instruments, for collecting data of interest about a particular study. The author further argued that the design of data collection instruments depends on the research type and the methods to be applied. According to Mengshoel (2012), some of the research tools for collecting data include case studies, checklists, interviews, observations, surveys, questionnaires and tests. This study used all these techniques except for interviews. Search engines included google search and yahoo.

Instruments for Quasi-Experiments

In the quasi-experiment, the participants were given a test to write. In Mathematics, a *test* is an instrument that can be used to examine the competences of individuals. There were instructions such as not to use a pen/pencil or the chalk. They could use any assistive devices that were user friendly by LVI. It was assumed that schools for the VI had assistive devices for teaching their learners. For those who did not have, they were to be given by the researcher. The research participants were given 30 minutes to answer the questions. When writing a test, some students may get all the questions correct, while others may get some or even fail on all the questions. Hence, the students were classified according to their performance such as poor, good and even excellent. Instrumentation of research tools were also necessary at recording the results from the tests. The respondents' performance in the pre- and post-test were to be recorded as in Table 10.

Table 10

Template for Recording Quasi-Expts Test Results

Province ……….. District ………….. School/College ……………

Score (%)	0 – 20	21– 40	41– 60	61 – 80	81 – 100
Candidate A	-	-	-	-	-
Candidate B	-	-	-	-	-
Candidate C	-	-	-	-	-
Remarks	Poor	Fair	Good	Very Good	Excellent

Adapted from Alibina, Z., 2023.

From the Table 10 above, if Candidate A was ticked under column 2, it suggests that the Candidate scored between 21 – 40%. If for B, it was under column 1, then the Candidate got between 0 - 20% and so forth. The adaptation on how to solve the above problems using the Abacus was made to the ICEVI tools. The firm suggested that when adding two or more-digit numbers on the Abacus, we should be starting with the last or highest value figures on the left of the Abacus, but the researcher adapted the work by starting the computations from the right, to be in line with the Zambian curriculum.

Checklists were used during the Observation Protocols when measuring the participants' behaviours related to the provision of education. Individual behaviours were recorded, which were later summarised for each school, and eventually for all the institutions. The attributes that were measured were teachers' morale, teachers' willingness to adopt the Abacus methods, and support from management. The teachers' morale were measured in terms of time management and attendance. If teachers were reporting late for lessons that could suggest that the activity was not interesting. The number of times a teacher reported for work was also cardinal for the progress of the learners. Absenting from work could suggest partial learning, hence retarding the learning process. The teachers' willingness to adopt the method of the Abacus was measured through their efforts to sourcing abacuses for their schools, and efforts for introducing Mathematics to LVI. Having the ability to solve Mathematics problems is one thing, and the teachers' attitudes to perform the work effectively was another. Their insatiable appetite or lack of it could be observed through their commitments to the subject. The attitude of the head teachers as to whether they would encourage their teachers to teach Mathematics to LVI was also to be noted during the study. A single template was used for entering data for the individuals and schools. The following table was a guide to the filling-in of the template on Observation Protocols:

Table 11

Template for Recording Observation Protocols

Data Collector: …………………………… Date:……………………………………………

Name	**Poor**	**Good**	**Very Good**
Comment			
Teachers' morale	-	-	-
Teachers' Willingness	-	-	-
Support from Management -	-	-	

Adapted from Osthoff et al (2009)

NOTE**:** After the tool was used to collect data from individuals, the totals for the 20 participants were also summed and coded in a similar way.

Instruments for Survey

In addition to the experimental tests**,** the research also carried out a cross-sectional survey. This was done through the administration of *questionnaires*. The questionnaires had some questions closed, with others open ended. The open questions had sourced for qualitative data. Qualitative analysis in the process of deductive and inductive inference, among the observed phenomenon (Creswell, et al, 2014). According to Prasko (2015), to create a good questionnaire, the researcher needed to conduct a pre-survey in order to make it comprehensively in content and data. The survey started with a piloting phase of questionnaires in 3 schools in an effort to make research tools clearer to most of the respondents. This helped to identify and solve any confusing points (Creswell, et al, 2014). For this study, only teachers were engaged in the pilot study. Some of the participants such as policy makers and lecturers could not be involved due to the laborious protocol matters for this group of participants. However, for reliability purposes, the tools for the policy makers and lecturers, were similar to those for teachers. The questions were tailored according to the roles each of the groups played. Due to insufficient funds, the pilot study was only done in one province, and this could have negatively affected the quality of the tools.

To design and administer questionnaire tools for a survey, Creswell, et al (2014) argues that there is need to start with defining the aims of the study, and thereafter the target respondents. As earlier alluded to, the aim of this study was to assess the scope to which LVI could learn Mathematics. Much of the literature review that was conducted was in line with the education policies, and all pointed to the fact that the teachers for learners with SEN needed to be well grounded. When designing the questionnaires tools, Mengshoel (2012) argues that it was important that each of the questions contributed to testing one or more hypothesis or research question established in the research design. The questions needed to be clear and meaningful to all respondents. They should be short and simple sentences, and also be precise. They should not embarrass respondents, and should avoid hypothetical questions. Creswell, et al (2014) further said that research questions should be of open formats. The expected responses also should not have been predetermined. This research had therefore, included questions that required participants to explain and elaborate. Some of the closed questions took the form of multiple-choice questions. E.g. who decides on the curriculum for Mathematics for the VI? (You can tick one or more): A). Universities/Colleges B). The MoE C). ECZ. D. None E. Other. Do you think Mathematics as a subject should be taken by LVI? 1. YES 2. NO. For this thesis, three types of questionnaires were developed. These were questionnaires for Teachers of LVI, for Lecturers from Institutions of Higher Learning (Special Education & Mathematics Departments), and for Ministry Policy Officers (see appendices F, G and H).

As pointed out earlier, the tools were piloted in 3 schools: 2 at primary and 1 at secondary school. Following some concerns from the pilot study, some changes were made to the content and language. For instance, in one question, instead of reading YES or NO, it read as Male and Female. The revised questionnaires were then administered to the respondents. The responses received were interpreted. The qualitative data were analysed through content analysis (Luo, 2021) by counting the number of times a particular word concept occurred in a narrative. This helpled in coming up with themes. It also aided in the triangulation of the data, with that collected through the quasi-experiments.

Additionally, an observation checklist was used to collect quantitative data through observations of the school environments, the libraries, presence or lack of abacuses, braille paper, styluses, writing frames, geoboards, and other methods. The findings on these were as follows:

Table 12

Checklist on Education Materials

Data Collector: ……………………..…… Date: ………………………………….

Province: ………………….. District: ……………………... School:…………………………..…….

	Poor	**Good**	**Very Good**
Availability of assistive devices	-	-	-
Presence of libraries for VI books	-	-	-
Presence of LVI in Maths classes	-	-	-
Participation of LVI in Maths classes	-	-	-
Participation of LVI in Maths exams	-	-	-
Use of Assistive Devices by teachers during lessons	-	-	-
Ability by learners to using Assistive Devices	-	-	-

General Comment: ---

Adapted from Osthoff, et al, 2009

Depending on how data is collected and analysed, research can also be analysed through deductive and inductive reasoning. Deductive reasoning is an approach that moves from the general truth to an event (Creswell, et al, 2014). It suggests concluding the relationship that is not apparent, based on the existing generalization. The lack of Mathematics on the school curriculum that was being offered to LVI could not easily be inferred from the current policies and practices. Policies could suggest that the government was not leaving anyone behind but pragmatically the statement may not be true. There was need to explore research to the latter by exploring through various approaches. Creswell, et al (2014) argues that inductive reasoning is a logical process that is from empirical data through observation to a theory. This research employed inductive approaches. It investigated through quasi-experiments, and discovered that the biggest challenge were the methodologies that were being used. There were also poor attitudes and inadequate research in the sector.

Operational definition of Constructs/Variables

Constructs or variables are the ideas the research questions are trying to explore (Creswell, et al, 2014). Agravante (2018) defines ‘operational definition of variables’ as the variables that were being measured or calculated as a numeric value. An operational definition needed to specify the range of possible values. It could also consider the variable’s level of measurement (nominal, ordinal or interval). Jennifer (2021) argues that an experimental study required measurements of variables. Some of the variables varied across the experiment over time.

Variables vary according to the way they have been operationalised or used in a particular study. Operational definitions were there to state the expected relationship between the variables under investigation. Yolanda, & Jennifer (2021) argue that in order to write an operational definition in a thesis, the researcher should first identify the characteristic of interest. Demographics was often captured by many as one of the important elements in research. The UNESCO Institute for Statistics (2019) defines demographics characteristics as data that help in understanding the population structure. There was therefore, need to know the gender (number of males and females) that participated, and code it as nominal of categorical data type. Other qualitative data that were coded that way included categories of schools such as special or inclusive education school.

In order to understand the data, Creswell, et al (2014) argued that there was need to classify data into categories. Data was classified into two main categories, namely, categorical data and numerical data. Categorical data is the method of assigning numbers to qualitative data that did not require ranking or natural order (e.g. 1 for male, 2 for female). It is the data that reflected characteristics or categories of variables such as gender and hair etc. Categorical data can be classified into nominal and ordinal (Creswell, et al, 2014). *Nominal data* is a categorical data type that describes qualitative characteristics or groups, with no ordering or ranking between categories such. Examples are gender, blood type and political candidates. Data has the same value, that is, one is not ranked above another. *Ordinal data* is slightly at a higher level, but unlike nominal data, there is also a meaningful order or rank between the options. Ranking was used in classifying the qualifications of respondents, their years of experience, and the number of topics the Abacus could be of support. This data could be coded as strongly disagree, disagree, neutral, agree, strongly agree, as used in the Likert Scale (Creswell, at al, 2014). This study mainly used the nominal categorisation, such as YES or No for most responses. The ages of participants were categorised into ranges, that is, 1 to 5 years, 6 to 10 years, 11 to 15 years, and above 15 years. All the age groups responded to the same questions.

Other than *categorical data*, there is also *numerical data*, and this type of data is measured in numbers (Johnson, et. al, 2007). Numerical data could be categorised further into *interval* and *ordinal* types. The interval data has an order (like ordinal data), but in addition, the spaces between measurement points are equal, which is not the case for ordinal data. Examples of ranking in percentages: 0 – 25%, 26 – 50%, 51 – 75%, and 76 – 100% (Wendy, 2004). The construct or variable of ‘years of experience’ for instance was divided into three: served less than 5 years, 5 – 10 years, and more than 10 years. This is a Numerical Ratio type of coding where there is ranking. By keeping all things equal, the higher one’s experience was, the more likely that one could be an effective teacher.

The interval numerical type of data analysis was applied during the Observation Protocols when observing the behaviours of respondents during the experiments. In addition to the interval data, the numerical ratio type of coding is ordered/ranked. It has a zero point in the coding. The numerical distance between the different points is consistent. The zero point in a ratio coding is an arbitrary zero point, which literately mean that there is nothing of that variable. The zero in Fahrenheit (interval data) does not mean that there was no temperature, but that the temperature is less than 100. Examples of ratio data are marks of students that may be classified in negatives, zeros and positives figures. This is common in the Natural Sciences faculty.

For this research, only categorical data techniques were employed. To be more specific, some of the key construct variables that were captured from the questionnaires and experiments were to do with methodologies. The teaching methodologies that were being applied were questionable. The other construct of concern was that surrounding the attitudes of policy makers, teachers and lecturers. Furthermore, there were also attitudes towards the Mathematics examinations that were set and printed out even when there were no LVI to write the Mathematics examinations. From such questions as ‘Do you think Mathematics as a subject should be taken by LVI?’ and ‘is Mathematics one of the subjects you train student teachers for the VI?’ the attitudes of respondents could be known. There was also a concern on the inadequacy of research in the sector.

Construct/Variable 1: Tactile Methodologies

Ingo (2018) explains that a researcher must identify the defect type of concern. In this case, teachers appeared to have received less training. It appears they were receiving general training that was not disability specific. In true experiments, the independent variable is manipulated, and that may result in a change in the outcome. One of the key variables that was tested was the use of the Abacus tactile methodology. By comparing competence scores at the pre- and post-tests, the study was able to establish if there were any significant difference in the results. Any significance changes could be due to the use of the mechanism, the Abacus (Luo, 2021). The participants' scores in the experiments were measured in percentages, and the results displayed on pie charts, bar charts and frequency polygons. The scores of the participants were varied and coded. The range of the scores were: 0 - 20%, 21 - 40%, 41 - 60%, 61 - 80%, and 81 - 100%, following the principles of numerical ratio coding. The operational predictor variables, according to Yolanda, & Jennifer (2021), are variables that are used to predict some other variable or outcome, to discern the future. The authors argued that because predictor variables are used for prediction, the terms independent and predictor variables are often used interchangeably. However, knowing that the LVI have challenges with sight, it could be right to predict that promoting the use of tactile methodologies could likely reveal much progress. The abacuses therefore, qualified to be the predictor variable for this research. Yolanda, & Jennifer (2021) author went on to say that predictor variable arises from a discipline of Mathematics that used probability theory to estimate future incidences. For instance, looking at the way people socialize, you can predict the rate at which Covid 19 is likely to spread. The outcome or results of the experiment as to whether the knowledge of teachers was enhanced or not was the 'dependent variable' (Ingo, 2018).

A dependent variable is often referred to as criterion variable (Agravante, 2018). The criterion or dependent variable was the variable that was being predicted in a statistical analysis. As a summary, the predictor variable for this study was ‘inadequate knowledge by education providers’, and the dependent variable was the ‘ability by the teachers to teach LVI’. From Figure 4, on the subject of ‘experimental cause and effect relationship’ the Abacus was the assumed mechanism. According to Ingo (2018), the mechanism was the proposed intervention. The lack of an effective curriculum and good methodologies could have contributed to the inadequate knowledge (independent/predictor) variable among the teachers. The curriculum and/or methodology can be altered for the better.

Construct/Variable 2: Educational Attitudinal Barriers

When carrying out research, it is important to be clear about the primary constructs associated with the research question(s) and hypotheses. This research also tried to find if ‘attitudes’ of teachers and policy makers were one of the variables that was contributing to the inadequate grounding of teachers. Attitudes related to the teachers’ morale, willingness to adopt the Abacus methodology and support from school management were taken note of during Observation protocols. Nganwa, et. al (2017) argues that teachers, just like other workers needed to be happy when carrying their work. Factors such as low salaries and poor conditions of services can affect the morale of workers (Kelly, 1999).

Construct/Variable 3: Volume of Research

One of the constructs of interest for this study was the amount of knowledge teachers appeared to have in the field under study. In Zambia, quite few studies could be found, such as the doctorate dissertation by Simalalo (2012). The study was a qualitative study on teachers' competences, on being able to offer Mathematics to LVI. True or quasi-experiments could not be found. This was suggesting that very little research had been carried out in this discipline. For this reason, Nganwa, et. al (2017) argues that the blame on the challenges of accessing the Mathematics curriculum by LVI should not be laid on their disabilities. The problem appeared to be beyond that. Howard Gardner's theory of multiple intelligence (Loewenberg, et al, 2008) theory postulated that there were specific types of learning for certain disciplines. Researchers should have known that the area of Mathematics for LVI was highly a technical field. If that was the case, a lot of interventions should have been found on how to handle various topics not only in Mathematics, but in other various subjects. Research needed to be guiding on the course outline for Adapted Mathematics. This should not be left to government departments only. There are many areas that could be researched on as Mathematics has a lot of topics. These include construction, frequency polygons, statistics, probability, vectors, matrices, sets, bearing, integers, approximation and estimation, ration and proportion, algebraic expressions, commercial arithmetic, cartesian planes, functions, mensuration, angles, statistics, number bases, and use of computers (CDC, 2013). Each of these topics require different methods of adaptation.

Researchers needed to demonstrate to the world that it was possible for LVI to be learning Mathematics. Additionally, researchers should also be documenting information about available constructs or assistive devices that were on the global market for teaching Mathematics. Another area that needed to be exploited was the need for affiliation for institutions that were still lagging behind. Researchers needed to be sharing this type of information to the institutions of higher learning. With more research being expounded, these institutions shall begin to have Adapted Mathematics as part of their university courses. Subsequently, the trainee-teachers should also have been improving their education delivery. The research also included questions on any other subjects the research may not have covered well. The issue of inadequate training came out most. It was measured from the lecturers as well as the teachers' perspectives.

Data Processing and Analysis

After all the necessary data has been gathered, the next step was to process the data. According to Bartholomew (2010) in Elsevier Ltd (2022), there are procedures to be followed when analysing data. It is argued that the first step should be to identify and describe the nature of the data that was to be analysed. This was to be followed by the establishment of relationships between the different types of data. A model that clearly summarised the relationship between the population and the data should then be created. The second step could be to prove if the model was valid. This study has attempted to follow these steps. It has identified and analysed the raw data descriptively in form of pie charts, tables and graphs. It has also summarised the demographical data. The processing of data is important for verification, organising, transforming and integrating data for subsequent use (Hudelson, 1994). The author further gave four examples of processing data: finding the central tendency (e.g. arithmetic mean), standard deviation (statistical dispersion), skewness (shape of the distribution), and correlation coefficient (statistical dependence). This section analysed the data in order to determine whether there were patterns and trends, as well as removing some bias. It drew meaningful conclusions from the raw and unstructured data that was collected. Both quantitative and qualitative analysis strategies have been employed in this thesis. Qualitative data analysis was measured in terms of content analysis. For quantitative, inferential statistics methods were greatly applied. This made the seemingly complex data easy to read and understand. Inferential statistics were used to study the relationship between different variables, and for making predictions for the entire population. Both inferential and descriptive statistics were used simultaneously in this research in scoring the mean and SD, to be able to draw conclusions from a sample size. Descriptive statistics have used charts, tables, and graphs, whereas inferential statistics, have used probability scores to reach conclusions. The research has employed causal statistics such as the t- and f- statistics that focused on determining causes of teachers' inadequacies. Such kinds of statistics are used in businesses to determine the reasons for failure and success (Weintraub, 2018).

QuestionPro (2022) argues that data analysis allows a researcher to know and interpret information to identify value points. It was further explained that when analysing data, it was important that we find out if the data answered the original research question. It should also help in defending any objections. It should also provide for the examination of limitations to the conclusions. According to Weintraub (2018), the first step in data processing is called coding. Coding should begin with familialisation of oneself with the data. During coding, a wide variety of data is reduced into a more limited set of attributes. For example, on the questionnaires, participants indicated their different ages, and these were summed up in groups. It could be laborious to refer to each person's age. For the sake of analysis therefore, data on the different ages was reduced to three categories as follows: 1. Below 30 years 2. Between 30 – 50, and 3. Above 50 years. Another example were the various answers respondents gave to the question regarding the type of jobs the national curriculum prepared LVI for. Several reasons were given, and were grouped into 3 for the sake of data analysis:

1. For jobs not requiring sight,
2. For Basic jobs requiring basic Education,
3. Jobs that involve tactile.

Weintraub (2018) says that scholars should learn the skill of mapping and aligning research questions/hypotheses to the data that has been collected. They need to question themselves if at all the results of the analysis have provided the evidence needed. For this thesis, the test results for the experimental study were aligned to answering the main research question. Likewise, all the quantitative and qualitative questions from the questionnaires were to respond to the first three subsidiary questions. According to Weintraub (2018), knowing the components of a dissertation is critical in alignment. The alignment of the data therefore, should be checked with all the sections of the study. The data should be organised or mapped in such a way that similar data is discussed together. For instance, respondents with higher qualifications were closely linked to those who were very experienced. There should also be alignment of data with Operational Variables.

During data collection and analysis, there are always effects of changes in the variables. Effects could be affected by situations in the school setup, or even a natural illness of a participant. The objective should be to establish cause and effect relationships. The strength and weaknesses of the relationship among such variables or measures should also be considered in order to be able to predict the ultimate criterion or the criterion validity (Weintraub, 2018). Numerical data should also be adapted to the Likert type response scale ranging from 1 – 5 (Hudelson, 1994). Questions that were related in the three types of questionnaire were analysed using factor variable analysis to determine if some variables were correlating. The researcher also needed to assess if some factors that were kept constant, could have perhaps influenced the results. These included the participants' educational background, and possible collaboration in between experiments.

Additionally, Microsoft Excel 2013 software was used to compute numeral data predictions, and identifying groups (IBM, 2020). The software was used to transform data into pie charts and frequency polygons for easy of interpretation. In the questionnaires, some questions demanded a response of YES or NO. During data coding, YES may be coded as 1 and 2 for NO. This was for questions such as, ‘do you think LVI should be taking Mathematics?’ (Please tick YES or NO). For Gender: 1 standing for males, and 2 for Females. By doing cross tabulations, data analysis sought to create patterns and relationships. The research also employed inductive reasoning in an effort to arrive at the conclusion.

Data was transformed into graphs after coding. Tables and figures were easy to visualise for the sake of communicating results effectively. Huge quantities of data were transformed into graphs such bar charts, line graphs and tables. Additionally, data was also categorised according to the different institutions such as regular education schools and Special Education school. The former tended to follow the inclusive education approach (Jenkison, 1997) by following the entire curriculum taught in regular schools. Special Education Schools on the other hand may only follow what they thought was applicable only to their learners, that is, for learners with disabilities. Other classifications were used in some tables to compare results from one school to the other, including comparing with institutions of higher learning. There were also comparisons of findings from the different departments of higher learning (Special Education versus Mathematics, Natural Sciences versus Specials Education). Data analysis was also classified according to variables such as years of experience and participants’ qualifications. As the codes were transformed from the pre-test, experimental tests and post-test, some software Microsoft Excel 2013 was used to produce accurate modeling of linear and non-linear relationships, and hence helped in making inferences.

Statistics appear to play a critical role in research in today's world. Inferential statistics could also be referred to as the random sampling of data from a larger population to make judgments (Edward, 2020). There seems to be various methods that can be used for performing inferential data analysis. According to Elsevier Ltd (2022), the most popular methods of statistical analysis are the central tendency (mean, mode and median) and standard deviation. The scholar says that the mean was the average score, whereas the mode or modal class was also a cen. It considers the measure that is most popular or most common characteristic of the sample. In others words, it is the majority score. In statistics, the median is the value in the middle that separates the higher half from the lower half of a population (Edward, 2020)**.** For a data set, to find the median, the figures should be arranged from the smallest to the largest or vice versa. If the figures are odd numbers, you pick the middle term. However, if they are even, the two middle terms should be summed up and divided by two.

There is also regression analysis, hypothesis testing, and sample size determination. The mean can be found by calculating the sum of the numbers in the data set and then dividing it by the number of data entries. Edward (2020) argues that it was not advisable to resort to using the mean as the only statistical indicator. This was because it could result in inaccurate decision making. The central tendency of mean often moves with median and mode. Median is the middle figure when the scores have been aligned from the smallest to the biggest. The mode is the figure that appears most. Other than the central tendency measurements, the standard deviation is another tool that appear to be used very widely as a statistical tool. It looks at the deviation of different data entries from the mean of the entire data. It is used to determine how the figures were spread around the mean (Mengshoel, 2012). This type of information could therefore, be used to decide whether the research findings could be generalised or not. The formula for SD is:

$$\mathrm{SD} = \sqrt{\frac{\sum |x - \bar{x}|^2}{n}}$$

Adapted from Edward (2020)

Where x is a variable, $\bar{x}$ is the mean of the variables, n is the sample population, and N the Population Sample. A low SD suggests that the values were closer to the mean, and a higher SD indicates that the values were far apart. The SD measures how far apart numbers are in a data set from the mean. Unlike SD, Mengshoel (2012), argues that SD is closely related to Variance, which measures the average degree to which all the points are from the mean. Variance takes into consideration the outliers that lie outside the boundaries of the mean.

$$\text{Variance} = \sigma^2 \text{ OR } \sigma = \frac{\sqrt{\text{Variance}}}{n-1} \text{ for Sample, and } \frac{\Sigma(x - \bar{x})^2}{n} \text{ for Population}$$

Adapted from Edward (2020).

This study had pre-determined some hypothesis: null hypothesis (H_o) and the direct opposite, the alternative hypothesis (H_a). A null hypothesis (H_o) could occur because of chance errors, and are therefore not significant (Weintraub, 2018). E.g, If a teacher claimed that her learners were performing at 70%, the general trend was that some learners could be performing at 70 +/- 5% (at significance difference of 0.05). Hypothesis testing therefore, tests the estimated alternative hypothesis by taking into effect all of the sample entries. The data entries are then converted into a single figure, which is often known as a test statistic (Bevans, 2023a). A test statistic can be used to test the validity of a conclusion upon processing of the data. The hypothesis is an assumption made at the beginning of the research. The hypothesis can either hold or be false, depending on the outcomes of the results. In research, it is important that data analysis techniques are employed so as to make informed and correct decisions. Such analysis also aid in identifying the problem or cause of the failure and make corrections.

Branson (2023) argues that there were various test statistics, and they include t-tests for calculating t-values and f-tests such as ANOVA for generating f-values. Such values could be referred to as test statistics. A test statistic is a standardised value that is calculated from sample data during a hypothesis test. A t-test is a hypothesis test that is used to compare the means of two samples**.** There are basically three different types of t-tests (Bevans, 2023a). The *one-sample t-test* is used to test whether a population mean is equal to some value (pre-determined alternative hypothesis). A prediction was made that Ha ≤ 25%, in reference to the performance of teachers at pre-test, and Ha ≤ 80% at post – test. A one sample t-test can be applied where the samples are not independent. An example of independent events is for example, where Mathematics teachers from different countries are compared. There could be huge variations. In Zambia, respondents were trained from within the country, hence, not much differences could be expected. In contrast, a *two-sample t-test* is used to test whether two population means were equal. For this research, the means of two schools or two provinces could be compared to determine if they were equal to each other or not at all. There is also the *paired sample t-test* for testing whether two selected population means are equal by comparing their means if the experiment was repeated.

According to Edward (2020), to perform a t-test, the steps should begin with stating the null and alternative hypothesis. A t-value should be calculated, together with the corresponding p-value. There were procedures for calculating the test statistic in comparing the research's data to what

could be expected under the null hypothesis. The formula for $T = (\bar{x} - \mu)/(s/\sqrt{n})$ (Edward, 2020)

where $\bar{x}$ is the sample mean, $\mu\, i$ the estimated population mean, s is the standard deviation and n is the sample sise.

A t-value is unusual, and it is not clear as to what is unusual about it (Edward, 2020). By itself, a t-value of 3.982 is meaningless. There was need for a more details. And that is where t-distribution tables and p –values come in. For a single study, you obtain a single t – value, but for multiple studies, many t - values are obtained. Such can be plotted on a t – distribution table, and the trend could be noticed, as to whether the different means differed a lot or not from the null hypothesis. The specific t-distribution table can be defined by its degrees of freedom (DF). In order to have a meaning to a t – score, it should be converted to a p - value. According to Statistics Kingdom (2023), the formula for finding t-values incorporates both the sample size and the variability of the data. A t-value of 0 suggests that the sample results equal the null hypothesis. When the difference between the sample data and the null hypothesis is increased, the t-value also increases (DataNovia, 2019). The formula for t - test is:

$$T = \frac{\bar{x} - \mu}{S/\sqrt{n}}$$

Adapted from Edward (2020).

Where x̄ is the sample mean, μ the population mean, s is the standard deviation and n is the population sample. When there are higher values of t-scores, it suggests that there the existence of

a large difference between the two samples (sample mean and hypothesised mean). The smaller the t value, the more similarity the two samples are (DataNovia, 2019). A t-value is unusual, and it is not clear as to what was unusual about it (Edward, 2020). By itself, a t-value is meaningless. Bevans (2023a) argues that to understand the t-value, it was important to make reference to t-distributions tables and p-values. When performing a t-test for a *single sample*, one obtains a single t-value. However, for *multiple random samples* of the same size from the same population, many t-values can be obtained. This can generate data for plotting on a t-distribution table. The goal was to determine whether the t-value is unusual enough to warrant rejection of the null hypothesis. To do that, there was need to calculate the probability (p – value). Branson (2023) argues that a *p-value* is an assumption that the null hypothesis is true. If the p - value is low enough, then the *effect* observed in the sample is inconsistent with the null hypothesis. The probability of the t – value was compared to a significance level of 0.05. The p - value must be lower than 0.05, to be able to reject the null hypothesis.

In an effort to assess the cause and effect relationship between variables, regression is a statistical tool that could be relied upon. It could determine the relationship between a dependent and an independent variable. It can generally be used to predict future trends and events. The basic type of regression is linear regression (Edward, 2020). Linear regression is often calculated as $y = mx + c$, where y is the dependent variable, x as the independent variable, m is the gradient, and c as the y-intercept.

When carrying out research, Branson (2023) argues that the principle of *randomisation* should be adhered to. Randomisation is not haphazard, it demands that participants are selected through a random probability process. An example is where a random permutation is generated such as the shuffling of cards or picking cards from a hut. Randomisation was engaged in the selection of Mathematics teachers. This was because the number of teachers was large, yet only a small fraction was required. However, for Special Education teachers who belonged to the Mathematics and Sciences departments, the entire population at most of the schools was used in the sample. The number for this category was small.

In descriptive statistics, doctoral students also need to learn how to analyse data by determining the interquartile range. The interquartile range explains how the data is spread (Edward, 2020). The data can be segregated into quartiles. It should be ordered from the lowest to the highest into four equal parts. The interquartile range contains the second and third quartiles of the data. In order to determine if the differences between the averages of three or more groups in a study were of significance, the ANOVA test could be used (Statistics Kingdom, 2023). The author argues that a one-way ANOVA test, tries to determine if the difference between the averages reflects a real difference between the groups, or is due to the random noise inside each group. ANOVA test is also a statistical technique that can be used to compare the means of more than two samples. It is further postulated that this test is usually used when there are at least three groups, since for two groups, the *two-tailed* pooled variance t-test and the *right-tailed* ANOVA test have the same result. The basic ANOVA test contains only one categorical value, one-way ANOVA. To carry out an ANOVA test, there is also need to find *degrees of freedom* (Edward, 2020)), that is calculated as the sample size minus the number of restrictions (df = n – 1). The author also stated that the 'margin of error' needed to be known, which is equal to half the width of the entire confidence interval. In order to find out the differences between the averages of all of the 6 schools under this study, the ANOVA test therefore, was used (Statistics Kingdom, 2023). Mengshoel (2012) argues that there were more complex ANOVA tests that contained two categorical variables or more. The F statistic represents the ratio of the variance between the groups and the variance inside the groups.

$$\text{F statistic} = \frac{\text{variance between the groups}}{\text{Variance inside the groups}}$$

Statistics Kingdom (2023).

Where variance, is the measure of dispersion or spread of data. Variance is often used along with SD, which is the square-root of variance. For this study, the presumed Ho, at post-test was that the average performance in the post-test was to be greater than 80% for all the schools. The Ha was that the schools were to perform at 80% or less on average. The Pre-chosen Significance level (α) was 0.05. ANOVA test includes outliers in its calculations. The *interactive effect medium* was 0.25, implying that one independent variable was being changed by other variables. There are often other variables that could be influencing the results. Given such information, and other details such as df, sample sise, the F Statistic can be calculated. The smaller the f statistic, the more likely that the averages were equal.

Other than the f- and t-tests, the z-test, is also a hypothesis test, commonly known as a *Standard Score* (Edward, 2020). It can be used to determine if the means of two independent means were different or not. The z-score assumes that the researcher knows the population SD. The z-score can also give an idea on how far a data point is from the mean.

$$Z - \text{Score} = \frac{x - \mu}{\sigma}$$

Edward (2020)

where x is the raw score, μ is the population mean, and σ as the population SD of the data. A negative z- score suggests that most of the participants scored less than the average. According to Edward (2020), figures outside this range are not significant to the research, they may be omitted for decision making, and such are often referred to as outliers. Outliers that may not affect the findings can be maintained. To understand the Z – Score, a researcher is also encouraged to calculate p - values. The p-values (or calculated probability) is the probability of finding the observed or more extreme values when the null hypothesis (H_o) of a study is true (Statistics Kingdom, 2023). The p-values may also be described in terms of rejecting Ho. The null hypothesis is usually a hypothesis of “no confidence”. That is, they can be used to determine whether to reject the null hypothesis or not. For instance, for this research, this could mean that there was no difference to the performance of LVI even with the introduction of abacuses. The Ho was suggested to be at 25% and 80% at pre-test and post-tests respectively. The p – value or probability, attempts at finding extreme values far much higher or lower than the Ho. The Statistics Kingdom (2023) argue that the smaller the p – value, the stronger the likelihood that the null hypothesis is rejected. A statistical significant test result of p - value less than 0.05 is considered to be false or nullified (hence the term null hypothesis). If it is greater than 0.05, the null hypothesis should be considered true (Edward, 2020). An Online Calculator can be used to calculate p – values from z – Scores or t – scores. Microsoft Excel 2013 can also be used to find P – values.

Another important statistic in hypothesis testing is the concept of significance level. The term significance level in hypothesis testing (Neil, 2010) refers to a pre-chosen probability. It is the probability of rejecting the null hypothesis when the null hypothesis is true. A 5% (or 0.005) significance level is a common choice for most statistical tests. It differs from the term p – value, which indicates the value that is calculated after a given study. The significant level (alpha) of an event is the probability that the event has occurred by chance (Creswell, et al, 2014). The author further explained that the synonym for level of significance is Type 1 error. The level of significance is often correlated to p – values. It is often expressed as a p–value between 0 and 1. The smaller the p – value, the stronger the evidence that the null hypothesis should be rejected. Hence a p-value $\leq$ 0.05 should be considered statistical significant. Therefore, typical p – values of observing extreme values by chance should be equal to 0.05 and 0.01, or in between. If the p-value was greater than 0.05, it implied that no effects were observed. In such a case, the null hypothesis cannot be rejected.

It was also found important as a doctoral student to try to understand the term ‘confidence interval’. This is the mean of the estimate plus and minus the variation in that estimate (Bevans, 2023a). This was argued to be the range of values within which the estimated values were expected to fall between if the test was to be redone. That is, to fall within a certain degree of confidence.

This suggests that confidence interval was another way to describe probability. A study with a defined confidence interval of 95% suggests that 95 out of 100 times of the estimate values shall fall between the upper and lower values. The desired confidence level was indicated to be one minus the alpha (α) value that was used in the statistical test:

$$\text{Confidence level} = 1 - \alpha$$

Bevans (2023a)

Therefore, if the significance (alpha) value was $p < 0.05$ for statistical significance, then the confidence level would be $1 - 0.05 = 0.95$, or 95%. It was also important to note that when an estimate in statistics is made, there is always uncertainty around that estimate. This is because the estimate is based on a sample of the population that was being studied (Statistics Kingdom, 2023). Most statistical programs do include the confidence interval of the estimate that is run. The point of estimate of confidence interval was usually the population mean.

Bevans (2023b) argues that doctoral students needs to learn about the term critical values. Critical values is about knowing how many standard deviations away from the mean needed to be part of the mean in order to reach the appropriate confidence level for the confidence interval of the sample. This entails that the critical value is the one that defined the upper and lower boundaries of a confidence interval. It defined the threshold of a statistical test. The author explained that there were 3 steps to finding the critical value. Firstly it required, choosing a significance or alpha (α) value. Secondly, deciding if you will need a one-tailed interval or a two-tailed interval**.** Thirdly, it required to look up the critical value that could corresponds with the alpha value. If the data followed a normal distribution, or if the sample sise was large ($n > 30$), the advice was to use the *z* distribution to finding the critical values. If the dataset was small ($n \leq 30$), the *t* distribution should be used instead. As mentioned above, p – Values can also be calculated from both the z and t – Scores.

The findings from the quasi-experiments and survey were later triangulated. According to Johnson, & et al. (2007), research findings can be triangulated through mixed research designs. The whole essence of combining research is that it increases validity of results because a weakness in one method is compensated for by another method (Creswell, et al, 2014). This study combined a quasi-experiment with a survey study. Using different approaches helped to reaffirm that the findings can be trusted. Greene, et al (1989) argues that mixed methods are justified for five main reasons: validation, complementarity, and development, discovery of contradictors and expansion of research. The questionnaires that were administered to the different parties (Ministry policy makers, lecturers and teachers) had almost the same questions. Should responses from the lecturers for instance agree with those from policy makers, it could imply that the results have been validated. The tools were initially piloted; however, the piloting was just among teachers and school managers. The research tools were not piloted to lecturers and officers from the Ministry headquarters. The content that was piloted in schools was however, similar to that to be administered to lecturers. The tools administered to the lecturers could therefore, also be considered to be valid as they were similar to those piloted to the teachers.

When research is being carried out, often there are some gaps that one faction did not see, and when you put the different pieces together, the data is believed to complement each other (Prasko, 2015). In the same way there could be some contradictions and ambiguity (Greene, et al, 1989). The use of mixed methods could therefore aid in either validating or disowning of some results. Sometimes a researcher may decide to take a research that was conducted before a little further, a process that is often termed as ‘development of the research’ (Greene, et al, 1989).

Because some researchers were tilted to certain paradigm disciplines, they often wanted to continue developing the research they previously worked on. According to Wendy (2004), triangulation may also be done by expanding the study through a broad range of inquiry. In this research, the pilot study was expanded through broadening the sample size, and by adding other participants such as university lecturers and policy makers that were not in the pilot study. This helped to deepen and widen the understanding of the findings. The intent of using triangulation was to decrease or negate the deficiency of a single strategy. While the integration of quantitative and qualitative research has become increasingly common, some authors express unease about these strategies (Attride-Stirling, 2001). The author also argued that the use of triangulation strategies does not strengthen a flawed study.

Study Processes and Ethical Assurances

Observing ethical principles is a requirement when carrying out research. This unit focused on various matters. It discussed the approval requirements by the Unicaf University in Malawi Research Ethics Committee (UREC). It also discussed the need for Informed Consent Forms, Debriefing of Participants, Confidentiality of Participants and Minimising of Risks. Before undertaking the study, 'the teaching of Mathematics to LVI', it had to be approved by the UREC. The purpose for addressing ethical issues is one of the final steps in any quantitative or qualitative research (Nosiba, & Elhaleem, 2022). Researchers are encouraged to be familiar with ethical guidelines and principles, as stipulated in the 'International Ethical Guidelines for Health-related Research Involving Humans, Geneva of 2016 (Council for International Organizations of Medical Sciences, 2016*)*. This dissertation utilised human subjects, hence it was a requirement that confidentiality and/or anonymity were achieved. The significance of observing ethical matters was to protect the respondents from possible harm.

Authority to conduct the research was done via the Gatekeeper letters that were approved by UREC. Since the expected participants were employees of the Ministry and institutions of higher learning, authority to conduct the research was sought from their respective leaders. The authority letters were sent to the relevant authorities such as the Permanent Secretary, District Education Board Secretary, Deans of Universities and College Principals. After getting permission from the relevant authorities, Informed Consent documents were read out to the participants. They were discussed and agreed upon with participants. The form had two parts: the Informed Consent Form with information about the research study and the Certificate of Consent for appending signatures for those who chose to participate. They had information that was relevant for them to make voluntary decisions (Ewelina, 2021). The Informed Consent documents had information on the expected quasi-experiments, observation protocols, questionnaires, research purpose, and instructions for participating in the research. The sampling technique was explained to would-be participants. The participants were mature enough; hence the Informed Consent Forms were discussed directly with them. Some participants felt that there was no need for them to indicate their names when signing the consent forms. For anonymity compliance, actual names of provinces and schools were written down but pseudo names for individual's names were agreed upon. The pseudo codes were A, B, C, D, etc., and these were adopted to prevent them from being potentially identifiable. Other than the consent forms, the research needed to foster confidentiality of participants when filling in the questionnaires.

There were also six (6) children or learners in the study that were less than 16 years of age. By the Zambian law, these were still young to be able to understand what they were being subjected to (Human Rights Commission, 2012). Informed consent was obtained from their parents and guardians. Adults have the ability to give free information from an informed consent. They were informed that participation was entirely voluntary and that they had the right to withdraw at any stage of the research without any consequences. It was also important to note that there was no relationship between the principal investigator and the participants.

Participants were also debriefed at the end of the research. They were reminded of the title of the study, its aim, details of the tasks to be undertaken, how each task was to be measured, as well as the researcher's hypothesis. Finally, it was important that participants that voluntarily participated were thanked for their energy and time for taking part in the study. They were assured that the data collected was to be held confidentially or anonymous. In case of any inquiry, contact details of the researcher and the supervisor were given to the participants. They were informed that their personal data was not going to be shared with anyone else. The research findings could however, be shared with them, and other research organisations through publications and conferences. Participants were also informed that in case they wished to make a complaint on ethical grounds, besides complaining to me, they could also direct the complaints to Unicaf Research. The data that was to be collected was to be stored carefully on a computer that has a password. After 5 years, the data was to be deleted.

The participants were also informed that the research was not going to involve any deception. Everything was to be as straight forward as possible. He was to make sure that there was official communication with participants throughout the period for the research. The trips to research sites were self-sponsored. The limited funding could have limited the amount of coverage of the research. To minimize influencing the analysis of findings, scientific procedures of data analysis outlined in this study were followed. The research was fully explained as bordering on methodology of teaching. And also that it had no perceived potential risks, other than risks pertaining to everyday life events (such as the risk of an accident when travelling to/from research sites). In order to minimise risks, the researcher observed traffic rules and making sure that the abacuses were in good shape. The direct benefit was that the participants had gained knowledge that would help them even in the future. They also received an Abacus each in effort to boost the teaching and learning resources at their schools.

Summary of Research Methodologies

As a summary on Research Methodologies, this study attempted to determine the effectiveness of using the Abacus in teaching Mathematics to LVI. Most of the countries appear to have challenges in teaching them the subject. This is despite the fact that universities such as Akita University (2023) arguing that various areas of the subject can be adapted. This research was conducted through a mixed research concurrent nested approach. The quasi experiments were the major resource of the data for examining the effectiveness of the Abacus. Data was collected through Mathematics tests and cross sectional survey using questionnaires. The questionnaires collected both open and closed responses in an effort to make them neutral and exploratory (Mengshoel, 2012).

The alternative hypothesis (H_a) for the study was as follows: teachers' methodologies shall only improve if well trained. The population sample targeted 100 participants for the survey and 26 for the quasi-experiments. The participants were Special Education teachers and teachers of Mathematics from schools that had LVI. To be more specific, in the survey, there were 60 teachers, 6 learners, 24 Ministry Policy makers, 16 lecturers from the universities and colleges that offered Special Education as well as those from the Mathematics Departments. In order to strengthen the reliability and validity of the study, a pilot study was conducted before the pre-tests. Observation protocols were also made during the experimental tests. The predictor or independent variable for the study was ‘inadequate knowledge by teachers’, whereas the dependent variable was the ‘ability by teachers to teach Mathematics to LVI’. The mechanism that was applied were the methods of computing the Abacus. This study was approved by the UREC (see Appendix I). The data was analysed quantitatively and qualitatively. The raw data was later converted into numerical codes for the sake of analysis. After coding the data, it was mapped through content analysis by bringing together data that was similar. To strengthen the findings, peer-reviewed articles and other policy documents were referred to.

CHAPTER 4: DISCUSSION OF RESEARCH FINDINGS

In an attempt to answer the research questions as well as assess the research hypotheses, this chapter has been organized into several subsections. It started with trustworthiness of data and the analysis of results that have been evaluated concurrently. The evaluation of the results is often referred to as the Discussion of Research Findings (Creswell, et al, 2014). The data was generated from two types of research methods, namely quasi-experiments and survey, using a mixed approach often referred to as a mixed research concurrent nested approach (Creswell, et al, 2014). The quasi-experiments' findings have included results from the Observation Protocols. In like-manner**,** the findings from the survey included the results from the independent observations that were made in the schools. The Discussion of Research Findings section has reported on the meaning of the findings to the research questions and hypotheses in light of the theories and the conceptual frameworks that were identified. The evaluation of the findings has also considered whether the results obtained were the expected ones given the literature that was referred to. It has also provided potential explanations for unexpected or conflicting results.

The mixed research study was guided by some research questions. The main research question was: To what extent can teachers teach Mathematics to LVI? This question was sub-divided into subsidiary questions as follows:

1. What challenges, if any, could LVI encounter, if they did not learn Mathematics?
2. What are some of the effective teaching strategies for the teaching of Mathematics to LVI?
3. To what extent can teachers use assistive devices for teaching Mathematics to LVI?
4. To what extent do the teachers' methodologies comparable for teaching Mathematics to LVI?

Three were 20 participants for the quasi-experiments: 3 lectures and 17 teachers. There were 100 questionnaires that were collected from 60 teachers, 24 lecturers and from 16 Ministry of Education Officers. There were also 6 LVI that partook in a video that demonstrated some of the skills learnt through their teachers on how to solve problems using the Abacus.

The purpose of the study was to find out if the use of abacuses could aid in the teaching of Mathematics to LVI. The learners were not fairing so well in national examinations (ECZ, 2016) with the methods highly focused on using the chalk and black board. The quantitative data from the Mathematics test were statistically analysed by Microsoft Excel 2013 software. Some of the data was compared to each other through statistical tests of ANOVA and T-Tests. Data from the questionnaires were analysed through Microsoft Excel 2013 software, and also through content analysis. The latter was done through triangulation of data from three different questionnaires: teachers, lecturers and Ministry Officers. Informed Consent was obtained from each of the participants. However, for the 6 LVI, their parents and guardians signed on their behalf. The sections of the results included the 4 specific research objectives. They were Trustworthiness of the Data, Study Procedures and Ethical Assurances, Demographics of Respondents, Challenges for not taking Mathematics by LVI, Effective Teaching Strategies for Teaching Mathematics to LVI, Teachers' abilities to use Assistive Devices for teaching Mathematics, and Comparing the performances of different Schools.

This section shall now discuss the trustworthiness of the data that was collected.

Trustworthiness of the Data

According to LibGuides (2023), the trustworthiness of the data should be the first item to be discussed under Chapter 4 of a research study. The authors argued that it was a requirement by qualitative researchers to articulate evidence of four primary criteria (credibility, transferability, dependability and conformability) to ensure trustworthiness of a qualitative study. In experimental quantitative studies, validity (internal and external) and reliability (test-retest) (McLeod, 2023) need also to be guaranteed.

Trustworthiness of the Quasi-Experimental Data

The trustworthiness of quantitative or experimental data is often measured through validity (internal and external) and reliability (test-retest) of the data (LibGuides, 2023). The author argued that the trustworthiness of quantitative data lied in it being valid and credible. By validity of the data, LibGuides (2023) argues that it referred to the accuracy of measurements. It tries to determine whether a causal relationship really existed. The author further explained that validity could be categorized into two: internal and external validity. The former referred to the accuracy of the measurement and the test itself (McLeod, 2023), while the latter was the ability to generalise the findings to the target population.

Internal validity was ensured through the piloting of the Mathematics tests. This helped the test items to be well refined. It also helps to determine whether the items were measuring the intended outcomes correctly. The test items were designed from the simplest to more advanced, in line with Bloom's Taxonomy Theory (Shabatura, 2022). After going through the 10 experimental lessons, a post-test was given that was similar to the pre-test. The test items that were used for the tests were derived from the Zambia school curriculum.

McLeod (2023) says that external validity was the ability to generalise the findings to the target population. Most of the teachers in Zambia were trained from local colleges and universities. This suggests that they had similar knowledge on how to compute problems related to numbers. If the teachers were subjected to some experiments on calculations, it was expected that they may score similar marks. If they had learnt how to be using the Abacus, as it was perceived in the null hypothesis related to the third research question, they were also going to score higher marks. However, it was also possible that some teachers had been trained abroad, from institutions where the use of the Abacus was taught. In such a case, there were going to be wider differences in performance, more especially at the pre-test. Since the quasi-experiments were conducted in different schools across different provinces, obtaining similar results could entail being able to generalise the results to the rest of the schools and provinces.

In quantitative research, McLeod (2023) says that the trustworthiness of data should also focus on its reliability. The researcher stated that a research should be reliable by addressing the overall consistency of the study's measurement instruments. This was explained as a test-retest, meaning that the results should be the same if the test was carried out on different groups of people with similar characteristics (Scheman, & et al, 2011**)**. If the scores obtained were similar, then the tools were reliable. The quantitative tools for computation should compare with similar studies in the discipline (LibGuides, 2023). The process should make research questions more researchable and meaningful to most of the respondents, and to avoid embarrassing respondents as Adelakun (2020) put it. A research may be carried out in one town, however, the results should be able to apply to other cities, and even in other countries. This also suggests that the findings from a few participants that have been involved should also apply to others that did not participate in the research. It also entails that if the method of measuring was accurate, then re-asking the same question in a different way should still produce accurate results. For instance, some of the questions that were asked were as follows: What is 53 x 4? Asked differently, 53 dogs have how many legs? The first question was in figures, and the second was in words, but were both conveying the same massage. There was also other strategies for testing the credibility. According to Hudelson, P. (1994), this can be done through re-asking a question or concept in a similar way and be able to produce the same results. For instance, 24 + 76 can be used to replace 34 + 57, and 75 x 8 with 78 x 7.

All the stages of the quasi-experiments needed to be consistent with scientific research (McLeod, 2023). Furthermore, the researcher was the principal data collector in the experiments, which gives an advantage of being more accurate, since the researcher may be well qualified for the task. Unforeseen errors (McLeod, 2023) such as teachers trying to mentally calculate problems instead of using assistive devices were immediately rectified by changing direct questions to slightly harder ones that could not allow for mental calculations but required the use of assistive devices. Example, substituting 7 + 5 with 25 + 97. The participants' behaviours were also observed throughout the period of the experiment on a quantitative standardised form that had indices or codes interpreted as 1 for Poor, 2 for Good, and 3 for Very Good.

Trustworthiness of the Survey Data

Qualitative data for the survey was credible in that it was collected from different stakeholders (teachers, lecturers, Ministry of Education officer and learners). The Ministry produced policy documents and other pieces of legislation. They designed the curriculum that was used for preparing school syllabuses, formal assessment and prescribed teaching methodologies. The Ministry also prescribed the curriculum for colleges of education. The universities on the hand designed their own curriculum in responding to the same societal needs. The teachers were mainly on the receiving end. They were grounded by the lecturers, however, when they were schools, they were to implement the curriculum designed by the Ministry. This combination of the three types of respondents for the survey definitely allowed for the triangulation of the results (Scheman, & et al, 2011). Additionally, the survey data was credible in that nearly all provinces were involved (see Table 9). Furthermore, the professionals had a variety and interesting qualifications ranging from certificates, through diplomas, degrees, masters, up to doctorate. A few had postgraduate certificates. With such seemingly good certificates, it was expected that credible data was going to be collected.

The trustworthiness of qualitative data also needed to be transferable (LibGuides, 2023), in relation to the extent to which the findings could be generalised. Though most of the data was drawn from two provinces (Lusaka and Western) (Table 9), the results can still be accepted by the rest of the provinces in Zambia, in that Lusaka had the highest number participants in the sector of special education. Additionally, Western Province being a rural province represented other rural provinces. The sample of 100 for the survey was relatively large, particularly for Zambia where most of the special education schools were far apart. Special Education teachers from both the government and private schools were engaged. The research had also engaged Ministry policy makers. These were drawn from the Ministry's departments in charge of Special Education and Mathematics. This category included officers from Curriculum Development Centre, Standards and Evaluation, and Teacher Education and Specialised Services. Other officers were from the Examinations Council of Zambia, the head teachers, deputy head teachers and senior teachers. This was an assurance for policy matters in special and inclusive education to be well represented in the report. Additionally, both the public & private universities were embraced, to accommodate diversity of knowledge. This was necessary so as to have a holistic view of the situation as it existed on the ground. Non-probability purposeful sampling techniques (Lauren, 2021) were involved by getting data from some of the schools considered to be the largest in the country.

The trustworthiness of qualitative data also needed to be dependable in terms of being able to be repeated (LibGuides, 2023). The data collection procedures were well described by the mixed research concurrent nested approach. The entire research was well structured and described in all its relevant steps. There was the 'introduction chapter' that introduced the background information, problem statement, and research questions. The 'literature review' also brought out data on statistics for LVI, policy and legal frameworks, and the theoretical and conceptual frameworks shed more insight on the issue. The 'methodology' chapter clearly explained how the data was to be collected. This chapter on 'discussion of results' has given the findings and their meaning to the study.

Elements of conformability were also adhered to by minimising the researcher's biasness (Scheman, & et al., 2011). Though the researcher was the data collector, portions of the study, such as the video were somehow independent. The abilities of the teachers could be observed from the video through the observation of the LVI they were teaching. From the video, teachers, LVI and a director made independent remarks that were not influenced by the researcher. In one study, in order to ensure the validity and reliability of the findings, the interview guide was validated by post-graduate students of the Department of Special Education and Basic Education (Clement, 2021). In this study, the Special Education teachers from the video served a similar purpose.

The measurements of conformability could also be assessed through scientific methods of data analysis such as the ANOVA and the T- test in Tables 29 & 28 respectively, in comparing the performance of teachers from different schools. The background and any other conditions of the teachers were not known before the research. This could have reduced on the researcher's biasness to the research, which is also a test for conformability.

The Results

This section on Results or Findings of the study provides an overview of the data analysis and its evaluation. The data also included demographics. The structure of data analysis of the research findings was organised around the research questions and hypotheses. The results from the findings presented in this section were analysed through descriptive and inferential statistical methods. The descriptive methods utilised pie charts, line graphs, bar charts and tables. The inferential statistical methods included calculations of mean, mode, median, SD, variance and hypothesis testing. Before the findings were tabulated, it is important for the readers to be familiar with demographics of the respondents.

Demographics of Respondents

To start with, data from demographics was collected in Q1 for all the types of questionnaires. Data was collected from nine of the ten provinces or regions in Zambia. One hundred twenty-six (126) respondents (100 for Survey, 20 for Quasi & 6 for the Video) were involved. Table 13 shows the regions where the participants were drawn from. The question was: What is the name of your province?

Table 13

Locality and Number of Respondents

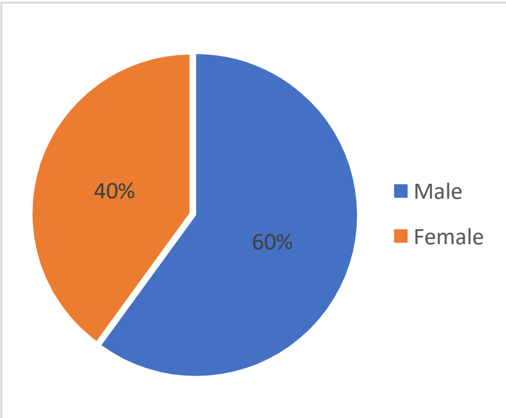
Province:	Lusaka	Western	Southern	Eastern	C/belt	Central	Northern	N. West	Luapula
Respondents:	74	36	02	02	02	04	02	02	02

From the Table 9 above, all the provinces in Zambia were represented except for Muchinga province. The province does not appear to have a school that is known to have LVI. However, that is not to say that the province did not have children with VI. It can also be observed that more than half of the respondents were drawn from one province, Lusaka province. This was followed by Western Province. Lusaka province, being the capital city of Zambia had more established institutions. The institutions included both schools and universities, including Ministry officers. Most of the schools were within the reach of the researcher. Hence it was purposeful and conveniently sampled. Other than Western province, on average, only about two participants were drawn from each of the other regions. These participants were fortunately chanced during a workshop in Lusaka. Distant places were equally important even if they had few respondents. They bring into research a diversity of different ideas. The lack of more representation from most of the provinces could have negatively impacted on the data collected. Fortunately Lusaka province, being the capital city of Zambia was endowed with many schools for LVI. It also had many universities for training special education teachers. There majority of the Ministry officers in charge of Special Education were in Lusaka district of Lusaka province.

The demographics also included data on gender. The Pie-charts 6 and 7 below show the categories of gender that participated, as well as their ratios, and actual numbers. The data also shows the ratios of gender according to the different approaches (quasi-experiments and survey) that were involved. The guiding question was: What is your gender?

Figure 6

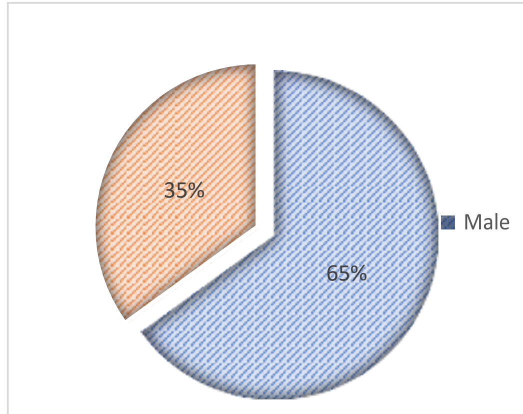
Sample for Quasi-Experiments



20 Respondents (12 Male, 8 Female)

Figure 7

Sample for Survey



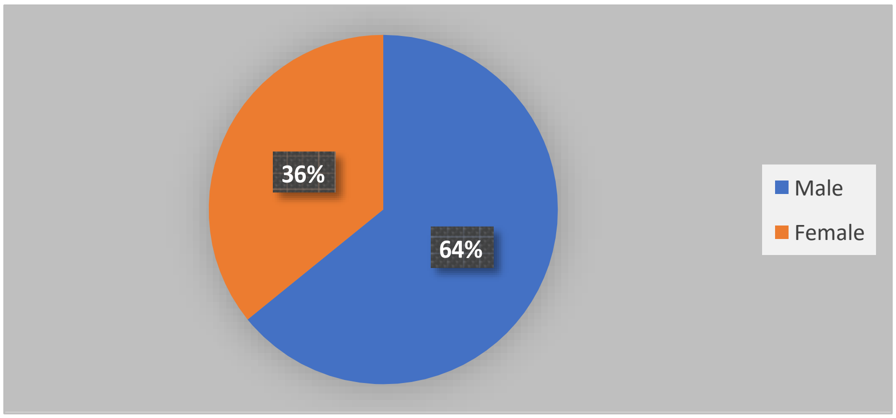
100 respondents (65 Male 35 Female)

From Figure 6, it was observed that 20 respondents had participated in the quasi-experiments out of 24 targeted. The response rate was at 83.3%. This was a relatively high percentage. The 20 participants were drawn from two provinces (rural and urban), and from six schools. The researcher spent at least a week in each of the schools. Only teachers of Mathematics to LVI in inclusive schools and Special Education teachers with a bias to Mathematics or Mathematics related subjects were allowed to participate in the research. On average about 3 to 4 teachers were found in each of the institutions. In many cases, all the teachers found suitable for the study were engaged. Where there were many, purposeful non probability sampling was applied for selection of participants. There were 100 respondents in the survey (see Figure 7) against the target of 102, which was a response rate of 98%. This was a high turn up to be relied upon.

A combined population sample for both the quantitative (quasi-experiments) and qualitative (survey) aggregate according to gender is given in Figure 8. The combined population sample also shows that in the mixed study, there were more males than female.

Figure 8

Sample Sise for both Quasi Experiment & Survey



120 Respondents (77 Male, 43 Female)

The ratio of the males to females in Figures 6 and 7 was about 2 to 3, implying that there were more males than females that participated. The higher number of males appeared to have come mainly from the Mathematics Departments from Inclusive schools. In Zambia, there were more males than females in the sector of Mathematics. This research however, did not investigate the reasons for this discrepancy. The participation of both gender was good for bringing diversity of experience to the sector.

Additionally, there were 6 (3 boys and 3 girls) primary going LVI that participated in a video. This research happened in two school. The research anticipated to find 8 LVI but managed to find 6, a response rate of 75%. This was equally good for the findings to be justified. The total number of respondents for both designs was 126 (20 for quasi, 100 for survey & 6 LVI) against the target of 138, which was a response rate of 94%. The Response rate has been summarised in the following table.

Table 14

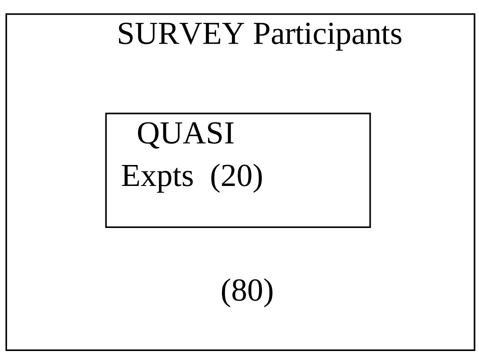
Response Rate of Participants

Type of Research	Quasi-Expt	Survey	Video
Targeted	24	102	8
Number Found	20	100	6
Response Rate	83.3%	98%	75%

A good sample is often referred to as 'power analysis' (Jones, et al: 2023). The application of the principle of power analysis attempted to ensure that institutions with more data were involved. It ensured that the population was well represented by the sample. The researcher would also want to clarify that 20 respondents were captured twice. This is because they all participated in both the quasi-experiments and survey. Graphically, the participants for both research approaches could be illustrated as follows:

Figure 9

Quasi as a Subset of Survey Respondents



From Figure 9 above, the respondents for the quasi-experiment were a complete subset of the survey. Both the Survey and the quasi-experiments constituted the mixed research. There were twenty (20) who participated in both designs, making it 20 for the quasi and one hundred (100) for the Survey. It can also be noted that eighty (80) participated in the survey only.

The respondents were also categorised according to age. There were four categories: Below 30, 31 – 45, 46 – 60, and above 60. The guiding question was: What is your age? (Indicate your age in years). This information is as shown in the table 15.

Table 15

Respondents for Survey according to Age

Age Range	Below 30	31 – 45	46 – 60	Above 60
Teachers	5	20	35	-
Lecturers		8	14	2
Ministry Officers		1	15	-
Sub Totals	5	29	64	2
Cumulative figures	5	34	98	100

The participants were from different age groups. Table 15 suggests that most of the respondents (teachers, lecturers and Ministry Officers) were in the age group of 46 to 60, and followed by those from 31 to 45 years of age. Having more elderly workers could suggest that they were a caliber of high experience.

The other information that was sought was that of qualifications of teacher-trainers or lecturers. They were asked the question: What qualifications do you have? **(**Tick all of them in the corresponding box below). Their qualifications were as displayed in Table 16 below:

Table 16

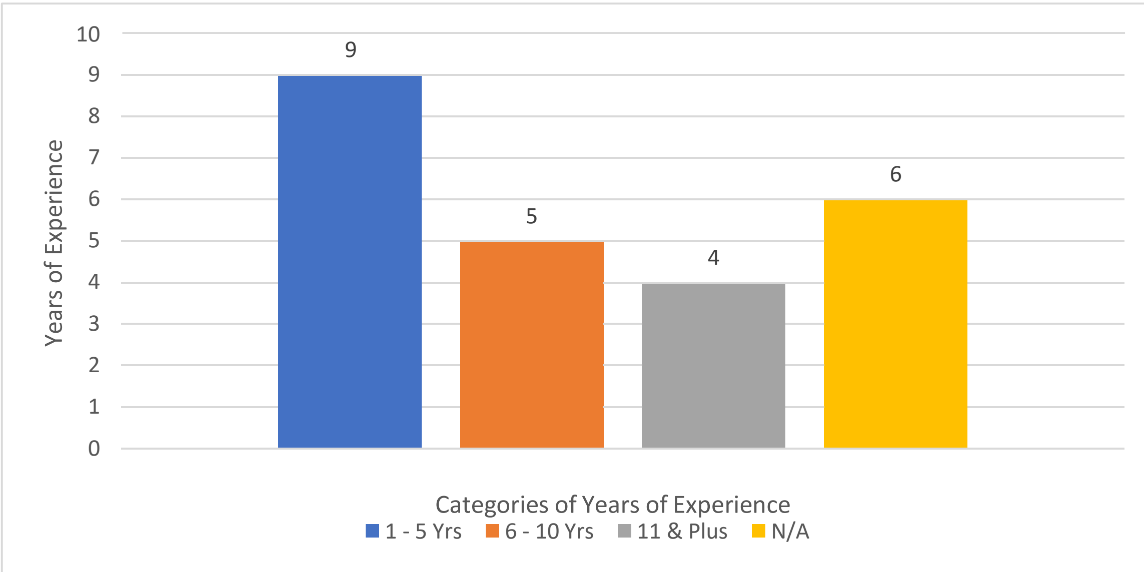
Qualifications of Teacher-Trainers for Learners with VI

Certificate:	PhD	MA	BA (Maths)	B. Special Education	Dip (Edu)	Dip (Special Edu)	Cert (Edu)	Post Grad Dip
Number:	8	20	30	35	20	10	4	2

From the table it may appear as though there were 124 respondents instead of the expected 100 responses. That was not the case as some participants ticked more than once, meaning that they had more than one certificate. It can be assumed that all those that had masters and PhDs also had the first degree. Hence, the majority of the participants had the first degree. Most of the participants with masters and doctorates were working for universities. The results also suggested that there was an even number of teachers and lecturers between the departments of Mathematics and Special Education. The results appear to demonstrate that LVI were taught by well qualified personnel, according to the set standards for higher education institutions and quality assurance (HEA, 2018). In an effort to determine the quality of the teachers, question 5 on the lecturers' questionnaire was: How many years have you served as a lecturer of trainee-teachers for LVI? (Indicate number of years). The experiences of the lecturers or teacher – trainers were as summed up in Figure 10.

Figure 10

Years of experiences of Teacher-Trainers for LVI



The majority had about one to five years of experience, and a good number indicated Not Applicable, suggesting that they have never conducted such training. There were few in the range of 6 – 10, and the lowest category was that of 11 years and above. The less number of years teachers were serving in special education suggested that attrition levels were too from the sector. This is in agreement with Malunga, et al (2018) who argued that stigma could be one the factors CSEN were not being properly taken care of. The results from Figure 8 were however, somehow contrary to those from Table 15

on 'Respondents for Survey according to Age' that indicated that many teachers in Special Education were quite old, in the ranges of 46 to 60. The data did not result in a corresponding increase of teachers to the sector. There were likely high attrition levels from special and inclusive education institutions, especially in the area of Mathematics. It could also mean that the sector was demotivating to work for, or that the teachers were unable to perform their duties, hence opted to go on transfer to regular schools. For the latter, it could be true to the words of Kelly (1999) that teachers did not know how to teach learners with disabilities. The research shall now attempt to give meaning to the outcomes of data to the research questions.

Challenges for not taking Mathematics by LVI

The first research question was: Kindly indicate some of the challenges persons with Visually Impaired faced as a result of lack of Mathematics in their school curriculum? The question (Q) was in Q11, 12 and 11 for lecturers, Ministry Officers and teachers respectively. The responses were under two themes:

A**).** Their Progress at School

- They don't reach their expected inert potential (n = 5, 31.3%)
- Struggle to understand Arithmetic concepts in Science subjects (n = 4, 25%)
- No wide choice of careers (n = 4, 25%)
- Disadvantaged in job opportunity (n = 3, 18.8%)
- They won't understand technical subjects (n = 3, 18.8%)
- Limitation in other academic programs (n = 3, 18.8%)
- Their progress is slowed down (n = 2, 12.5%)
- No idea (n = 2, 12.5%)

B) Life in general

- Getting change upon buying something (n = 6, 37.5%)
- They have challenges in solving day to day life problems (n = 5, 31.3%)

- Their options were very limited (n = 3, 18.8%)
- Need to depend on others (n = 3, 18.8%)
- Anything Arithmetic will not make sense (n = 3, 18.8%)
- No meaningful contributions on topics that require numbers. (n = 2, 12.5%)
- Limitation in societal orientations (n = 1, 0.1%)
- No idea (n = 1, 0.1%)

From the above results, some of the common challenges persons with VI faced as a result of not learning Mathematics, were noted to be those related to independent living, such as not being able to get the right change upon buying and selling goods. They could also not reach their expected inert potential, hence, their progress at school was greatly affected (Mader, 2017). Definitely the results could also mean that LVI had been taking few subjects at school, thereby, making it difficult for them to have school certificates. The restricted curriculum could have narrowed on their career choices. Question 8 on both the Lecturer and Ministry's questionnaires was: What kinds of jobs were persons with VI prepared for in relation to the curriculum that was being offered to them. The 24 Ministry Officers gave the following answers:

- Could only be employed in teaching and lecturing (n = 8, 33.3%)
- They can be in Information Technologies (n = 6, 25%)
- They can be Telephone Operators (n = 6, 25%,)
- Customer Service related jobs were good for them (n = 5, 20.8%)
- They can do anything as long as it does not require sight (n = 5, 20.8%)
- They can also do Arts (Music) (n = 4, 16.7%)

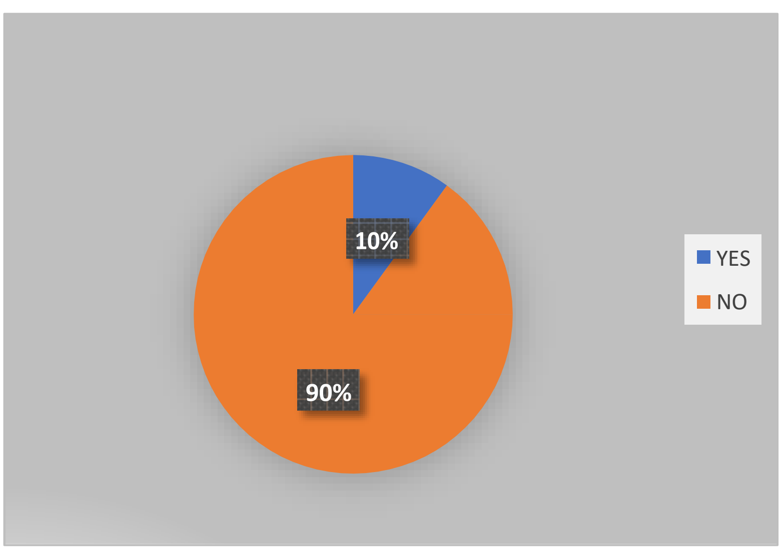
On the other hand, the 24 lecturers postulated that:

- LVI could be trained in all types of jobs (n = 18, 75%)
- Not sure (n = 14, 58%)
- Simple jobs not abstract in nature (n = 11, 45.8%)

According to the teachers: teaching, lecturing and telephone operating were the main careers the Zambian curriculum was preparing LVI for. However, the lecturers argued that LVI can master any discipline as long as they were trained in it. The lecturers appeared to be in line with Howard Gardner (Kendra, 2023) who argued that what was lacking in many cases was specialised type of training. In Q6 of the lecturers' questionnaire, the teacher-trainers were asked the following question: Is Mathematics one of the subjects you train teacher-trainers for the visually impaired? The results were as in Figure 11:

Figure 11

Teacher-Trainers that have taught Mathematics to the Visually Impaired

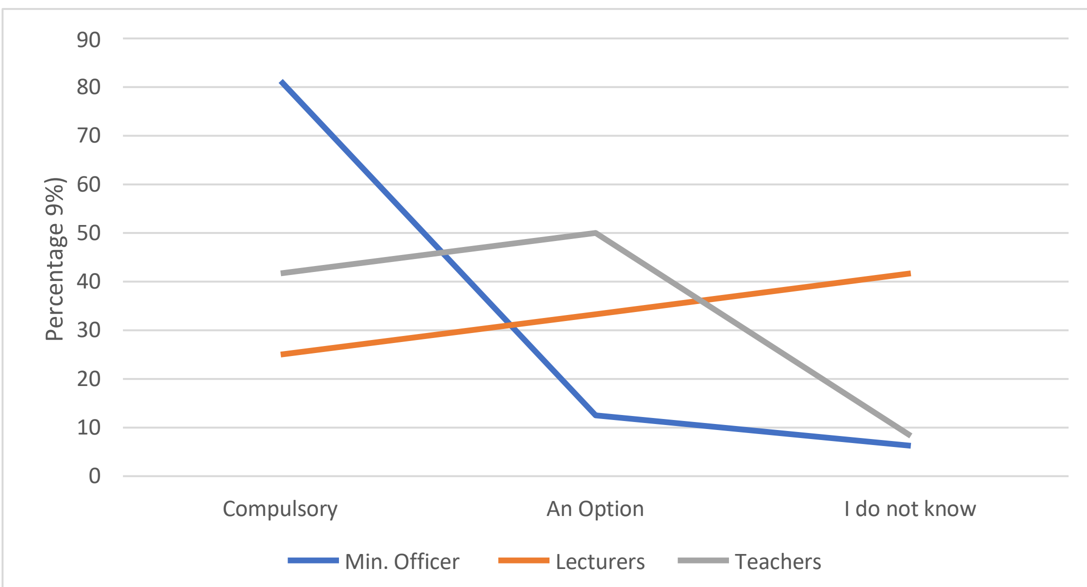


The results suggests that about 90% of the respondents had never taught trainee-teachers for the LVI in Mathematics. This confirms the studies by Hwang, & Taylor (2016) who argued that STEM subjects were not being offered to students with disabilities.

There was also a question as to whether Mathematics should be a compulsory or an option subject for LVI. This was in reference to questions 13, 7 and 8 for teachers, lecturers and Ministry Officers respectively. The responses were indicated in the line graphs in Figure 12.

Figure 12

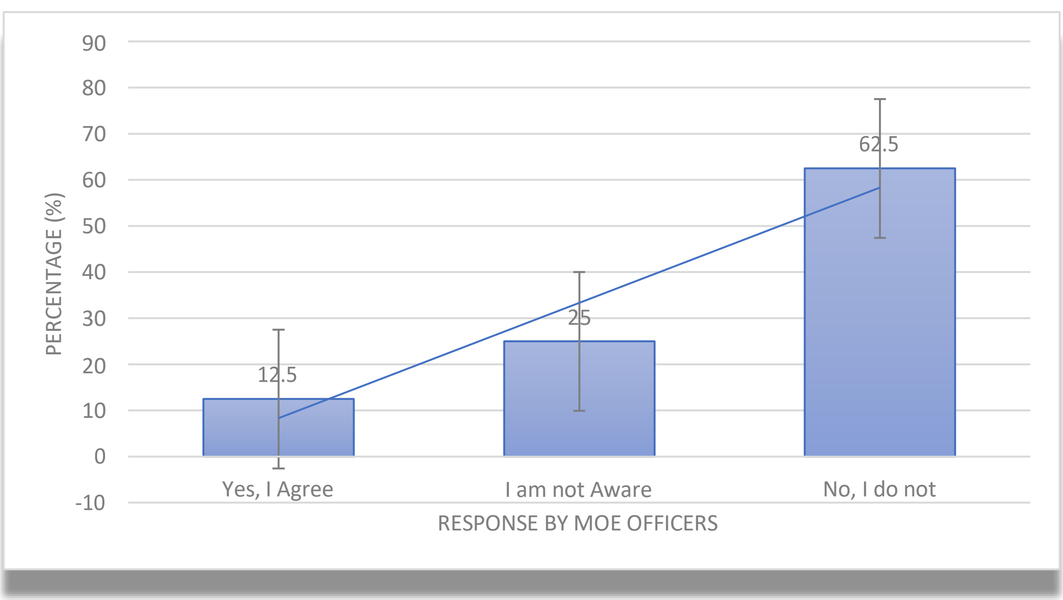
Maths be made Compulsory or an Option to LVI



From the line graphs, about 80% of the Ministry officers strongly believed that Mathematics should be a compulsory subject to LVI, but only about 41% of lecturers and 26% of teachers agreed with the idea. The contradictory views from both sides should not out rightly be thrown off. The Ministry appeared to have looked at it from a policy perspective, whereas the others could have looked at it from practice based on the existing teaching methodologies. According to the Ministry the subject was compulsory (CDC, 2013), suggesting that it was possible to offer the subject to the VI. The contrary views also seemed to suggest that there was less collaboration among the stakeholders in the sector. About 50% of the teachers felt that it should be an option subject. About 41% of the lecturers stated that they were not sure. One of the reasons for LVI not taking Mathematics was because many governments were not providing teaching and learning materials to support the discipline (MoCDNCH, 2015). The Ministry Officers were further asked in Q7A if they were in agreement with LVI in most schools not being offered Mathematics. The question was: According to the Revised Curriculum of 2013, some subjects such as English, Mathematics and Science were compulsory, however, some learners such as those with VI were not being offered subjects like Mathematics, especially at secondary school**?** Are you in agreement with this statement? The findings were as shown in Figure 13.

Figure 13

If Mathematics offered to LVI?



From the findings in Figure 13, about 62.5% of the 16 Ministry Officers did not appear to know whether LVI were learning Mathematics or not. For the majority of the Ministry not to know, could imply that even some senior officers had some attitudes that were negatively affecting the education for CSEN (Mader, 2017). It could also mean that they were not monitoring the schools, or it could be due to poor attitudes or stereotypes for the sector. Only about 12.5% of them said YES, implying that they were also in agreement with the lecturers as from the Figure 12 that LVI should not be offered Mathematics. Definitely this calls for more research for improvement to be realised.

The respondents were asked further in 7B to give reasons to their answers in 7A. The responses for those that said NO, that LVI should not be offered Mathematics gave the following reasons:

- I am not aware of this situation (n = 8, 50%)
- The training received was not adequate (n = 7, 43.8%)
- The Special Education teachers were not specialised in Mathematics (n = 6, 37.5%)
- Some teachers were trained in Mathematics but not in Special Education (n = 5, 31.3%)
- The structure of the subjects possesses a problem in terms of symbols (n = 5, 31.3%)
- Inadequate facilities in institutions make it difficult to teach LVI (n = 5, 31.3%)
- Abstractness of the subject (n = 4, 25%)
- They do not have knowledge in Braille Mathematics (n = 3, 18.8%)
- Due to remuneration challenges (n = 3, 18.8%)
- Lack of interest by teaches in the subject (n = 3, 18.8%)
- Lack of interest by LVI in the subject (n = 2, 12.5%)

For the 12% of the 16 Ministry Officers who said YES that LVI should be offered Mathematics mentioned the following:

- Teachers were capable of making modifications for LVI (n = 3, 18.8%)
- Teachers were well qualified to handle the subject (n = 2, 12.5%)
- Some have passion or it is a call of duty (n = 1, 6.3%)

It could be observed that inadequate training was one of the causes for not offering Mathematics to LVI. This is in line with Walmsley, et al (2007) who argued that Special Education teachers were often not well grounded. It could also be noted that some teachers that the LVI were not interested in learning Mathematics. This research shall not comment much on it as the survey research did not include the learners in the sample. Further researcher should explore on it. However, it was clear from the findings that that the LVI were being taught by teachers who were limited in knowledge. The teachers did not have the right methodologies for offering Mathematics. Hence to please the society, they could have been mentioning that it was the learners that were not interested in the subject. Additionally, this section has revealed that effecting teacher educators' strategies were those that targeted all the five human senses. However, even without having them all, Walmsley, et al (2007), argues that all that was required was grounding of teachers well around issues of disability. Some teachers had also argued that they were not trained in Special Education. The ordinary Mathematics teachers could complain of this. They were trained in the use of blackboard and chalk, targeting those without sight challenges. However, in inclusive schools, the learners with and those without sight learnt together, side by side, from the same classroom. The actual interpretation of this was that inclusive schools mainly targeted those without disabilities. Issues of learners with disabilities tended to come as an afterthought. Their concerns were often discussed when the resources and budgets had been depleted. These challenges may continue till the concept of reasonable accommodation was adhered to (Human Rights Commission, 2017). For Q7A and Q10B for teachers and policy makers respectively, respondents were asked if secondary schools in Zambia were offering Mathematics to LVI. The question was: Do secondary schools in Zambia offer Mathematics to visually impaired learners? The results were shown in the Table 17.

Table 17

Mathematics & LVI in Secondary Schools

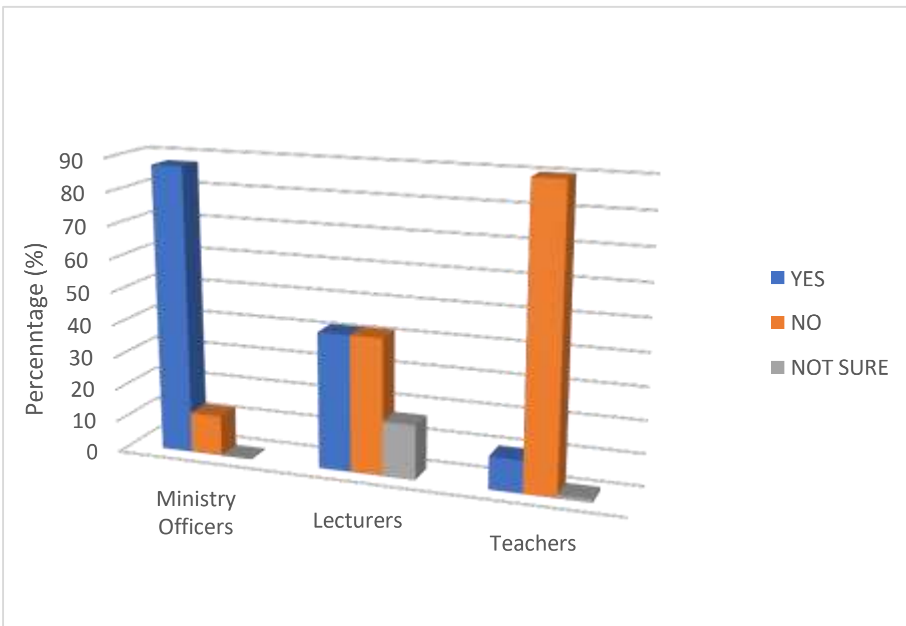
Response	Ministry Officers	Teachers
YES	8 (33.3%)	12 (20%)
NO	15 (62.5%)	46 (76.7%)
I do not know	1 (4.2%)	1 (1.7%)
No Response	0 (0%)	1 (1.7%)
Sample Sise	24 (100%)	60 (100%)

From Table 17 above, about 33.3% of the Ministry Officers argued that Mathematics was being offered to LVI in Secondary Schools. However, only about 20% of the teachers agreed with the practice. Since the teachers that were ever in the classes mentioned a much lower figure, there was need for the Ministry it up in order to reconcile the figures. However, both figures for the Ministry and the teachers suggested that there were very few numbers of LVI learning Mathematics in secondary schools. This tallied well with Derrick (2012) who had made reference to Rapp and Rapp article that a large proportion of learners with disabilities were not taking Mathematics in secondary schools.

All the respondents were also asked as to whether LVI should be taught all topics in the Mathematics curriculum that were offered in the mainstream. This was in Q9, Q10 and Q16A for lecturers, Ministry Officers and teachers respectively. The question was: Should LVI be taught all topics in the Mathematics curriculum that are offered to regular stream learners? The response rate was as shown in Figure 14.

Figure 14

Learners with VI should learn all Maths Topics



From Figure 14, about 85% of the 16 Ministry Officers said YES, and listed down the following:

- LVI were capable of understanding all the topics (n = 5, 31.3%)
- The subject encouraged innovativeness (n = 4, 25%)
- It was very important in the implementation of inclusive education (n = 3, 18.8%)

To the contrary, most of the 60 teachers (88%) said NO, and they postulated the following:

- LVI required different pedagogies such as verbalisation (n = 21, 35%)
- Some concepts were too difficult for them to teach (n = 20, 33.3%)
- Mathematics requires that a learner should have full human senses (n = 6, 10%)

An almost equal number of the 24 lecturers, however, had a balanced view. They postulated that:

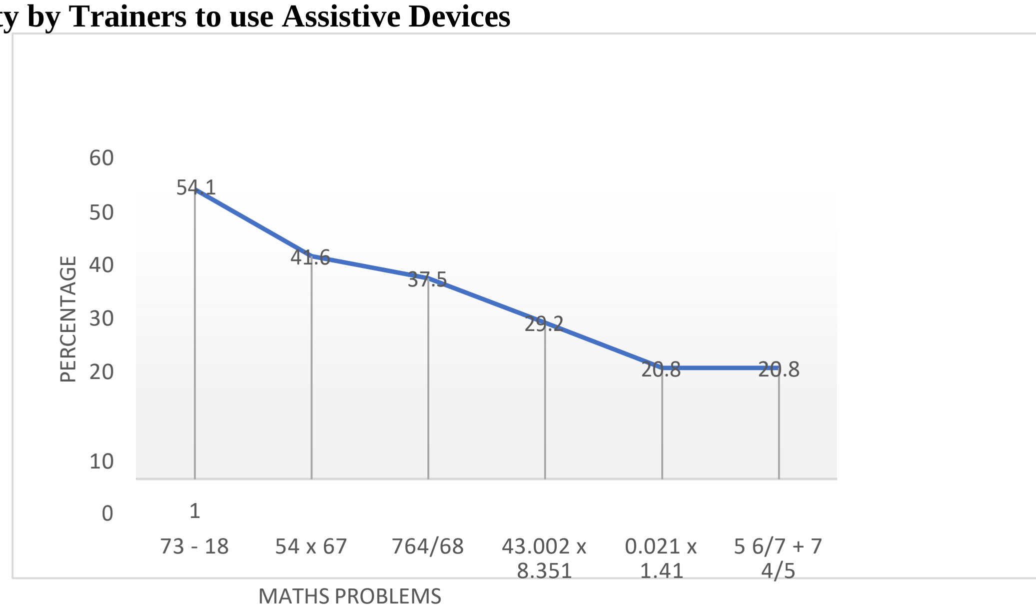
- With the availability of specialised teachers/lecturers, it could be possible to teach the VI all the topics (n = 8, 33.3%)
- They did not have prior experience (n = 7, 29.2%)

The lack of sufficient research materials as expressed by the university lecturers could suggest that more research needed to be done in the sector (Simalalo, 2012). The lack of sufficient instructural materials in Special Educations tallied well with what the findings by the MoCDMCH (2015), the UN (2016), and the Ministry (2018). The findings were also consistent with Malungo, et al (2018), who argued that most governments did not provide teaching and learning aids for learners with special needs on the pretext that they were expensive. Even though the instructional materials were costly, with minimum resources, some materials such as abacuses could locally be made. The most cardinal thing was to catch the concept that was intended to be delivered. It was in fact costlier when the materials were not made available, as the PWD will have to depend on others perpetually. State parties should be providing the needed materials in order to be able to provide quality education. That way, both the individual and national benefits could outweigh the cost. From the responses, some teachers had argued that LVI should not be learning all topics in Mathematics. According to them, the subject required the use of all the senses. This view was also supported by researchers who argued that teaching was best if it targeted all senses (Federal

Communications Commission, 2022). These findings, however, were not in tandem with discoveries in Gambia, where Alieu, a blind child was excellent in Mathematics (Sightsavers International, 2022). Definitely, the methodologies that were being used for Alieu, were appropriate for the disability. Therefore, though, the availability of all the senses makes learning much easier, the lack of one or a few may not fail someone to learn. It is important for institutions of higher learning to be monitoring themselves. Where they see some challenges, research should be instituted. They could also affiliate to other institutions that appeared to have advanced in research. The findings had to some extent validated the initial assumption that inadequate knowledge among the teachers was the main reason for their challenges to teach the learners effectively. In Q13C, lecturers were asked the following problem: Can your trainee-teachers solve the following problems using assistive devices? The response rates were shown on the line graph in Figure 15.

Figure 15

Ability by Trainers to use Assistive Devices



It can be noted that about 54% and 42% of the trainee-teachers were able to solve problems on addition, and subtraction respectively using assistive devices. The graph also shows declining abilities to compute problems involving multiplication, division, fractions and decimal numbers. The findings were consistent to the findings by Clement (2021) who argued that student-teachers had little knowledge and use of the basic assistive technology tools. In 9B and 15C, from the lecturer and teachers' questionnaires respectively, there was a question about the performance of LVI in Mathematics in National Examinations. It was as follows: What is the performance of learners with visual impairments in Mathematics in National Examinations? The results were as shown in Table 18.

Table 18

Views on Performance of LVI in Mathematics

	Frequency	
	Lecturers	**Teachers**
Excellent	-	-
Very Good	-	-
Good	3 (12.5%)	5 (8.3%)
Poor	15 (62.5%)	45 (75%)
Not Sure	4 (16.7%)	8 (13.3%)
No Response	2 (8.3%)	2 (3.3%)
Sample	24 (100%)	60 (100%)

The 3 lecturers and 5 teachers (total = 8 out of 84) that said that the learners' performance was good, pointed out the following:

- LVI were capable of understanding Mathematics (n = 7, 10.7%)
- Mathematics was the basis for innovations (n = 6, 9.5%)

- Mathematics enabled inclusive education to be implemented (6 = 8, 3%)
- There were qualified teachers who could handle the subject (n = 5, 7.1%)

The majority (62.5% of lecturers & 75% of teachers, altogether 84 of them) however, argued that the LVI's performance was poor. The contributing factors were:

- They could not see from the blackboard (n = 6, 7.1%)
- Some topics were had for them (n = 6, 7.1%)
- The Ministry did not have an adapted curriculum (n = 6, 7.1%)
- The curriculum was not supported with the right materials (n = 5, 6.0%)
- They were NOT SURE (n = 5, 5.9%)
- The nature of their disability could not help them (n = 4, 4.8%)
- They depended on verbal (n = 4, 4.8%)
- They needed to carry out research (n = 4, 4.8%)
- The LVI were taught by teachers who were limited in knowledge (n = 3, 3.6%)
- Most of the textbooks were in print, meant for the sighted (n = 3, 3.6%)
- The LVI were relying on the ordinary Mathematics curriculum (n = 3, 3.6%)
- Mainstream Mathematics teachers were unable to read Braille (n = 3, 3.6%)
- Some concepts require that the learner had sight or full senses (n = 3, 3.6%)
- They were usually the lowest in Mathematics examinations (n = 2, 1%)
- The LVI needed more time to learn Mathematics (n = 2, 1%)
- The LVI were not interested in the subject (n = 1, 0.5%)

From the responses, it can noted that LVI were capable of understanding Mathematics. It therefore, falls on researchers to ensure that the necessary ingredients were put in place for effective learning to be in place (Hwang, & Taylor, 2016). One was of the major challenges expressed was that of lacking specialised teachers in Mathematics. This was a likely response, knowing that schools depended highly on the traditional methodologies of using the chalk and blackboard that appear not to be effective for LVI. This response was expected as most of the schools did not show evidence of stocking abacuses during the period of the study. It appeared that the schools were not aware about how effective the tool was for solving mathematical problems. If they were aware, either, they did not receive specialised training on how to use it, or it was just attitudinal challenges. There was a challenge of the lacking of an Adapted Mathematics. Without such a deal, meant that teachers were teaching from trial and error. This concern seemed to be genuine as some of the methodologies for the sighted and non-sighted could not be the same. The sighted can see, while the non-sighted needed to touch.

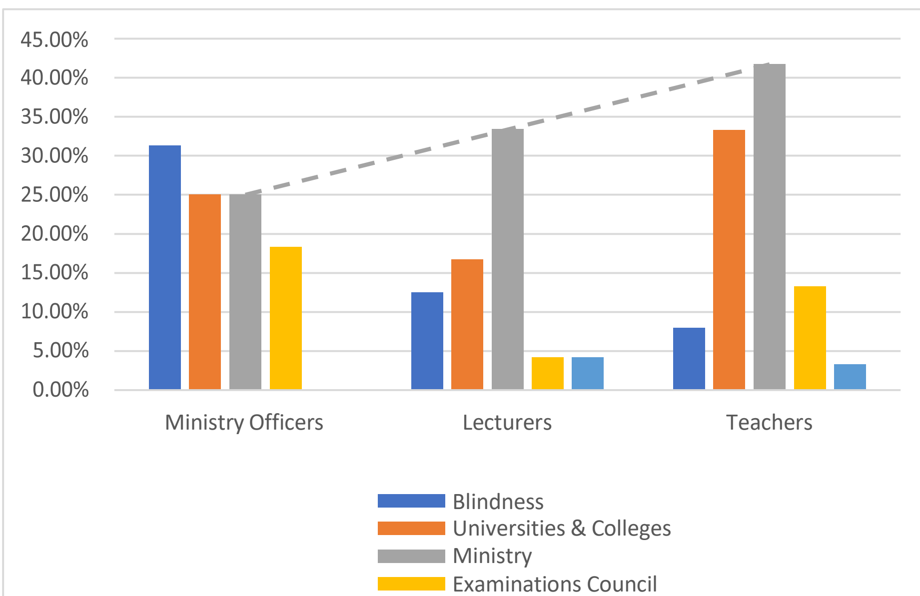
In Q15A and Q16A for Lecturers and Ministry Officers (40 in total) respectively, the question was: Some teachers have been trained in Special Education but opted not to teach Mathematics to learners with VI, please explain. The respondents indicated the following:

- Not aware of this situation (n = 8, 20%)
- They were not specialized in Mathematics (n = 7, 17.5%)
- Maths possesses a problem in terms of symbols and abstractness (n = 7, 17.5%)
- The training received was not adequate (n = 7, 17.5%)
- They do not have knowledge in Braille Mathematics (n = 6, 15%)
- There are remuneration challenges (n = 5, 12.5%)
- Facilities in institutions make teachers not to teach the LVI (n = 5, 12.5%)
- Lack of interest in the subject, and no passion or call of duty (n = 4, 10%)

The percentages responses were general low to be able to make tangible decision. However, when we read through all the comments, it can be seen that there was a relatively balanced view. Factors such as not being aware, not being specialised, Mathematics being abstract in nature, and inadequate training had taken the lead. These factors could suggest that the sector of Mathematics for LVI was unique, as Howard Gardner's theory of multiple intelligence had put it (Kendra, C., 2023), that certain disciplines required unique strategies. A follow up question in 11B, 15C and 6A for Ministry Officers, lecturers and teachers respectively had the following question: When learners with VI did not perform so well in Mathematics, who was to blame? (You can tick more than once from blindness, universities and colleges, the Ministry policies, the terminal examinations, and other factors). The results were as shown in Figure 16.

Figure 16

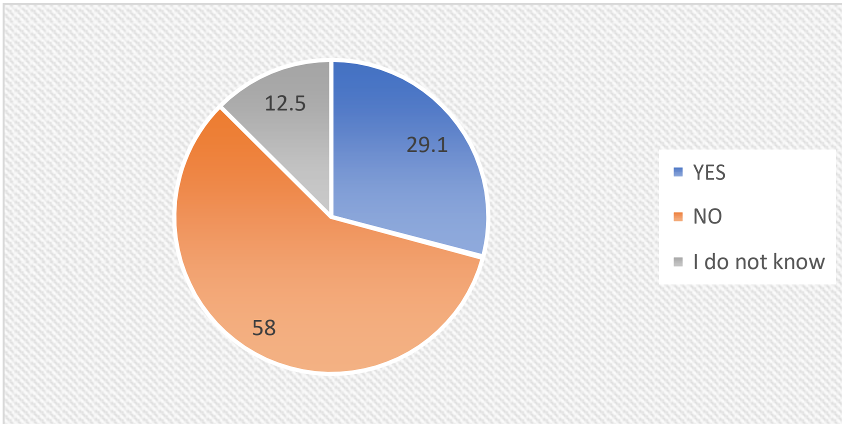
Causes of Poor Performance among LVI



From Figure 16, the findings were as follows: according to the Ministry, 34%, 25%, 25% and 17% was due to blindness, universities, Ministry and other factors respectively. From the lecturers' perspective, 34%, 17%, 13% and 4% were due to the Ministry, universities, blindness, examinations and other factors respectively. For the teachers, 42%, 33%, 13% and 7% were due to the Ministry, universities, blindness and other factors respectively. The findings show that each party was blaming the other. The Ministry was blaming universities and colleges for not adequately preparing their trainee-teachers. Other than blaming the Ministry, the teachers also blamed the universities and colleges, where they had received their training. The teachers were also blaming the Ministry, for not putting in all that was required for schools to provide quality education. The results also indicated that there was less blame that was placed on the National Examinations as well as Other Factors. The general trend was that of putting blame on the Ministry of Education. It hard the highest scores. However, according to Kelly (1999), most of the challenges in education tended to be lamped on the teacher. These results also pointed to the fact that the knowledge of the discipline of Mathematics for LVI was not only inadequate among the teachers, but even in institutions of higher learning and in the Ministry of Education (ICEVI, 2007). There was also a question if at all they were aware of the use of assistive devices in the teaching of Mathematics to the LVI. Most of them had indicated that they were aware. Some of those that were above 50 years and above, used to use them for learning how to count. However, little did they know that it could be a special tool particularly for LVI. From the responses to Q17B and Q16 for the lecturers and teachers respectively, it was suggested that the number of Mathematics topics needed to be reduced. This suggestion did not appear to make sense, as a reduction in the number of topics did not make the selected topics simpler. However, that was worth trying. The Ministry could start with introducing manageable topics, then gradually introduce more topics as more knowledge was availed. The University of Illinois (2010) argues that it is important that the society ultimately remove some of the disabling barriers. In response to Q11B, about 33% of the Ministry Offices had attributed the low academic levels among LVI in Mathematics to the existence of blindness in the learners. However, this was contrary to the Gestalt theory by Fredrick Peris (Bustamante, 2023), who argued that attributes of the whole should not be deduced from analysis of the parts in isolation. The poor performance could have likely been due to other factors, such as the inadequate training of their teachers. The Gestalt theory was in line with the 34% of the lecturers and 42% of the teachers' assertions to Q17B and 6A respectively, where it was pointed out that sometimes blindness was not the real cause. The solving of problems appeared to be taking place in the brain (Lisa, and Daniel, 2020), hence, there could be other factors, other than the VI disability itself. In response to 16A, about 76.7% of the teachers said that it was not possible for LVI to learn all the topics in Mathematics. But the Understood Team (2020) argued that even problems such as $y = x^2$ and $x = -b \pm \sqrt{(b^2 - 4ac)}/2a$ can be mastered by them. The research team argued that many such formulas can be worked out using many invented tools for the VI. There were also tools for drawing lines, shapes, angles, and other geometric features. Such tools included crayons, tracing wheels and geoboards, braille meter sticks, analog model clock and the tactile thermometer (Jenkison, 1997). The availability of such tools on the global market suggests that Mathematics was as easy as any other subject for the VI. In Q16, lecturers were asked the question: Is your institution affiliated to other universities with regards the teaching of Mathematics to the LVI? The findings were as follows: 58% said YES, 29% were for NO, and 12.5% for I DO NOT KNOW, as in the Figure 17.

Figure 17

Affiliation of Colleges & Universities



When requested to list down the institutions affiliated to, the responses were as follows:

- Only the University of Zambia was mentioned (n = 6, 25%).

Only one university was mentioned. This was likely listed down by respondents from the two colleges of education that were affiliated to the institution. It appears that international universities that were providing education in the similar sector were unknown. Or it could be that they thought the question referred to local universities only. The responses to Q8 indicated that 58% of the institutions of higher learning were not affiliated to other institutions globally, in the sector of Mathematics for the VI. It also pointed to the fact that less research had been conducted in this sector. Such factors could have been compromising with the quality of education. The lack of inadequate collaboration between different universities appeared to have contributed to the poor quality of education among children with disabilities (SADC, 2015).

In question 8A, the teachers were asked the question: Do you know of any institution of higher learning globally where teacher-educators were trained in Mathematics for teaching LVI at secondary school? The responses were as shown in Table 19 below:

Table 19

Institutions Globally that offered Adapted Mathematics

Knowledge among Teachers	No. of Teachers
YES	5 (8.3%)
NO	53 (88.3%)
No Response	2 (3.3%)
Total	60 (100%)

Over eighty (80%) of the teachers indicated that they were not aware. This is a high number, and could suggest that the sector may not be receiving much attention.

Effective Teaching Strategies for Teaching Mathematics to LVI

The second main research question was: What teaching strategies were effective for the teaching of Mathematics to LVI? The question was evaluated against the assumed null and alternative hypotheses. As a reminder, the null hypothesis (H_o) for the second research question was that teacher educators' strategies were effective with regards the teaching of Mathematics to LVI. The alternative hypothesis (H_a), which was of concern, was that teacher-educators' strategies were not that effective. In Q16 and 15B for teachers and lecturers respectively, the questionnaires had the question: In your opinion, how can the teaching of Maths to learners with visually impaired be enhanced? The lecturers said that:

- There was need for research in the sector (16 = 6, 66.7%).
- Using assistive devices (n = 14, 58.3%).
- Not sure (n = 8, 33.3%).
- There was need to reduce the number of topics (n= 6, 25%).
- Need for teaching methodologies that were learner centred (n = 3, 12.5%).
- Lecture methods (n = 3, 12.5%).

The 60 teachers on the other hand listed the following:

- All teachers should be trained in special education (n = 15, 25%).
- Need for a separate syllabus for LVI that should have easy topics (n = 13, 21.7%).
- There should be the use of verbal and aural methodologies (n = 12, 20%).
- There should be continuous professional development programmes (n = 10, 16.7%).
- Some topics needed to be removed such as drawing (n = 10, 16.7%).
- Training should have been in Mathematics and Braille (n = 8, 13.3%).
- LVI should not be following the curriculum for the sighted (n = 6, 25%).
- They also blamed the way examinations were being set (n = 6, 10%).
- The duration for writing the examinations should be increased (n = 6, 10%).

From the responses, the lecturers and Ministry Officers respectively indicated that most of the Mathematical concepts were hard for LVI. It was explained that their teachers were not specialised in Mathematics for the VI. This is in agreement with Kelly, M (1999) who argued that schools did not know how to teach learners with disabilities. Additionally, the teachers argued that there should be specialised training, and for in-service teachers, they should be receiving continuous professional development programmes. This is in line with Howard Gardner's theory that argued that some areas were highly specialised (Loewenberg, et al, 2008). It also tallies well with Walmsley, et al (2007), who said that Special Education teachers were not well-grounded enough around the adaptation of the school curriculum.

In Q9B, Q12A and Q13 on the teachers, lecturers and policy makers' questionnaires, respondents were asked the question: Have you ever heard of assistive devices for teaching Mathematics to learners with visual impairments? If so list them.

The 24 lecturers listed the following:

- I do not know (n = 12, 50%).
- I do not have prior experience (n = 10, 41.7%).
- Braille (n = 6, 25%).
- Calculator (n = 5, 20.8%).

The 60 teachers from the Mathematics departments listed the following:

- The abacus (n = 34, 56.7%).
- Slates and slates (n = 25, 41.7%).
- Braille machines (n = 10, 16.7%).
- Phones (n = 7, 11.7%).
- Perkins Brailler, (n = 7, 11.7%).
- Calculator (n = 6, 10%).
- Personal computer (n = 6, 10%).
- Jaws (n = 5, 8.3%).
- Geoboards (n = 5, 8.3%).

- Magnifying glasses (n = 4, 6.7%).
- Cubes (n = 4, 6.7%).
- CCTV (n = 3, 5%).
- No idea (n = 3, 5%).

About 66.7% of the lecturers argued that there was need for research in the sector. Kamal (2015) agrees with the assertion that research was an important element in finding solutions. It can also be noted that 58.3% of the lecturers suggested that more research was needed in the use of assistive devices. This discipline could be described as highly specialised going by Howard Gardner's theory of multiple intelligence (Kendra, 2023). Fortunately, over 50% of the teachers listed a lot of assistive devices, suggesting that a lot of efforts were being done in schools. Organisations such as ICEVI (2023) were in collaboration with many governments in the promotion of assistive devices for LVI. In Q10C, teachers were asked the question: Are assistive devices readily available in Zambia? The responses were as shown in Table 20.

Table 20

Availability of Assistive Devices in Schools

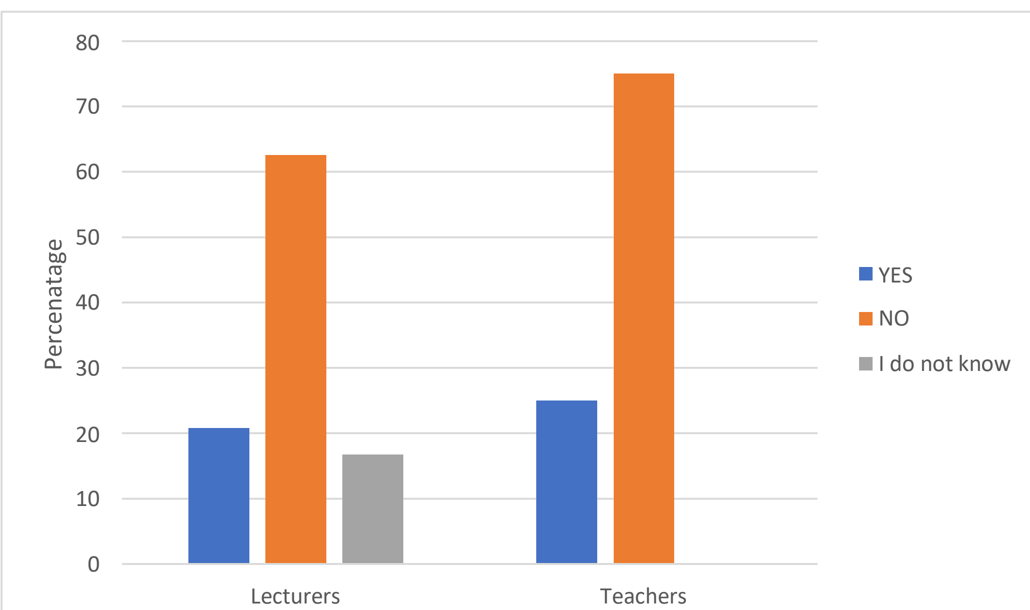
Availability of Assistive Devices	Lecturers	Teachers
YES	4 (16.7%)	12 (20%)
NO	17 (70.8%)	43 (71.7%)
I do not know	2 (8.3%)	3 (5.0%)
No Response	1 (4.1%)	2 (3.3%)
Total	24 (100%)	60 (100%)

Over 70% of both lecturers and teachers said that they did not have the named assistive devices in their institutions of learning. Even to carry out the quasi-experiments, the participants did not have assistive devices, a situation which appeared to be a world-wide challenge (UN, 2023). During the observations of schools and universities, it was noted that most of the institutions did not have stocks of assistive devices in their store rooms. A few schools though had a few, but they complained that they did not know how to use them. Special Education schools appeared to have more assistive devices than inclusive schools. This was especially evident in the private special school. There were some abacuses of different types that were appropriate at different grade levels.

In 12B for lecturers, the respondents were asked if at all the training package for teachers of the LVI embraced the use of assistive devices. The question was: Does your training package for trainee-teachers include the use of Abacuses? The responses were as follows:

Figure 18

Teachers were Trained on Using the Abacus



The bar graphs suggest that about 62% of lecturers and 75% of teachers did not receive training in the use of assistive devices. Oliv, and Anne (2019) encouraged the use of tactile methodologies for teaching persons with disabilities.

Additionally, in Q14 and Q13 of the Ministry and Lecturers (40 in number) respectively, were asked to list down the topics in the Mathematics curriculum they thought the Abacus could be used for in computations. The indicated the following:

- Counting (n = 35, 87.5%).
- Addition (n = 23, 57.5 %).
- Subtraction (n = 22, 55%).
- Place Value (n = 20, 50%)
- Multiplication of Numbers (n = 8, 20%).
- Division (n = 6, 15%)
- Fractions (n = 4, 10%).

In Q15 and Q13A (II) of the Ministry and Lecturers respectively, the question was: On which topics in the Mathematics curriculum do you think the Abacus may not be used for computation? They listed down the following:

- Fractions (n = 12, 30%).
- Statistics (n = 10, 25%).
- No idea (n = 9, 22.5%).
- Sets (n = 8, 20%).
- Trigonometry (n = 7, 17.5%).

- Probability (n = 6, 15%).
- Measurements (n = 6, 15%).
- Calculus (n = 5, 12.5%).
- Linear programming (n = 4, 10%).

From the findings above, it appeared that the Ministry and the lecturers knew about the use of the Abacus. It was mainly known for Counting (87.5%). About 57.5% also believed that they can be used for Addition. However, they did not appear to know that the Abacus can also be used for Multiplication and Division. In Q14A and B on the lecturers' questionnaire, they were required to fill in some gaps with one or a few words. The first question was: The VI use …. when taking measurements.

The 16 lecturers listed down the following:

- No idea (n = 8, 50%)
- Dotted rulers (n = 6, 37.5%).
- Tactile (n = 6, 37.5%).
- Rulers (n = 6, 37.5%).
- Estimates (n = 3, 18.8%).
- Strings (n = 2, 12.5%).

The second question was: The LVI use …. when drawing circles. The 16 lecturers listed down the following:

- No idea (n = 10, 62.25%).

- Braille paper (n = 7, 43.8%).
- The stylus (n = 6, 37.5%).
- Dotted rulers (n = 6, 37.5%).
- Tracing wheels (n = 5, 31.3%).
- Tactile rulers (n = 5, 31.3%).
- Fingers/hands (n = 4, 25%).

One of the major topics in Mathematics that was taught in schools was Measurement (CDC, 2013). The subject appears to be a precursor for understanding other topics. About 50% of the lecturers did not know how the VI can be solving problems based on measurements. About 62.3% also did not what the LVI should be using for drawing circles. This is in line with Salamonczyk (2020) who argued that teachers had challenges in offering work that had graphics to LVI. Topics such as linear programming, construction and circle geometry were graphical in nature. Without knowing how to teach such topics, it suggests that LVI cannot receive adequate training.

Teachers' abilities to using Assistive Devices for teaching Mathematics

The third research question examined the practical nature of this research. It directly answered the main objective, and main research question. To what extent can teachers use assistive devices for teaching Mathematics to LVI? Being the main concern of the research, it was therefore, the QUAN part (Jennie, 2013). The participants were tested on basic Mathematics, at the level of primary school. There were two types of respondents: Special Education teachers and ordinary Mathematics teachers. Additionally, there were also lecturers from the two stated categories. The question on the impact of using abacuses to the computations of numbers was investigated through a quasi-experimental approach. There was a pre-test, experimental tests, and post-test. The participants were to use methodologies that were used by LVI in computing Mathematics. Hence no pen, pencil nor chalk were to be used.

The third research question was identical to the *null* hypothesis (Ho), that there was no relationship between the use of Abacus and the teaching and learning of Mathematics to LVI. The null hypothesis was that teachers shall score more that 25% on average, on the given pre-test items. The inferential statistics for the null hypothesis (H_o) was: The null hypothesis, (H_o)**:** $\mu > 25\%$: the knowledge of teacher trainers to the teaching of Mathematics to the VI was better than 25%.

The alternative hypothesis, Ha**:** $\mu \leq 25\%$, that is, the knowledge of teacher trainers to the teaching of Mathematics to the VI was not better than 25% (where μ was the population mean). After the 10 items were undertaken by all the 20 participants, the total for each of the participants was converted into percentages. Examples of questions: (1). 5 + 7, (2). 37 + 45 (3). 73 – 18 (4). 54 x 67 (5). 54

Pre-Test Results

The results of each of the 20 participants at Pre-test, with pseudo names were as follows:

Table 21

Performance of Respondents at Pre-Test

Institution	UT Sp Ed	Mun Girls Sec	Sisa Sp Ed	Sef Sp Ed	Sef Sec Sch	St. Mul	Mbu Sp	Kas Sp	ZAM
Participant	A B C	D E F	G H I	J K	L M N	O	P	Q	R S T
Score (%)	20,10,20	20,20,10	20,20,30	20,30	10,20,20	20	20	20	20,20,30

From Table 21, the letters A, B, C and so forth, were not really their actual names, but pseudo names. From the table above, participant A got 20%, B had 10%, and so forth.

The *mean* ($\bar{x}$): 20. Total Marks/n, 400/20 is 20. Where n is the Sample sise.

The *Median*: 20. 10 10 10 20 20 20 20 20 20 20 20 20 20 20 20 20 20 30 30 30

The Median: 20. Since the figures were even, the median is found by adding the two middle numbers and dividing by 2. (20 + 20)/2 = 20

The *mode*: 20. The mode is the figure that appears most. As a summary, the measures of central tendency were summarised as in Table 22.

Table 22

The Mean, Mode and Median Scores at Pre-Test

Average	Mean	Mode	Median
Score (%)	20	20	20

All the three measurements of central tendency scored were 20, suggesting that the results were to some extent reliable. From the above table, the mean scores of the institutions were also found. Just like for names of individuals, the names used in Table 21, such as UT Sp Ed Sch, Mun Girls Sec and so forth, were not really the actual names, but pseudo names. These names were adopted to protect the integrity of the institutions. Other than being interested in the performance of individuals, the average performance of all the teachers per school was equally considered. Five schools and a college of education had participated in the quasi-experiments. The mean scores of the institutions were as shown in Table 23. Schools with just one participant were left out.

Table 23

The Mean Scores of Institutions at Pre-Test

Name of School	UT Sp Ed	Mun Girls	Sisa Sp	Sef Sp	Sef Sec School	ZAM College
Special OR Maths	Sp Educ	Maths	Sp Edu	Sp Edu	Maths	Special &Math
Mean Score (%)	16.7	16.7	23.3	25	16.7	23.3%

The mean values were calculated from the individual values as was obtained in Table 21. Most of the schools that had performed better at pre-test were Special Education Schools (e.g Sisa Special Education, Sef School for the Blind). The schools that performed poorly were mainly conventional (Inclusive) schools, where the VI were taught by Mathematics teachers (e.g Mun and Sef Sec School). The findings were segregated according to whether the teachers were of Special Education or Mathematics oriented. Schools such as UT Special Education School, Sisa Special Education School and Sef School for the Blind were typically Special Education Schools. Most of the teachers in such schools did not take Mathematics as a teaching subject. Those who did at colleges or universities appear not to have been well grounded. They mainly took social science subjects such as Office Practice, History and Home Economics. On the other hand, schools such as Sef Sec and Mun Secondary Schools were mainly manned by teachers with Mathematics qualifications. A comparison of test means from the two models of education has been illustrated in Table 24.

Table 24

Performance of Special and Maths Teachers at Pre-Test

Type of Teachers	Special Education Teachers			Mathematics Teachers	
Institution	UT	Sisa	Sef Sp Ed	Sef Sec	Mun Sec
Marks (%)	20,10,20	20,20,30	20,30	10,20,20	20,20,10
Mean (%)	21.25			20	

Adapted from Szczepanek (2023).

From Table 24, the findings show that Special Education teachers had scored the highest (21.25%) in the area of Mathematics for the VI compared to teachers of Mathematics (20%). The findings were also segregated according to schools and institutions of higher learning. From the findings in Table 21, the total marks for all candidates was 400. From the same table, the total marks for college lecturers (R, S & T) was 70%. This suggests that the total marks for all the teachers was 330% (400 – 70). There were 3 lecturers and 17 teachers in total. Hence 330% divided by 17 teachers gives 19.4%, as per Table 25.

Table 25

Pre-Test Results according to Schools and Colleges

Institution	**Average Score**
Schools (teachers)	19.4%
ZAM College (lecturers)	23.3%

The results at pre-test suggested that lecturers were better than teachers in the sector of Mathematics for the VI. They had an average of 23.3% compared to 19.4% for teachers. The Pre-Test was followed by a number of experimental observations. Statistically, the null hypothesis (H_o) or raw scores at pre-test, was set at 25%. This was the researcher's presumed percentage at which the teachers and teacher educators were likely to score in the pre-test. Statistically, this could be represented as ($\mu < 25$). That is, the teachers and teacher educators were not going to score more

that 25% in the pre-test. They however, scored a Sample Mean ($\bar{x}$) of 20%. The SD was 5.62**.** This suggests that participants were within the range of 20 ± 5.68 (or 14.32% – 25.68%).

It became necessary that outliers were checked for at post-test in order to determine the figures that were influencing the hypothetical mean so much. These were figures which were not in the range of SD of 5.62, that is, outside 69 +/- 5.62 or 14.38% – 25.62%. Outliers sometimes can be removed and replaced by average figures (Edward, F., 2020). For this study, they were not removed as they did not appear to affect the findings. The outliers are outside the box, as can be noted from the Table 26.

Table 26

Outliers at Pre-Test

Outliers 10, 10, 10	20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20,20	Outliers 30, 30, 30

The three 10s and the three 30s were the outliers. If they appear to disturb the results, they should be done away with. When using analysis of variance (ANOVA), outliers were not deleted as the formula included all data points (Edward, 2020).

The use of the Abacus as a mechanism or methodology was conducted by the researcher on *10 experimental lessons*, often marked as X_{1}, X_{2}, $X_{3} \ldots X_{10}$. The lessons were on the following topics: 1. Addition of Single Digits, 2. Addition of Double and Multiple Digits, 3. Subtraction, 4. Multiplication, 5. Division, 6. Addition of Decimal Numbers, 7. Subtraction of Decimal Numbers, 8. Multiplication of Decimal Numbers, 9. Addition of Fractions, and 10. Division of Fractions. Experimental participants were asked to solve the problem using assistive devices. They were not supposed to use a pen, pencil, or chalk. The observations from ten the experiments were as follows:

The Ten (10) Experiments

Experiment 1: 5 + 7

Most of them had serious challenges solving the problem on One Digit Abacus Addition using assistive devices. It was like they have never heard or used assistive devices for solving Mathematics problems. In order to proceed with the experiment, the participants for the experiment were shown what to do. The Abacus was shown to them (please refer to figure 2). It has columns where the beads have been placed. Each column has 10 beads. They were told that for ‘addition’, they should use the far most columns on the right of the Abacus. You start by adding 5 beads, and followed by the 7 beads. Apparently, after getting the 5 beads, only 5 beads remained, hence you cannot get the 7 beads. To compute the problem, you have to keep the 7 beads at the back of your mind, and add then add to the 5 beads to get twelve. To insert twelve beads, two beads should go to the ones column whereas one bead should be placed in the tens column. After the example, they were given two problems as an exercise. They progressed at 100% on the item.

Experiment 2: 37 + 45

The participants were then given a problem on Addition of Two Digit Numbers. Some participants just placed the answer without showing the calculations. That was considered to be wrong. The correct procedure was explained. A closer look at this question shows that the answer to 7 + 5 = 12 cannot fit in the 1st column. Therefore, the skill of carrying over some figures was necessary. You add by starting the computations with the first column, then go to the second column. An exercise on two problems was given. Almost all of them were able to follow.

Experiment 3: 73 - 18.

The third question was on Abacus Subtraction. About 20% of the participants managed to solve the problem. The principle of calculating was similar to that of addition. The major challenge was how to subtract 8 beads from 3 beads. It was explained that they needed to borrow a bead from the (which was equivalent to 10) from the 7, making it 13. Subtracting 8 from 13 gave 5. Then 6 – 1 gave 5. The answer was therefore, 55.

Experiment 4: 54 x 67

Questions on Abacus Multiplication followed. No one got this question right. Multiplication at this stage was in the 4th grade in the Zambian curriculum (CDC, 2003). The problem was explained to them as follows: Set 54 beads on the left-most of the Abacus, leave a column blank, then insert the second figure (67). Start multiplying the units of the first figures of the two numbers (7 x 4). Place the answer (28) on the right most the Abacus. The second step was to multiply 7 x 5 = 35. The reader should take note that the 5 stands for 5 tens (50), hence this is 7 x 50. The answer (7 x 5 = 35) should be placed in the second and the third columns. The similar rules should be observed for multiplying with the 6. The rules on addition should also be followed. The final answer should be 3,618. Two questions were given for practise. However, it was found that some teachers had challenges with the multiplication table. For instance, 7 x 4 was a bit of a problem for some Special Education teachers.

Experiment 5: 1,764 ÷ 6.

The fifth experiment was on Abacus Division. None of the participants got it right. It was then explained. Place the dividend (1,764) on the right most of the experiment, and the divisor (6) on the left most. Then you start dividing 6 into 17, it gives you 2, leaving a remainder of 5. Place the 5 beads near to the divisor but leaving one column blank. Then divide 6 into 56, you get 9, leaving a remainder of 2. Place the beads in the column next to the beads. You must be remaining with 24 beads. Divide 24 by 6, you get 4. Place the 4 beads next to the 9 beads. The answer or quotient is 294.

Experiment 6: 28.2 + 7.57

The sixth experiment was on Abacus Decimal Numbers. None of them was able to solve the problem. They were then told to use two abacuses, and making sure that the decimal points were in a straight line. The decimal point was represented by a strip of paper. Since the second figure (7.57) had two decimal points, the first (28.2) with one decimal point should follow the second in their alignment. By adding corresponding figures, the answer comes to 35.77.

Experiment 7: 43.002 – 8.35

For Abacus Subtraction of Decimal Points, the figures were aligned just like for Abacus Addition. They should be like: 43.002 – 08.350. Then subtract corresponding entries. You get 34.652

Experiment 8: 348 x 785

To solve the problem, divide it into three parts as: (348 x 5) + (348 x 80), (348 x 700), and then add the three sub-answers giving 273,180. An Abacus with about 15 columns should be used. In the absence of such an Abacus, it is advisable to use two abcuses.

Experiment 9: 0.021 x 1.4

To solve this, participants were told to remove the decimal points. 0.021 has 3 decimal numbers, whereas 1.4 has 1, altogether adding up to 4. Then treat the question as 21 x 14. Compute the problem as for Abacus Multiplication. The answer is = 294. Then count 4 decimal places and insert the decimal point. The answer is 0.0294.

Experiment 10: 5 6/7 + 7 4/5

For mixed fractions use two abacuses. Start with adding the whole numbers: 5 + 7 = 12. Place the 12 at the right most of one Abacus. In another Abacus, place 6/7 by inserting a paper to represent the slash (/) between 6 and 7. Leave two columns blank and place 4/5. At the right most of this Abacus, place the common denominator of 7 and 5, which is 35. Divide 35 by 7 and multiply by 6, you get 30. Clear the 6/7 and replace it with 30. Divide 35 by 5 and multiply by 4, you get 28. Clear the 4/5 and replace it with 30. Add the two numerators:

30 + 28 = 58. Place the 58 adjacent to the denominator 35 and clear the 30 and 35. Separate the numerator from the denominator with a piece of paper. Divide the numerator 58 by the denominator: 58/35, which is 1 23/35. Remember to add the whole number 12 that was stored in the other Abacus to the 1, you get 13 23/35.

Post - Tests

After all the ten lessons had been conducted, Post - Tests were administered to all the experimental institutions. The inferential data analysis was applied. Just like at Pre – Test, central tendency measurements were taken. The means, mode and median scores of the data were calculated. These scores were calculated for the entire groups and for each school. Each of the participants' results at post-test were converted into percentages. The pseudo names of each of the 20 participants at pre-test were maintained at post-tests. Their test results were summed up as in Table 27:

Table 27

Performance of Respondents at Post-Test

School	UT Spec	Mun Sec	Sisa Sp	Sef Sp	Sef Sec	Zam College
Participants	A B C	D E F	G H I	J K	L M N	R S T
Score (%)	70,60,50	90,90,70	80,80,70	60,70	80,70,70	80,60 50

Following the experimental tests, all the participants were noted to have increased in knowledge of using the abacuses. Some participants scored as high as 90% while the lowest got about 50%. In general, their performances had greatly improved. The marks were coming from the 20 participants from the different nine quasi-institutions. From these individual marks, the central tendency scores of mean, mode and median have been summed up in Table 28.

Table 28

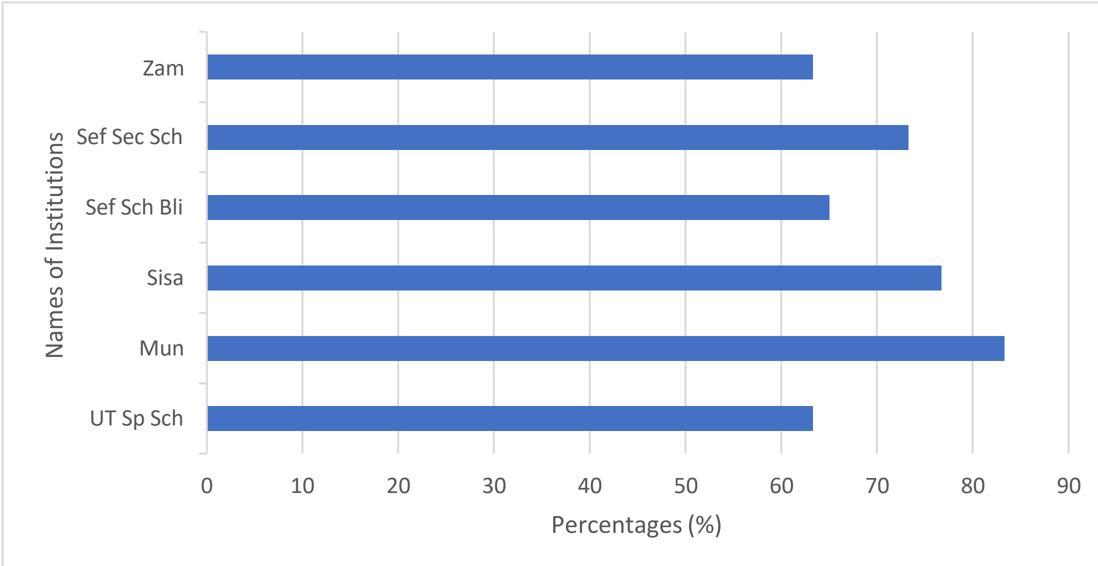
Average Scores of Respondents at Post-Test

Average	Mean	Mode	Median
Score	69%	70%	70%

Since there wasn't much variation in the central tendency measurements, the average of 69% can be considered to be a good measure. The findings of the participants at post-test could also be categorised according to the five schools and a college of education. The averages of individual results per each school were also summarised, as can be observed in Figure 19.

Figure 19

Mean Scores of Institutions at Post-Test



Most of the schools scored above 60%, with the highest scoring an average of 83%. Most of the schools that performed better were a Private Special Education School (Sisa Special Education) and Inclusive Education (Mun Girls Secondary and Sef Sec School). The Special Education Schools were at the bottom (UT Sp Ed Sch, Sef School for the Blind and ZAM College). The Inclusive Education Schools had teachers with Mathematics qualifications. The results were the opposite to the ones at pre-test where Special Education schools were at the top. The private school appeared to have remained relatively at the top throughout the experiments.

The scores were also classified according to the nature of the institution (Special and Mathematics). The objective was to compare performances of the teachers of Mathematics and Special Education teachers. The results were summarised in Table 29:

Table 29

Comparing Special and Maths Teachers at Post-Test

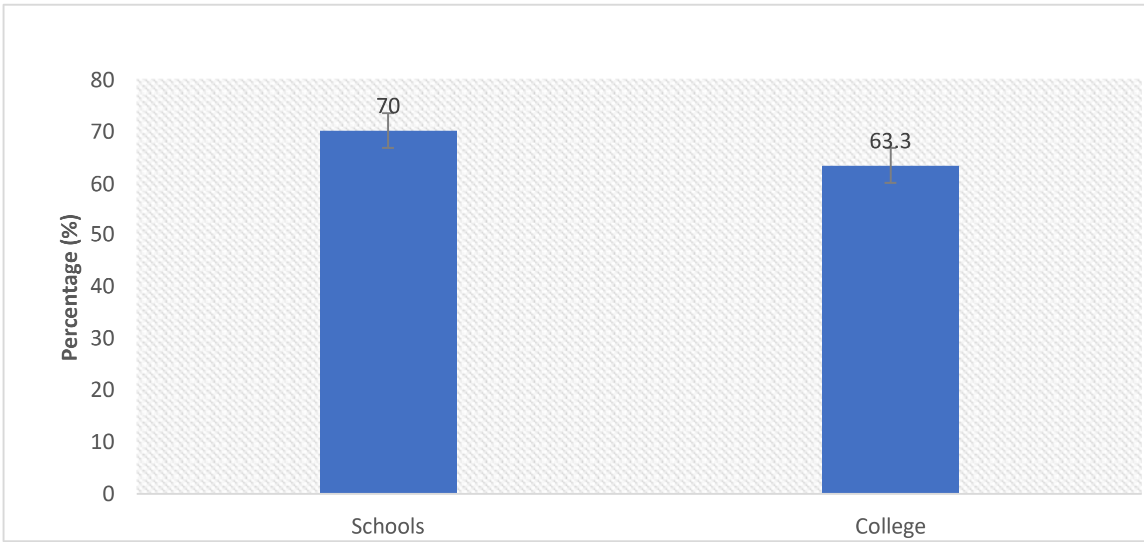
Type of Teachers	Special Education Teachers			Mathematics Teachers	
Institution	UT	Sisa	Sef Special	Sef Sec	Mun
Scores	70,60,50	80,80,70	60,70	80,70,70	90,90,70
Mean	67.5%			78.33%	

From Table 29, the findings were that teachers of Mathematics had quickly learnt how to be using abacuses during the training, compared to their counterparts, the Special Education teachers. The gap was quite large, with an average difference of over 10%. A closer examination can also show that Mun, a school with teachers of Mathematics was the best. The rate of understanding appeared to be much higher among the teachers of Mathematics than the Special Education teachers. Teachers who did not clearly understand the multiplication table had more challenges.

The post-test results were also categorised according to whether the institution was a college or a school, as in Figure 20.

Figure 20

Post-Test Results of Schools & a College



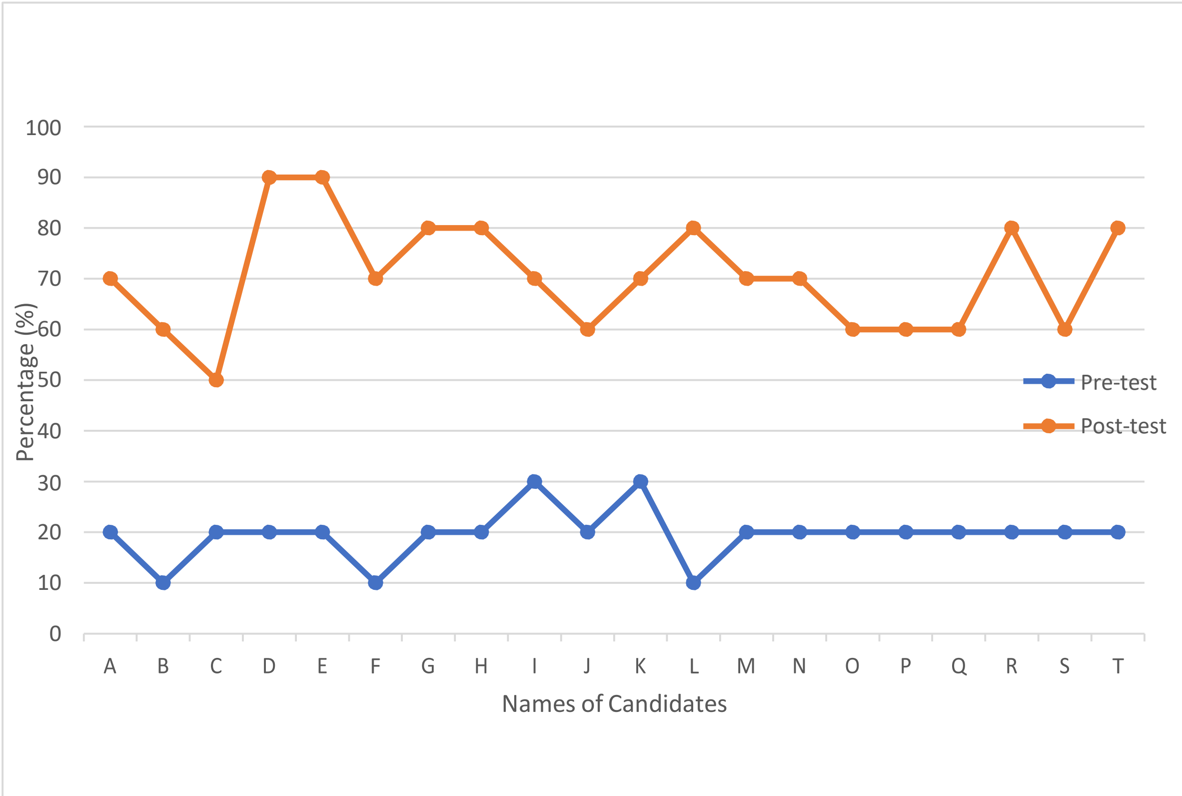
There were 20 participants for the experiments: 17 teachers and 3 lecturers. The total score of the teachers was $\sum x$ = 1,190. The mean score for teachers was therefore, 1,190/17 = 70%. The total score for the lecturers was: 190/3 = 63.33%. The overall results at post-test were that teachers had better results than the lecturers, with a margin of about 7%. Lecturers were expected to be better than teachers, but it appeared that more could be happening in the schools about the use of abacuses compared to the colleges.

Comparing Pre- and Post-Test Results

The means at pre- and post-test results were also compared in order to determine the degree of change in the results. Figure 21 has individual results at both pre- and post-test. At Post-test, the null hypothesis (H_o) was set at scoring more than 80%.

Figure 21

Trends at Pre- & Post-Test

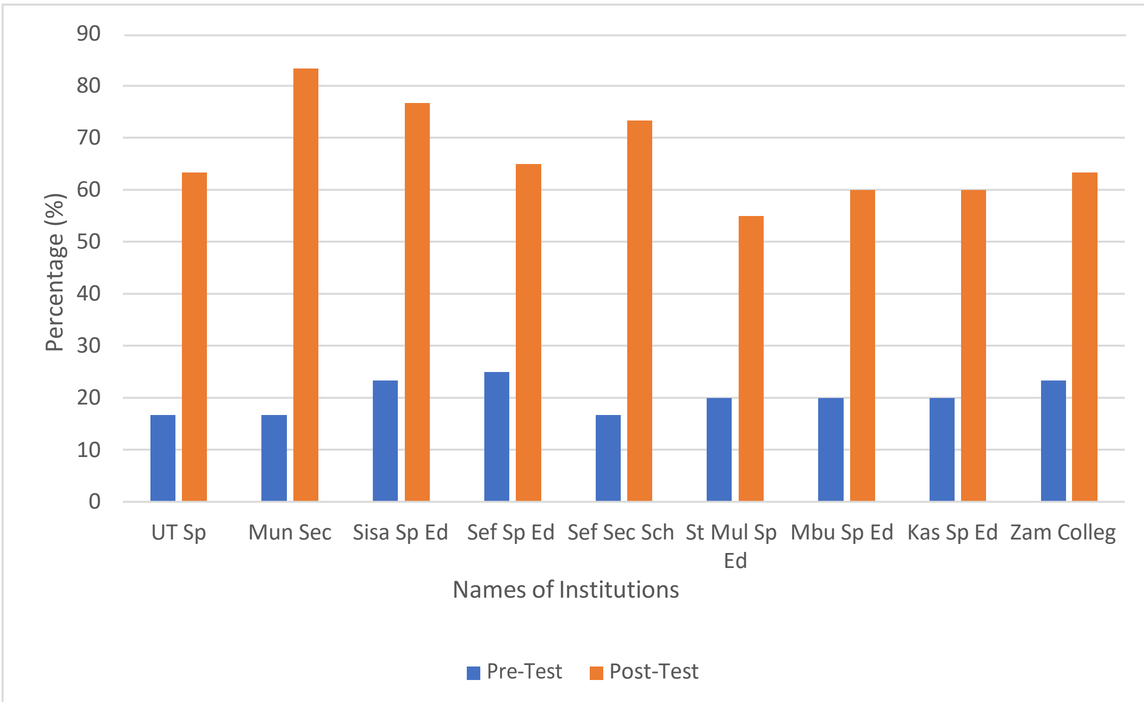


The 80% was the researcher's presumed sample population mean after the teachers and teacher educators' performance had gone through the experimental tests. The Sample Mean ($\bar{x}$) was 69%, and the SD was 11.65. This suggests that most of the participants scored in the range of 69 +/- 11.65 or 57.35% – 80.65%. The higher scores at post-test definitely suggested that the Abacus methodologies, if taken on board, could greatly produce wonders.

The improvement was also analysed institution by institution. From Figure 22, on the following page, it can be seen that the schools that had scored poorly during the pre-test were the best during the post-test. For instance, Mun Girls Sec was one of the lowest at pre-test with 16.7%. Sef Sec School also had similar characteristics.

Figure 22

Mean Scores of Institutions at Pre- and Post – Test



In general, the Special Education Schools lagged behind on the post - tests, even though they had taken the lead in the pre-tests.

Findings from Observation Protocols

There was also consideration of Observation Protocols during the Quasi-Experiments. Other than the scores on the different sub-topics in Mathematics at pre- and post-tests, the participants were also observed on other attributes. This was important because effective learning required that certain ethos were in place (Kelly, 1999). The attributes on which the participants were observed on were: teachers' morale, willingness to adopt the use of the abacuses, and management efforts to support program.

To measure the teachers' morale, the time for reporting and rate of attendance were measured. Attendance was usually above 95%. It was noted that the participants were more than ready to learn how to use the Abacus. This was noticed on how they were managing their time. In brief, there was morale around learning how to use the new methodology, 'the Abacus'. This was more so for the teachers. Lecturers at the college were somehow not cooperative. They were reluctant to participate in the quasi-experiments. Only three accepted to participate. The beginning though was difficult. Most of the participants had a lot of challenges at pre-test, in placing beads on the Abacus, hence, some could not manage solving even 5 + 7. The researcher had to explain the principle of place-value when placing beads, that is, how to place beads in ones, tens, hundreds, thousands and so on. Most of them just attempted questions on addition and subtraction. None of them attempted problems on multiplication, division and fractions. They submitted their answers well before the allocated time of 30 minutes had elapsed. Even on addition and subtraction, it looked like there were mental calculations, and copying from each other. The researcher had to change the problems such as 5 + 7 and 9 - 2 to problems such as 26 + 67, and 53 - 27 respectively.

The second aspect that was measured during the quasi-experiments was the willingness by the participants to adopt the use of the abacuses, as one of their teaching strategies. Most of them wanted to know where they could source for them. That was a strong indication that they had embraced the teaching methodology. Additionally, attributes that were noted, was whether they were ready to introduce Mathematics to LVI or not, taking into consideration the knowledge they had received. It was noted that most of them were not ready to implement what they had learnt. However, some of them were noticed to have gained some confidence. They explained that there was likely to be some improvement in their delivery of the subject.

The third aspect that was monitored was that of support from the school managements and college principals. Generally, there was encouragement throughout the experiments. This was especially so from the private schools. The schools managers permitted their teachers to be attending the training sessions. It was also noticed that teachers from the special education schools were highly supported by management than those from the inclusive ordinary schools. Though, the teachers seemed not to be very clear about the use of abacuses, to some extent, data collected seemed to point towards the new technology as being very effective.

During the note taking of Observation Protocols, there were some trends that were discovered. The best results at Post-test during the quasi-experiments had come from Mathematics teachers in inclusive schools. Some Special Education teachers appeared not to catch up as the work advanced. As we collaborated, it was learnt that they did not learn Mathematics whilst at the college. Teachers at the private school had also performed much better. The school was noted to have some stocks of abacuses. It appeared efforts were being done at the school in the learning of Mathematics. Most of the low results came from teachers in Special Education schools. In Table 28 of the Observation Protocols, under the ‘results of findings’, the participants’ morale was measured through ‘time management and attendance’. There was also strong will for sourcing of abacuses for their institutions. That was expected to happen, and according to the Behaviourist theories by B. F. Skinner (Kendra, 2022), behaviour is a response to the external behaviour. At the end of the one-week training, the researcher wanted to find out if they were ready to introduce Mathematics to LVI. Most of them seemed not to be ready, suggesting that they could not have gained sufficient knowledge. The period for the training could have been too short. It also required policy direction. The Mathematics curriculum in its entirety needed to be adapted. The instructural materials needed to be found in the schools if they had them. Many teachers also were required to be capacity built. This suggests that the outcomes of the research needed to be shared with the senior management at the Ministry headquarters. A summary of the results that were observed during the experiments can be seen in Table 29.

Table 29

Observation Protocols during Quasi-Experiments

Attribute	Measurement Attribute	Score	Comments
Teachers' Morale	Time Management	Very Good	Most of them observed time.
	Attendance	Very Good	Attendance was excellent.
Adoption of abacuses	Efforts to source abacuses	Very Good	Most of them embraced the need to have abacuses in their schools.
	Efforts to introduce Maths to VI	Good	Most respondents were not ready
Management Support	Supporting teachers to participate & provision of support services	Good	Average, with more support from Special Education schools

Teaching and Learning Assistive Devices in Schools

The research also had the aspect of a Survey, where observations in the schools were made in relation to the existence of an atmosphere that could be very supportive for the teaching of Mathematics to the VI. A checklist was used to collect the data. The data that was sought included the availability of assistive devices in the schools. A summary of observations of assistive devices the schools was as shown in Table 30.

Table 30

Evaluation of Assistive Devices in Schools

Province ……………… District …………… School …………… Date:…………………

	SCORE		
	Poor	**Good**	**Very Good**
Availability of Assistive Devices in classes	Poor		
Presence of Assistive Devices in libraries/resource centers	Poor		
Presence of Libraries with books for the VI	Poor		
Presence of LVI in Maths classes	Poor		
Participation of LVI in Maths classes	Poor		
Use of Assistive Devices during Maths periods	Poor		

From Table 30, it can be noted that schools did not have sufficient abacuses. On a scale of 1 to 3, the scores were poor throughout, suggesting that the country was still far from the knowledge of using assistive devices for LVI.

Comparing Performances of Schools through Hypothesis Testing

It also became necessary to determine if there were differences in performance among the research schools. T-, Z- and F-statistical tests were used to test such hypothesis (Edward, 2020). At Pre-Test: Ha: $\mu \leq 25\%$, that is, the knowledge of teachers for teaching of Mathematics to LVI was not better than 25%. A *one sample t-test* was carried out to compare the means of the different schools with the hypothetical value (25%). The test was used to test whether a population mean of various schools was equal to some value (pre-determined alternative hypothesis of 25%).

From Table 31, for a two tailed test, $P < 0.05$. Such a result is considered significant. The null hypothesis that the teachers could score more than 25% at Pre-test were therefore nullified. The data was computed for all the schools, and was summarised in Table 31.

Table 31

One Sample T – Test Hypothesis of Teachers at Pre-Test

School	UT	Mun	Sisa	Sef-B	Sef Sec	Zam Coll
Marks (%)	20,10,20	20,20,10	20,20,30	20,30	10,20,20	20,20,30

Ho	**Mean**	**N**	**SD**	**T**
25%	20%	17	6.12	-3.369

Conversion of T – Value to P – Value

T-Value	**Df**	**Type of Tail**	**Sig level**	**P**
-3.369 16	16	Two Tail	0.05	0.0039

Adapted from DataNovia (2019)

The P – Value = 0.0039, that is, $P < 0.05$. The evidence is very strong in supporting the alternative hypothesis. The teachers therefore did not have enough knowledge beyond scoring 25% at pre-test.

Other than being concerned with supporting or rejecting the null hypothesis for individual respondents, an ANOVA test, the analysis of variance, was used to measure the average degree to which all the data points were from the mean (DataNovia, 2019). The units for the analysis of variance is the F – Value. ANOVA is used to find out if some groups are different from one another. Though there were 9 schools, however, three of the schools only had one participant. In analysis of ANOVA, a group means having at least two members, hence only six schools of the nine schools that had at least two members were included in the analysis. A group or school can have large or small variations among its members. There can be concerns if some members within a school were not performing as expected. This can also happen where some schools could be performing very poorly when others were doing very well. The ratio of analysis of variance (ANOVA) between the groups and inside groups for the 6 six institutions at pre-test was illustrated in Table 32.

Table 32

ANOVA Test of Schools at Pre-Test

Group	Marks	N	Mean	SD	SD Error
Ut Spec	20,10,20	3	16.67	5.77	3.33
Mun Sec	20,20,20	3	16.67	5.77	3.33
Sisa Spec	20,20,30	3	23.33	5.77	3.33
Sef Bli	20,30	2	25	7.07	5.00
Sef Sec	10,20,20	3	16.67	5.77	3.33
Zam Coll	20,20,33	3	23.33	5.77	3.33

ANOVA Summary

Source	Degree of Freedom	Sum of Squares (SS)	Mean Squares (MS)	F-Stat 1.24
Between Groups	5	216.66	43.33	**P- Value**
Within Groups	11	383.33	34.85	**0.35**
Total	16	599.99		

Adapted from DataNovia (2019).

Where Between groups: DF: K – 1, where K is the number of groups.

Within groups: DF: N – K, where K is the total number of participants, and

$$\text{F statistic} = \frac{\text{Variance between the groups}}{\text{Variance inside the groups}}$$

Adapted from Statistics Kingdom, 2023.

The F-statistic value = 1.24, implying that the ratio of the variance between the groups to the variance inside the groups was 1.24 to 1. This is almost 1 to 1, suggesting that the variations between to within the groups weren't much. The higher the ANOVA value, the higher the ratio of variance between schools to that inside the schools. For a p-value equal to 0.35, suggests that $P > 0.05$. The results were therefore, *not statistically significant*. The null hypothesis could not be rejected. That is, for the six schools that took part in the quasi-experiments, there were some differences in the scores though not much, since T = 1.24. The results could apply to all schools in the nation. It is also important to note that when calculating the analysis of ANOVA, the larger figure should always be the numerator (DataNovia (2019). It also became necessary to determine whether to support or reject the null hypothesis at post- test. A One Sample t – test data was computed as summarised in Table 33:

Table 33

One Single T – Test Hypothesis at Post-Test

School	UT Sp Ed	Mun Girls Sec	Sisa Sp Ed	Zam Coll	Sef for Bl	Sef Sec
Scores	70,60,50	90, 90,70	80,80,70	80,60,50	60,70	80,70,70

Mean	SD	Hypothesised mean	DF	Type of Tail	Sig level	T-value	P – Value
70.58	11.97	80%	16	Two tailed	0.05	- 3.242	**0.0051**

Where $T = (\bar{x} - \mu)/(s/\sqrt{n})$ (Edward, 2020). At Post-Test: Ha: $\mu \leq 80\%$**,** that is, the knowledge of teachers for teaching of Mathematics to LVI after treatment lessons was not to be better than 80%.

The T – value was -3.242, and P – Value was 0.0051. The *decision*, therefore, was that the findings were *extremely statistical significant*. The alternative hypothesis, Ha, that the respondents cannot score more than 80% even after the treatments lessons was therefore accepted.

The research has brought out a lot of factors such as the lacking of Mathematics during the training of Special Education teachers. Some of the participants were lecturers, hence, the general trend was to think that they will score exceedingly high. The null hypothesis was set at 80% (Ho > 80%). Looking at the poor attitudes, low research and poor methodologies, the Ha, was that the participants shall not score than 80%. With the p – value being significant, it meant that there was strong evidence against the null hypothesis, as there was a less than 5% probability to reject the H_o. Hence, the alternative hypothesis (H_a) was accepted. It suggested that even after the training, few of the teachers could score more than 80%, unless other factors were also worked on. It became necessary that outliers were checked for, at post-test, in order to determine the figures that were influencing the hypothetical mean so much. Outliers are figures which were not in the range of SD of 11.65, that is, outside 69 +/- 11.65 or 57.35% – 80.65%. For this study, the Outliers were not removed as they did not appear to affect the findings (Edward, 2020). The outliers were outside the box, as can noted from the Table 34.

Table 34

Outliers at Post-Test

Outliers	60 60 60 60 60 60 60 60 60 70 70 70 70 70 70 80	Outliers
50 50		90 90

Before and after the box, there are two 50s and two 90s as outliers. It was also seen prudent that the differences and similarities were noted between the two major provinces where data was collected. Lusaka province was from the urban setting, where schools were thought to be usually staffed with quality teachers. Western province was from a rural setting. One of the schools in Lusaka province was a private school. It appeared to be well equipped with teaching materials. Comparing the two may also bring out differences related to urban and rural.

Using the calculator, the mean and standard deviations were first found. In order to find the F Value and P – Value, there was need to look for the sample sise and degrees of freedom (df). The first column in the ANOVA summary (see Table 32) is labelled 'Source'. The source indicates which of the sources of variability is being referred to. It could be the 'between groups', 'within groups' or 'total'. The ANOVA could be calculated as shown in Table 35.

Table 35

ANOVA Test for Schools at Post-Test

Group	**Marks (%)**	**N**	**Mean**	**SD**	**SD Error**
1	70,60,50	3	60.0	10.0	5.77
2	90,90,70	3	83.33	11.55	6.67
3	80,80,70	3	76.67	5.77	3.33
4	80,60,50	3	66.33	15.28	8.82
5	60,70	2	65	7.07	5.0
6	80,70,70	3	73.33	5.77	3.33

ANOVA Summary

Source	**DF**	**Sum of Squares (SS)**	**Mean Squares (MS)**	**F-Stat**	**P-Value**
				2.32	**0.114**
Between Groups	5	1169.17	233.83		
Within Groups	11	1127.35	93.94		
Total	16	2296.50			

Adapted from Good Calculators, 2023.

$$\text{Where F statistic} = \frac{\text{Variance between the schools}}{\text{Variance inside the schools}}$$

Where Variance between groups: DF: K – 1, where K is the number of groups.

Within groups: DF: N – K, where K is the total number of participants.

The F-statistic value was 2.32, and the P-value was 0.114. This figure is P > 5. The results were therefore, not statistically significant. It means that there were no effects, hence no need to worry much about the differences between the schools.

Summary of Findings

There were several key points from this Chapter on Discussion of Findings as to whether Mathematics can be learnt effectively by LVI. From demographical data, it was observed that though the teacher educators had appropriate qualifications (HEA, 2018) they were however, not well qualified to offer Mathematics to LVI. It appeared that they did not have the right content from the courses that they were trained in, hence their knowledge was not in tandem with the Adapted Mathematics curriculum for the VI, as argued by the Loewenberg, et al (2008). It could be said that the teachers and the lecturer's knowledge was inadequate around the subject matter. The study had also shown that there were high attrition levels from Special Education Schools. Most of the teachers did not serve for more than 5 years in the area of Mathematics for the VI. This suggested that the sector may not have been attractive to working in. These factors could have been contributing to the yearly shortfalls of teachers from the special schools.

The research found that Zambia had policies that supported the provision of Mathematics to all its learners (CDC, 2013). However, it appeared that implementation was the biggest challenge. Furthermore, the Ministry did not appear to have data on whether LVI were learning Mathematics or not. This appears to be a matter to do with poor attitudes, hence it could be one of the barriers to their education. The research has also shown that there was less collaboration among stakeholders over the subject matter. The revelations that LVI could not manage certain topics in Mathematics were found to be contrary to the low performance of the teachers on the pre-test. Their average score at Pre-test was 20%, suggesting that they had inadequate knowledge to be able to handle the subject. That also implied that the area was unique. It required specific knowledge as argued by Howard Gardner's theory of multiple intelligence (Loewenberg, et al, 2008). The research found that some officers, especially at the Ministry, attributed the low academic levels among LVI to the existence of blindness. However, contrary to this assertion, the teachers blamed the Ministry. They argued that they did not receive adequate training, coupled with insufficient teaching and learning materials. It was also interesting to note from 85% of the Ministry Officers, that it was possible to make LVI access the Mathematics curriculum through adaptation. The lecturers from the universities also supported this idea, they argued that with sufficient research, it could be a done deal. It can therefore, be concluded that this study was not a research in futility. The findings from Chapter 4 have also shown that the institutions of higher learning were not affiliated to other institutions globally, in the sector of Mathematics for the VI. This suggests that there was less interest for the sector. There were some challenges to do with attitudes.

The first research question was intended to find out if there were challenges among LVI that could be associated to the lacking of Mathematics in their school curriculum. Lacking of Mathematics was found to be causing restrictions to the learners on what they could study at higher institutions of learning. Additionally, it restricted on the nature of jobs they could engage in. It was found that STEM disciplines were not open to them, partly due to the curriculum they followed in school. Generally, they were offered subjects such as Religious Education, History, and Social Studies. These subjects appeared not to be too marketable compared to the natural sciences subjects.

In reality, LVI were taking few and restricted subjects, making it difficult for them to have school certificates. Without school certificates, a learner may not proceed for further tertiary education. It was imperative that the attitudes of academicians and policy makers changed with unfolding research.

The second research question was intended to find out some of the effective strategies for teaching of Mathematics to LVI. There was also a general complaint that Special Education teachers were not specialised in handling Mathematics for LVI. It was pointed out that teachers were limited in knowledge. This challenge appeared to be a global problem (Kelly, 1999). The universities had indicated that there was just need for more research in the sector. Another suggestion for enhancing the methodology for teaching the VI, was that of reducing the number of topics. This appeared to have made sense, considering the challenges of teaching some topics, as well as the lacking of appropriate teaching and learning materials. It was also explained that more time was needed to teach a concept of Mathematics to the blind as compared to the sighted. This could be done by making adaptations to the school time table. It was also found out that teachers highly depended on the traditional methodologies of using the chalk and blackboard. This was the norm especially in inclusive schools where the sighted and non-sighted learned together. The schools were following the curriculum designed for the sighted, and appeared not to be bothered by the presence of learners with disabilities in the same classes. Some though could have been concerned but the interventions were beyond them. They appeared not to have received specialised training (Kendra, 2023).

An analysis of the research findings at pre-test and post-test were average scores of 20% and 69% respectively, suggesting that the use of the Abacus techniques had greatly contributed to the high performance of the respondents. Chapter 4 also brought out that schools for the VI did not have sufficient instructural materials in the subject. Additionally, many of the respondents seemed not to be aware of the Abacus devices. They were also not aware of the topics in the Mathematics curriculum on which the Abacus could be applied on. A few respondents were however, noted to be aware of the role of assistive devices such as abacuses, for teaching Mathematics to the LVI. To be aware of a teaching methodology is one thing, and to be able to effectively use it is another. Some of the teachers were aware, but they did not know how to use them. Hence the alternative hypothesis (H_a), that the teacher educators' strategies were not effective to the teaching of Mathematics were accepted to be correct. In brief, there was no effective strategies that was found for teaching Mathematics to the VI.

The third research question examined the practical nature of the research. It directly answered the main objective. That is, the impact of using abacuses on the computation of mathematical problems. Being the main concern of the research, it was therefore, the QUAN part. From the pre-test results, teachers and teacher educators demonstrated that they did not have the right knowledge and skills to offer Mathematics to LVI. Their performance was found to be at an average of 20%, which was not in tandem with the null hypothesis *(*H_o), that the teachers could perform far much higher than the presumed population mean of 25%. The work that was given to them was at basic primary work. There were two types of respondents: Special Education teachers and ordinary Mathematics teachers. Additionally, there were also lecturers from the two related departments. None of these categories appeared to have had the knowledge on how to use the Abacus. In short, there was a challenge of specialised teachers and lecturers in the discipline.

For the Post-test, the preassumed null hypothesis (H_o) mean was set at 80%. This was the researcher's presumed performance mean score or raw data. However, the teachers and teacher educators' average performance after the 10 treatment lessons was at 69%, that was how far much they could score. This strongly suggested that the Abacus could be a trusted and effective tool to the teaching of Mathematics. At Post-test, the P-value was 0.0051, suggesting that the results were extremely significant. That was not a good thing for lecturers and teachers, as well as the Ministry of Education. This therefore, demanded for more research to be conducted. Many factors could have affected their poor performance at post-test. Since the presumed raw score was set at 80%, and the average sample score was 69%. The alternative hypothesis was therefore accepted, that it was not possible for the teachers to be scoring far above the presumed mean of 80% even after receiving the training. Other factors appeared to be at play. Teachers' conditions of services and the availability of teaching and learning materials all needed to be taken into consideration.

During the experiments, it was noted that the participants were more than ready to learn how to use the Abacus. This was noticed on how they were managing their time. Most of them used to observe the time. Attendance was usually above 98%. In brief, there was morale around learning how to use the new methodology, 'the use of the Abacus'. This was more so for the teachers. Lecturers, were somehow not cooperative. They were reluctant to participate in the survey. Another area of interest was whether the schools had stocks of Braille books. There was very little evidence of stocking such books nor abacuses during the period of the study. The private school had more stocks than the others. Additionally, the special education schools had more stocks than inclusive schools. Another aspect that was measured during the quasi-experiments was the willingness by the participants to adopt the use of the abacuses, as one of their teaching strategies. Most of them wanted to know where they could source for them. That was a strong indication that they had embraced the teaching methodology. Another attribute that was observed on was on whether the teachers were ready to introduce Mathematics to LVI, taking into consideration the knowledge they had received. It was noted that most of them were not ready to implement what they had learnt.

Perhaps there was still a challenge with policy directions. However, for those that were already practicing, especially those from the elementary grades, they felt that there was going to be some improvement in their delivery of the subject.

Another aspect that was monitored was that of support from the school managements and college principals. Generally, there was encouragement throughout the experiments. This was especially so from the private schools. The special education schools were also highly supported by management than the inclusive ordinary schools. Data collected from different participants were triangulated. To a greater extent, data collected through the survey also pointed towards inadequate knowledge. However, data from the survey could not point to the level of competences of teachers in the sector. The use of the Abacus was able to produce direct results where the respondents had an average of 69% at post-test.

The LVI that were taught by the teachers that had been trained appeared to have also improved a lot. In a video, 6 teachers could be seen solving Mathematics problems using the Abacus. About half of them were teachers with visual impairments. Six (6) LVI could also be observed calculating some problems. Both the teachers and the LVI appeared to be content with the new methodology. The teachers requested for donation of more abacuses. A head teacher commended the new pedagogy, however, she complained of the high cost of abacuses on the market. She suggested that there was need to train all teachers in the use of abacuses for LVI to pass Mathematics. This video was watched by Ministry of Education officers, and most of them appreciated the pedagogy.

On the other hand, the survey provided reasons why respondents performed poorly at pre-test. The comparisons of the two research methods helped in triangulation, through complementing each other. The alternative hypothesis (H_a), that the LVI could learn Mathematics was therefore, correct. There was urgent need to join other researchers to ensure that the implementation of these findings go on smoothly. From the pre-test results, teachers and teacher educators demonstrated that they did not have the right knowledge and skills to offer Mathematics effectively to LVI. Their performance was found to be at an average of 20%, which was against the null hypothesis (H_o) mean of 25%. At the Post-test, the null hypothesis (H_o) pre-chosen mean was set at 80%. By using a One Sample T – Test hypothesis at Pre-Test, the null hypothesis was set at 80% ($H_o > 80\%$), $t = 4.22$, and $p = 0.0004$ for a two tailed hypothesis. $P < 0.05$, hence it was *extremely statistically significant*. This suggests that even after receiving some training, the teachers still had some challenges. An ANOVA Test was also carried out to determine if the ratio of variance between and within the schools at Post-Test was statistically significant. The F-statistic value was found to be 2.49, the P-value = 0.09. This figure is $P > 0.05$. The results were therefore not statistically significant. That meant that there were no much effects or differences in performance between different schools and within the same schools.

CHAPTER 5: IMPLICATIONS, RECOMMENDATIONS AND CONCLUSIONS

Chapter 5 of the research is the “implications”. It provided an overview of the problem statement, research purpose, methodologies, limitations and ethical dimensions. It also looked at research implications and recommendations. The recommendations were for immediate applications and also for future research. They ended with a conclusion. The problem statement was that many persons with VI appeared to have a lot of challenges in life. The challenges included high poverty and illiteracy levels. There were also challenges with stigma and discrimination from the society. Because of having disabilities, schools tended to shut them out of the schools of their communities. Those in schools were being excluded from taking certain subjects such as Mathematics yet it was the schools that had failed to make reasonable accommodations (Mizunoya, 2018). Most schools had accessibility challenges that included the lacking of ramps for wheel chair movements, and rails for support when moving along corridors.

The school infrastructure in some schools was also not accessible. Most school subjects appeared to be inaccessible formats. The national examination assessments appeared to be targeting mainly those with sight, hence, not easily accessible for LVI. By comparing the number of learners with disabilities at primary school to those at secondary level, it was noted that less than 15% of LVI transitioned from the lower level to the higher grades (MoGE, 2018). This was not a health environment. The Human Rights Commission (2012) argued that there was a challenge with participation and retention in schools by children with disabilities. This implied that more research needed to be instituted. In Zambia and many other countries, Mathematics had been found to be an important subject in the cognitive development for learners. This was the likely policy in most countries. It was made a compulsory subject for all learners. However, for LVI, most of those good policies were just on paper. The subject was still optional for them. There were many factors that were found by this research that appeared to have contributed to the denial of learning Mathematics to the learners. For this research, the assumed cause for not offering Mathematics to LVI was the 'inadequate knowledge' by teachers and teacher-educators. The assumed cause was confirmed in the quasi-experiments as inadequate knowledge. That tallied well with Kelly (1999), who argued that teachers did not know how to teach learners with disabilities. It appeared therefore, to be an issue to do with pedagogy. The traditional method of the 'chalk and blackboard' did not appear to be helping much with regards the learning of numbers by LVI. As an intervention, it was thought that the VI needed tactile strategies. The use of the Abacus was highly recommended by ICEVI (2003), and the tactile methods have been confirmed in this study.

The lacking of Mathematics by LVI was of great concern particularly at secondary school where most of the teachers appeared to lack the pedagogical skills. The achievement of this research could not only be of great significant to Zambia, but to various nations. The Ministry also reiterated that PWD should access an inclusive, quality primary, secondary, and tertiary education (MoE, 2007). Hence, the findings of this research were likely to contribute interventions to the challenges in the Ministry. Additionally, the research was in line with the policy of the Zambian Curriculum Framework of 2013 that reiterated that the curriculum for CSEN should be an adapted one (CDC, 2013).

Globally, this research is in line with the UNCRPD of 2006, whose objective was that of enhancing education delivery to learners with disabilities (Human Rights Commission, 2012). An improvement in pedagogical skills could be seen as a recipe for the learners to develop their full human potential. This can be seen as promoting their sense of dignity. It was also in line with the fulfillment of the SADC Protocol on Education and Training of 1997 (SADC, 2015), that spelt out the minimum basic needs and services which vulnerable children and youth should be having as access to education and vocational skills. It could also be an intervention for effective mainstreaming of the youth, women and children with disabilities (African Union, 2020). In an effort to achieve the above purposes or lack of it, the research had employed mixed research designs.

The research employed a mixed research concurrent nested approach (Creswell, et al, 2014) where both the quantitative (quasi-experiment), and quantitative and qualitative (survey) approaches were conducted concurrently, with the survey nesting on the quasi-experiment. For both approaches, the researcher was the principal data collector. A cause (predictor variable) and effect (ability to teach) relationship, with the proposed mechanism (use of Abacus) were examined during the quasi-experiment. The alternative hypothesis (H_a) that was examined was that that there was a relationship between the use of the Abacus and the ability by the teachers to teach Mathematics effectively for LVI. A survey was also carried out that collected both quantitative and qualitative data through questionnaires. By collecting data at once, the survey fitted-in as a cross-sectional survey (Hudelson, 1994). This research was initially piloted, so as to authenticate and validate the research tools. That was followed by a pre-test. The pre-test was followed by 10 treatment lessons on how to manipulate mathematical problems using the Abacus. A post-test was also administered. During the quasi-experiments, Observation Protocols were noted. These were checklists for observing specific behaviours, knowledge, and skills of research participants systematically (Mengshoel, 2012). The observations from the Observation Protocols were triangulated with the findings from the tests in order to enrich the data. The research collected demographics data of the respondents that included the names of their institutions, job title, gender, age, one’s qualifications and years of experience. The respondents were Special Education teachers, teachers of Mathematics, School Administrators, Ministry Policy makers, and lecturers from the universities and colleges that offered either Special Education and Mathematics courses. For the quasi-experiment, 20 participants (17 teachers & 3 college lecturers, and 6 learners) were selected through non-probability sampling techniques of purposeful and convenient sampling. For the survey, 100 participants (24 lecturers, 16 Ministry Officers, 60 teachers) were selected through probability sampling techniques of simple probability sampling.The total population sample was therefore, 126, including the LVI.

This study had also considered ethical assurances. The study was initially approved by the Unicaf University in Malawi Research Ethics Committee (UREC). Informed consent was assured from all the participants, following a thorough discussion. Participants however, had initially refused to append their names and signatures on the informed consent forms. They only signed after agreeing to using pseudo names (using letters A, B, C, D, etc.) to prevent them from being potentially identifiable. That was to make them anonymous. Participation was entirely voluntary. Authority to conduct the research was done via the Gatekeeper letters that were approved by UREC. The research had no perceived potential risks, other than risks pertaining to everyday life events. The direct benefit was that the participants for the quasi-experiments gained knowledge immediately. In order to foster confidentiality of participants on the research tools, the participants were not to include their identity in the questionnaires. Only names of the provinces, districts and schools were to be included.

After the data was collected, the participants were debriefed, by thanking them for their voluntary participation, and for providing any other useful information that contributed to an in-depth understanding of the nature of the research. The respondents were assured that the data collected was going to be held confidentially or anonymous. They were also informed that they had the right to withdraw their data retrospectively and without any explanation. Participants were given both the researcher and supervisor’s contact details, in case they needed more clarifications. This chapter on Implications, Recommendations and Conclusions shall now begin by examining the Implications of the research findings.

Research Implications

Elsevier Author Services (2022) defined research implications as how the key findings in a research were likely to impact on the society in the world. This suggests that some findings could be significant to policymakers, the society and/or other researchers. The speculations of research, when made in good faith, should elaborate how the findings can help the different organisations (Elsevier Author Services, 2022). The author further explained that research implications needed also to explain how the findings of a study were similar or dissimilar to the findings of other previous studies. The study should reaffirm or disapprove the results of other studies. Additionally, it may also suggest future directions to be researched on in the light of the findings. The conclusions from each of the research questions (and or) hypothesis should be supported by actual data from the research findings. Additionally, the results should be placed back into the local, Zambian context of a developing country. The results should also be placed into the global world to determine how they fit in with research world-wide.

Implications to Policy Makers

The statement of the problem was that if Mathematics was not going to be offered to LVI, these people were to forever be leading miserable lives. The findings of this research have shown that it was possible for LVI to be learning the subject. The implications of such results are that people with VI shall be enjoying their right to education to the fullest. Additionally, Zambia being a signatory to the UNCRPD and VISION 2030, shall be in a good standing to achieving the goal of not leaving anyone behind in development. The latest 2013 Zambian Curriculum Framework policy had suggested that the Ministry was going to adapt the curriculum for learners with disabilities. With the favourable outcome of this study, the Ministry's dream of having an adapted Mathematics curriculum was to be a thing of the past. The 2011 Education Act and the 2015 Disability Policy may also see their fulfillment for the improvement of livelihoods for PWD. The Ministries of Education could start the implementation of the programme in a few schools, before they could roll out to the entire country. This is important for a smooth planning of allocation of the limited number of teachers and resources. They School attendance for learners with disabilities may also improve following an improvement in the education delivery. It was also brought out from the literature that the majority of children with disabilities were not attending school (World Bank, 2020). With the positive changes in their curriculum, parents were likely to be encouraging their children to attend schools. The adage that 'disability is not an inability' (UNESCO, 1994) shall be clearly understood when professionals start seeing the LVI taking technical subjects. It was also expected that teachers and teacher educators were to increase in knowledge as they got more and more exposed to the use of the Abacus. Though the results were not excellent, there was a great change. If the training in the pedagogy had taken even just a month, the results could have been far much better.

One of the research questions was: Can LVI learn Mathematics as effectively as the sighted? From the research findings in Figure 12, about 80% of the Ministry officers appeared to have agreed that Mathematics should be made a compulsory subject for all learners. The implications were that, there appeared to be a strong will among policy makers towards people with differential abilities. This is in line with the Ministry policy, which reiterated that Mathematics should be a compulsory subject for all learners (MoE, 1996). In Figure 11, it was noted that about 10% of the teachers had experience in teaching Mathematics to LVI. The 2013 Revised Curriculum framework, also indicated that the curriculum for CSEN was to be adapted. These policies were pointing to the fact that some efforts were being made to reinforce the programme. Should the findings from this research be implemented, some of the challenges the Ministry could have been having may be reduced.

In Figure 11, it was observed that LVI were taking Mathematics even though they did not benefit much from it. This also suggests that some teachers were making some efforts. Policy makers therefore, have an assignment, of finding ways of making the subject accessible. From the demographics, it was noted that policy makers, teachers and lecturers were making efforts of upgrading themselves in the disciplines of Mathematics and Special Education. The efforts by the Ministry Officers, teachers and lecturers, suggested that the sector of Mathematics for learners with SEN were quite important. It was also pointing to the fact that with consented efforts, one day a solution was going to be found. This also implies that if the learners were denied the subject, they were likely to experience other ripple effects, such as having challenges in other learning subjects that depended on it. Subjects such as Sciences were known to be highly depending on Mathematics. Many subjects involved the use of numbers that were taught in Mathematics. The ripple effects of using numbers were not only in schools but even in life in general. These findings were in tandem with Hansen & Gray (2010) in Bogdan (2019), who argued that Mathematics significantly influenced learners' education both in academics and in terms of moral education. Additionally, there was need by the Ministry to strengthen their policies, through monitoring teachers to ensure that the Ministry's policies were being implemented. They needed to be putting in place policies that could allow them to be allocating some funds for capacity building of their teachers. They could also develop policies that could allow a few teachers to be trained in renowned universities in the area of Mathematics. The Ministries of Education may need to be getting in touch with those that were well vested on how to be using the abacuses so as to capacity build or train other staff. They may also invest into manufacturing abacuses in an effort of making them affordable. Additionally, the education system needed to be reminded that they should not be making judgements as to who could succeed or who may not, especially with respect to the presence of a disability. Their role should be more to do with conducting research in order to find the necessary interventions.

Implications to the Society

By society, the research is referring to various organisations and the ordinary communities. The research has brought out that some of the challenges people with VI faced were due to barriers and misgivings due to their disabilities. The literature review had indicated that if nothing was done about their education, the VI may continue finding themselves prevalent to many vices. The research has brought out that Mathematics was a very important subject, which was necessary for every learner. If that was the case, the systems should be encouraging children to be learning the subject. They can support their children with VI in many ways such as in the purchasing of their teaching and learning materials. They can also encourage their children with VI to major in Mathematics as was the case of Alieu of Gambia (Sightsavers International, 2022).

This study also referred to various conventions and protocols. It sought to contribute to the resolutions that were made at the international conventions, such as the UNCRPD of 2006, article 24 (ACBRAN, 2017). The interventions to these good intentions are to alleviate the high poverty levels of citizens. International organisations such as the World Bank, International Monetary Fund, the UN, AU and SADC could do well to capacity build teachers in the use of the Abacus.

They can set up centers of excellence at international and regional levels for this good cause. Trainer of trainers could then be trained from various countries. Should the use of the Abacus be adopted, it is likely that LVI shall be performing competitively with their fellow sighted peers. Such a position, shall definitely lead them into good paying jobs. There is also need to discuss the implications of the findings with reference to existing literature.

Implications to the Researchers

Implications to researchers could come in different ways. This research validated, and disapproved findings of previous research. It also made suggestions for future research. At pre-test, the teachers and teacher educators had scored an average of 20%. This validated the findings by Kelly (1999), who had argued that teachers did not know how to teach learners with disabilities. It also validated the argument that the poor performance of LVI was not necessarily due to the VI disability (Nganwa, 2017), but it was due to the inadequate pedagogical skills by teachers and teacher-trainers. In this research, the ‘Abacus’ was used as the mechanism for change. The change in scores from 20% at pre-test to 69% at post-test, had validated the arguement by Jenkison (1997) that the Abacus was an effective tool in the teaching of Mathematics to blind learners. These findings can be used by implementers for training their teachers and teacher-trainers. There is need for researchers to be conducting quasi-experiments in an attempt to establish a cause and effect relationship between the predictor, and the dependent variable (Kamal, 2015). From the results in Figure 12, it was noted that 35% of lecturers and 50% of teachers argued that Mathematics should be optional to LVI. Such a statement suggested that less research had been done to the sector.

There were also implications with reference to the Howard Gardner’s theory (Loewenberg, et al, 2008). This research has demonstrated that the discipline of Mathematics for the VI was unique. It required to be followed up so that it can be well situated in universities and college structures. Being a typical specialised area, there was need to determine on how it fitted well with other university courses. Some questions have not been answered by this research. For instance, how possible can the blind learn topics such as probability, matrices, sets and so forth. Future research therefore, should focus at examining the learning of specific topics in Mathematics by the blind. Question 8 on both the lecturer and the Ministry's questionnaires brought out data on the types of jobs that persons with VI were likely to be given in relation to the school curriculum they followed. According to the Ministry Officers, they could be employed in teaching, lecturing, information technologies, Arts (Music) and customer service related jobs such as telephone operating. This is in line with Jitka & David (2016) who pointed out that such people could not work in technology, building industry and banking, where mathematical formulas were required. However, with the findings from this study, research needed to be heightened in institutions of higher learning. The adaptation of Mathematics needs to be applied to many engineering and technical programmes in order to access the blind to such programmes. Researchers also needed to intensify research in various fields in order to enable LVI to realise the development of their full inert potential. People with VI should not be forced into professions they may not want. If they can become lawyers or medical doctors, let it be. From the findings, the null hypothesis that Mathematics was difficult for LVI was rejected. Instead, the alternative hypothesis was accepted. The implication is that Mathematics can be learnt by LVI. Researchers therefore, should not be hesitating in carrying out research, even in areas that others think were impossible.

From the results in Chapter 4, it was observed that the teacher trainers did not have answers to Q16 on what the LVI should be using for drawing circles as well as taking measurements. These were topics that were in the ordinary Mathematics curriculum. The failure to compute the problems by the education providers suggested one thing: they did not have the knowledge to teach Mathematics to the VI at secondary level. It could also be said that they did not receive adequate training around those aspects. It was also observed that most of the respondents were not aware of assistive devices. If the teacher-trainer or lecturer did not know, it follows that even the teacher, and ultimately, the learner will not know as well. It was also noted that there was a critical shortage of assistive devices in the research sites. Since the LVI could not see from the blackboard, the lacking of assistive devices could imply that learning and teaching had not been that effective. These findings suggest that researchers needed to intensify research in finding appropriate teaching methodologies. Fortunately, lecturers were also researchers, and therefore, enjoyed academic freedom. They needed therefore, not to overlook the area of Mathematics for LVI.

Before the research was undertaken, some of the stakeholders thought that the methodologies that were being applied were effective. Hence, the corresponding null hypothesis (H_o) for the second research question was that teacher educators' strategies were effective with regards the teaching of Mathematics to LVI. The previous paragraph has given evidence that the teaching strategies were ineffective. The implication was that the alternative hypothesis (H_a) was correct. The teacher educators' strategies of using the 'blackboard and chalk" were simply not effective to the teaching of numbers to LVI. There was urgent need by researchers to carry out research to intervene in the matter. The corresponding null hypothesis (H_o) to the second research question was: There were no challenges associated with learning Mathematics by LVI. The study found that there were a lot of challenges. Without attending to them, it could further worsen the challenges they faced. For the sighted who were taking the subject, some of them could go higher and higher in the academic circles. They could become medical doctors, engineers and lawyers.

But for the LVI, even the small jobs that were supposed to be given to them were usually taken away. Research therefore, was necessary, to ensure that the world does not discriminate them.

The third research question was identical to the null hypothesis (H_o) that there was no relationship between the use of Abacus and the teaching and learning of Mathematics to LVI. The alternative hypothesis (H_a) was the opposite. The use of the Abacus had proved to be effective. This suggests that the education systems needed to carry out a lot of research on the use of abacuses. Abacus Mathematics books needed to be written and made available in schools. They will help in the development of knowledge. Researchers have a role of ensuring that the Abacus tool was widely investigated for their effectiveness. They should have been examined in the context of their different countries to ensure effective delivery. This study has also reaffirmed to the fact that the curriculum for teaching LVI should be including the tactile sense (Adelakun, 2020). It strongly disapproved the use of the black board and chalk for solving problems related to numbers, to LVI. It also questioned on the qualifications of the teacher educators that were being trained to teach Mathematics to LVI. A teacher with a degree in Mathematics or Special Education scoring about 20% at elementary work implied being illiterate in the discipline. This could imply that the HEA was not closely monitoring the responsible institutions of higher education. HEA needed to ensure that lecturers and teachers had the competences, skills and knowledge that matched the education of learners with SEN.

From the Observation Protocols, in Table 20, under sub-heading ‘Performance of Special and Maths Teachers at Pre-Test’, it was noted that specialised teachers of Mathematics were performing better than Special Education teachers. This implies that research needed to be heightened on how the two types of teachers could be working as a team. This is line with the Connection Theory, that *individual neurons have very little power on their own*, however, *when* *interconnected, could do great works* (Edward, 2023). The findings in this study appear to be unique. They are likely to contribute a lot to the global society. It was therefore, necessary that the study was pursued with the support from UNICAF University in Malawi at the level of doctorate. Of course, every study always has some gaps. There were definitely some gaps also in this research, more especially in the sector of using software for data analysis. To be followed in this section are recommendations for application by various stakeholders.

Recommendations for Application

The recommendations for application have been organized around each of the research findings, as well as the literature review. The following recommendations were made: From table 5, concerning the performance of LVI in Mathematics in national examinations, though the learners' performance was not good, it was argued that accessibility to the subject was their human right. They further explained that accessibility enabled inclusive education to be implemented. According to UNESCO (2019), learners with disabilities were entitled to learning these subjects, and by learning the same curriculum, it was seen as minimizing differences between students. In responses to Q8 on both the lecturer and the Ministry's questionnaires, the lacking of Mathematics was seen as restricting them to such jobs as teaching, lecturing, information technologies, Arts (Music), and customer service related jobs such as telephone operating. This was in line with Jitka, H and David (2016) who pointed out that people with such meagre qualifications could not find jobs in technology, architecture, building industry and the banking sector. Efforts should therefore, be made to help LVI to learn the subject in order to increase their chances for employment and survival. There were recommendations for application and for further research. The recommendations have been organised around each of the research findings, as well as the literature review. The following recommendations were made:

Recommendation 1: ***Review of Policy Guidelines***

The policy direction should look at various elements of the education system that affect PWD. The first issue has to do with making Mathematics an ‘option subject’ for LVI in the piloting stages. It should also examine the need for Special Education Teachers and Regular Mathematics teachers to specialise in Adapted Mathematics. The length for the Special Education course also is an important part for review. To minimise on the cost of procurement, the Ministry may have to localize the development of teaching and learning aids. Additionally, the timetable for learning for LVI needed to be reviewed, for the possibility of increasing the time. For serving teachers, there was need for the promotion of continuing professional development programmes. It was also thought that starting the programme at an early start during the early childhood education stages could be an effective intervention strategy. The desired environment by the World Declaration on Education for All of 1990 in Jomtien, Thailand (UNESCO, 2014) was that every person should benefit from the educational opportunities designed for education institutions. The recommendations shall now be explained in bit more detail.

It is recommended that Mathematics should be taught to all learners. From the responses to Q12, Q10 and Q11B for the Ministry Officers, lecturers and teachers respectively, it was indicated that the lacking of such knowledge could imply serious challenges in daily life. It could also lead to challenges to the realisation of the development of one’s full inert potential. For similar reasons, the learners could also have challenges in understanding other technical subjects. According to Mader (2017), to understand subjects like History, Science and Geography, mathematical concepts should have been understood. The balancing of chemical equations in Chemistry for instance, required an understanding of the principles of multiplication and division. Hence, Mathematics needed to be taught to all learners, as it was a precursor for understanding most school subjects.

The is need to examine whether Mathematics should be made compulsory or optional. From the findings in Figure 12, only about 41% and 26% of the lecturers and teachers respectively supported the idea that Mathematics should be made compulsory for the VI. They had argued that schools did not have sufficient instructional materials for the implementing of the programme. This therefore, suggests that the Ministry should not be in a hurry at implementing the findings of this research. Only schools that had the needed resources and qualified teachers should implement the practice. Additionally, it was postulated that ‘catering for learners with SEN was costly (MoGE, 2018). Zambia’s limited resources therefore, could hamper with the full implementation of policy intentions. It is therefore, advisable to start with supporting a few schools before scaling it out to all schools. The project could start as an optional subject in schools where specialised services were available.

From the demographics, it was noted that there were two categories of teachers: Special Education and ordinary Mathematics teachers. This could imply that Special Education teachers did not specialise in Mathematics. The Special Education teachers, by nature of their titles, were the major custodian of children with disabilities. It was therefore, imperative that some of *Special Education teachers specialised in Mathematics*. In general, nearly every country has teachers of Mathematics. Nations can take advantage of this opportunity and capacity build the‘Regular’ or ‘Mainstream Mathematics Teachers. These teachers relied so much on the ‘chalk and blackboard’ as a teaching methodology. *Teachers of Mathematics should be trained on the use of the new* *methodologies, 'the Abacus'* for the benefit of blind learners. They were already mathematicians, hence they could learn the Adapted Methodologies for LVI relatively easier.

Another policy that could be reviewed was the need to increase the period of training for Special Education Teachers. From the less number of experienced teachers in Figure 10, it was noted that teachers had challenges in solving basic mathematical problems. That could be attributed to the quality of the training they had received. At Michigan State University and University of Georgia (BBB, 2020), the Special Education programme took about 5 years. That allowed the students to engage in intensive internship experiences. The longer period of training also allowed for the teaching of specialised courses commonly known as 'additional curriculum' in the UK and 'expanded core curriculum' in the US (Willings, 2022). According to ICEVI (2007), a Special Education teacher should be a teacher first, and a special education teacher later. To avoid compromising with the quality of education, the time for college/university training should be increased to allow for the completion of the ordinary Mathematics courses, and thereafter engage in the Adapted Mathematics courses. In relation to this, there was also need to have a policy for increasing the time for learning some subjects such as Mathematics for Learners with VI. This is because solving problems using the Abacus took relatively longer as compared to using the chalk and blackboard. This concern was expressed to responses to Q9, 10 and 16A for the lecturers, the Ministry Officers and teachers respectively. To learn Mathematics, the VI are also required to learn many skills. In Kenya for instance, the VI also learnt braille and typing (Adelakun, 2020). In order to catch up with their peers in the regular classrooms as well as accommodate these additional skills, the time for learning for the VI needed to be increased.

There should also be a policy on the promotion of Continuing Professional Development for *Teachers.* In response to Q9A, Q10A and Q4 for Lecturers, the Ministry Officers and Teachers respectively, some teachers had suggested that some topics and concepts needed to be removed from the Mathematics curriculum. Such topics were considered hard for this category of learners. Such a statement also suggested that the teachers did not have the knowledge on how to adapt such topics for the benefit of LVI. It was therefore, necessary that some continuing professional development programmes were designed for teachers in Mathematics. The Ministry can source for specialists in the area to train trainers-of-trainers (TOT), who can then, in turn train other teachers. It was also important that nations had policies on the development of Adapted Mathematics Curriculum. In response to Q15B of the teachers' questionnaire, it was argued that the Mathematics curriculum needed to be modified to suit the learners. A modified or adapted curriculum for the blind, is a modification of the one used by the sighted into accessible modes such as tactile methodologies. It was just logical to have it as the skills for learning in tactile format were different from those that were being used by those with sight. Writing in Braille required the use of styluses while the black board needed the use of chalk. The 2013 Zambia Education Curriculum Framework (CDC, 2013) also recognised the need to develop an Adapted Curriculum for children with disabilities in some subjects. Zambia and other nations, should just be implementing what was contained in their policy documents. Clement (2021) argues that nations should continue to restructure the mathematics curriculum to suit the integration of assistive technology tools. It is therefore, recommended that stakeholders make available and accessible common basic assistive technology tools for schools for the VI.

In addition to the development of own teaching and learning resources, it is recommended that the Ministries of Education procure some assistive devices that they may not manage to make. It was observed from responses to Q17A and Q16A for lecturers and the Ministry Officers respectively, that Special Education Schools did not have sufficient instructional materials. The

Ministry of Higher Education and Social Sector Plan (2022) had pointed out that they were aware of the barriers that tended to hinder the education of persons with VI (MHESSP, 2022). This study recommends that some assistive devices were not easy to develop. There was need to procure such from the international market. For nations that had the will, the materials were not beyond the budgets of even developing countries (ACBRAN, 2017). The study also makes recommendation that newly employed teachers sign period contracts. It was observed from responses to Q17A and Q16A for lecturers and the Ministry Officers' questionnaires respectively, that attrition levels were high among teachers from Special Education schools. The teachers appeared to be preferring to teaching in the mainstream classes, on the pretext of fostering inclusive education. To curb this, I recommend that newly employed teachers should be made to sign 'period contracts' to be working from their designated Special Education schools for at least 4 years before they could be allowed to transfer to other sectors. The study also makes a recommendation that employers should be looking for teachers with skilled competences when recruiting. This study had revealed that relying on certificates alone when employing Special Education teachers was not sufficient. The Ministry thought they had employed people with appropriate papers, but it wasn't the case. It is recommended therefore, that would-be employees should be given aptitude tests such as the one that was given during the pre-test for this study. If they were to offer Mathematics to the VI, the competences to be tested on should be related to what was demanded in the classroom set up. Applicants should also be demonstrating how they will teach topics such as Sets, Algebraic equations, and so forth to LVI before they could be recruited. If they cannot find the officers locally, they should be extending the search to the global market.

The policies should also consider the motivation of the special education of teachers. One of the responses to 17A for lecturers and 16A for the Ministry Officers indicated that there were high attrition levels from Special Education schools. To curb this, this study suggests that teachers of Mathematics for the VI should have an added responsibility allowance for motivating them. To effectively teach Mathematics to the LVI, it was more taxing. It required learning both the entire Mathematics curriculum, as well as the Adapted Mathematics courses. It is therefore, necessary that they were paid an extra allowance for being specialised in the field of Adapted Mathematics.

Recommendation 2: ***Use of Assistive Devices in Mathematical Problems***

Many studies recommended the use of assistive devices for LVI (Mader, 2017). From Chapter 4, it was noted that most of the teacher-trainers did not have answers to Q16 on what the LVI should be using for drawing circles as well as taking measurements. This suggests that their training courses did not have elements of how to be using assistive devices. Since these devises have been validated by this research to making remarkable contributions, it is recommended that researchers explored the knowledge behind the use of the assistive devices. The methodologies should be followed as urgently as possible for progress to be made, and to minimise inconveniencing the recipients.

Recommendation 3: ***Recognising Adapted Mathematics Department***

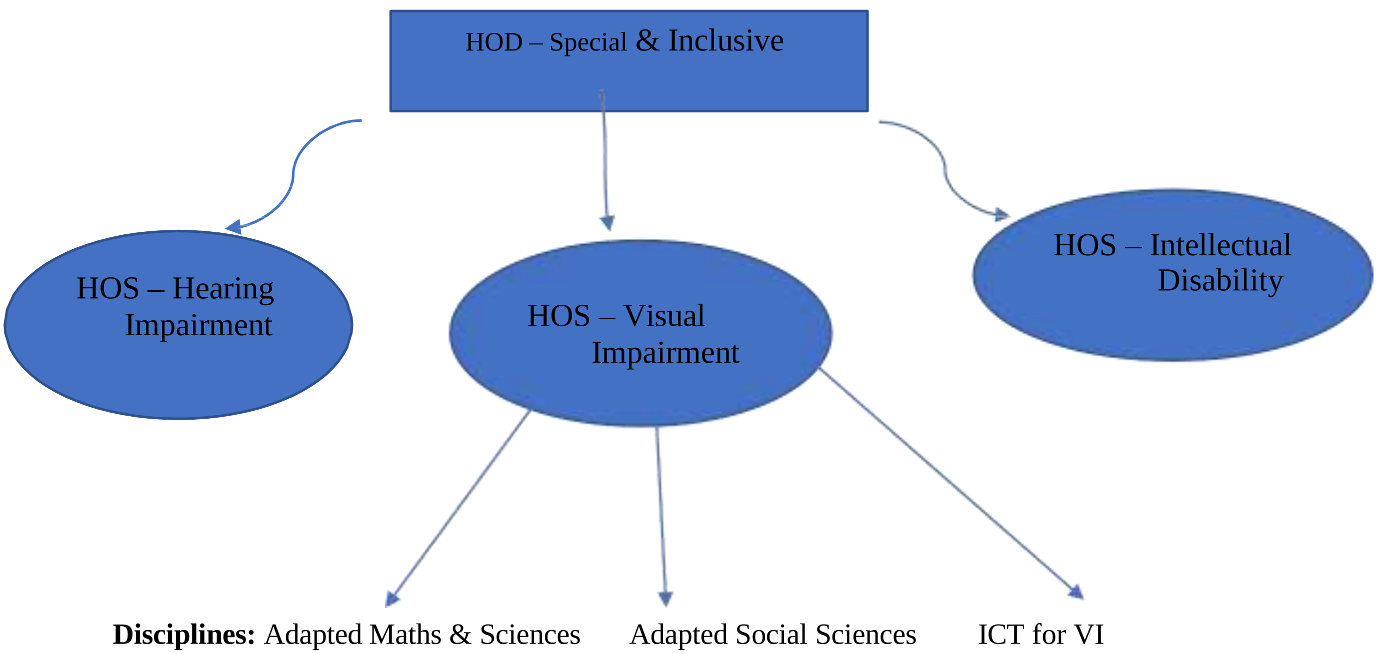
From the findings in Table 12, it was noted that the lecturers appeared to be well qualified in their respective disciplines of Mathematics and Special Education. From figure 5, it could also be observed that some of the lecturers had served over 11 years, as trainers of trainee-teachers for the LVI. Despite having the higher qualifications, and more experiences, they still had the challenges of teaching numeracy to LVI. In order to encourage trainee-teachers to be taking up the profession of Adapted Mathematics, it was necessary that the discipline was given the status quo it deserved.

There was need for a fully-fledged Adapted Mathematics Department, with recognised heads of departments. When a discipline was officially recognised, even salaries and other conditions became attractive, hence, becoming very competitive on the world market. It could begin attracting many students and researchers to venture into the sector.

. The section of Special Education in secondary schools deserved to be recognised just like other departments in the structure of teachers at Secondary school. In other departments where the Heads of Departments (HOD) for Mathematics, Sciences, Literature and Languages were recognised, and the HODs were in higher salary scales. The Special Education Section was usually run by an HOD who was in charge of the units for VI, hearing impairments, and intellectual disabilities. However, the HOD for Special Education was not officially recognised, hence was not receiving a salary equivalent to that of other HODs. One of the reasons the Special Education teachers were receiving lower salaries could be that the sector was considered as a cross-cutting issue (MoE, 1996). The Special Education teacher belonged to two departments. That is, if a teacher offered English to LVI, such a teacher belonged to Literacy and Languages, as well as the Special Education. In terms of official structures, only the Literacy and Languages was recognised. And the subject specialists were considered to be more specialised in the area. Hence, most promotions were given to the subject specialists. This seemingly discrepancy also contributed to the high attrition levels from Special Education. This was despite the fact that Special Education in some cases was more involving than the conventional subjects. To teach Mathematics to the VI for instance, one needed to learn the ordinary Mathematics as well as the Adapted Mathematics (Jenkinson, 1997). If the sector was to attract teachers to this section, then there was also the need to officially put in place a structure of Special and Inclusive Education. The structures could be as suggested in figure 23.

Figure 23

Proposed Structure for Special and Inclusive Education st Head Quarters



HOD from the figure stands for Head of Department, and HOS standing for Head of Section. The above structure has aligned specialisation to the subject areas in schools and not to the disability, as it was in most institutions of learning. The positions should go with salaries.

Such specific departments were also necessary in institutions of higher learning. They needed to incorporate the use of the Abacus as has been demonstrated in this research. They can do this through advertising for lecturers that were competent with the skills. Where possible, the departments to be created, to be named Adapted Mathematics and Science for the VI or any other similar name. Specific departments were necessary because they will have some officers to be discussing challenging concepts together on a daily basis. A department is likely to be engaging into further research for effective delivery of the subject. It can start on a small note, and slowly grow into a fully-fledged department. In response to Q8A, teachers seemed not to be aware of universities abroad where they could train in Mathematics for LVI. The study makes recommendation that universities in Zambia and other nations *affiliate to top ranking universities* in this area. Examples of such universities include Akita University (Akita University, 2023) and Michigan State University (BBB, 2020). Universities could also affiliate to other organisations that have shown some success in this specialised discipline.

Recommendation 4: ***Remove Attitudinal Barriers through Sensitisation***

From the responses to Q11, 12 and 11 for lecturers, the Ministry Officers and teachers respectively, it was noted that LVI suffered from high poverty levels, long distances to schools, poor shelters and many other challenges. In order to implement the Mathematics programme effectively, the education system should not just focus on the academic requirements. The learners also needed support in other sectors of life. Such a holistic approach provided them with the least restrictive environment that promoted independence and academic progression (Yolanda, & Jennifer, 2021).

According to the findings in Figure 16, about 32% of the Ministry Officers had put blame on learners' blindness, concerning the failure by LVI to performing competitively in school. That was a quite a huge number, coming from the Ministry responsible for their education. This suggested that something needed to be done. According to Malungo, et al (2018), many see the disability and not the ability in PWD. The study recommends that there should be sensitisation programmes aimed at helping education providers to understand that education was a right for PWD. Such programmes could reduce on prejudice and discriminatory habits.

Sensitisation programmes about the effectiveness of the Abacus could be done through the broadcasting media (televisions and radio), print media (newspapers and magazines) and the internet. This will help the society to learn about the new methodology, and hence, likely to support it. People needed to see demonstrations from the television, and vividly observe real life situations to believe that a LVI can learn Mathematics. To remove the attitudinal barriers, the Disability People's Organisation (DPOs) should also be engaged. The Ministry may not know that there were gaps in their curriculum. The DPOs were well placed to understanding the challenges PWDs went through, hence, they could play a pivotal role of advocacy on behalf of the learners.

Recommendation 5: Sourcing for Increased Funding for Supporting the Programme

To implement any programme, funding is required. The government alone may not manage to source all the necessary funds. I therefore, request that co-operating partners such as UNICEF, Sightsavers, and World Vision help countries in capacity building their officers in Adapted Mathematics pedagogies. These organisations can source for trained experts from some countries to help others. Often governments are slow in implementing programmes, likely due to length protocols. Cooperating partners can come on board so that the benefits trickle quickly to the beneficiaries.

Additionally, international organisations such as the World Bank and International Monetary Fund IMF could be engaged to support different governments. The challenges of teaching Mathematics to the LVI appears to be a global challenge, hence these large organisations should come on board. They can train a few officers to be trainer-of-trainers for various countries. In Africa, the SADC and African Union could be supporting African Countries. The African Union should fund training programmes for all African countries. At the Dakar Framework for Action in

2000, it was realised that State Parties had challenges of providing quality education (UNESCO, 2000). This suggests that the challenges were not just in Zambia, but Africa as a whole. This is an opportunity for the African Union to train its nations on the Abacus methodology. SADC can also take advantage to train its nations in the Southern and Central Africa. The African Union and the SADC were institutions that were well placed for supporting low income countries. These were some of the initiatives for increasing the funding to Special and Inclusive Schools.

Recommendation 6: *Early Intervention in the Early Grades*

It is necessary to be introducing LVI to be learning Mathematics as early as possible. Early intervention in the early grades has been observed to hold significant promise in the teaching fraternity (Jitka, and David, 2016). This may be easier to develop in Zambia as there was already an existing policy for Early Childhood Education. Schools were admitting children from 3 years of age. The policy on early childhood education (ECE) should also be extended to LVI. The ECE curriculum should also be well adapted for easy of accessibility. The study shall now focus on recommendations in areas that needed further research.

Recommendations for Future Research

Research must also consider the implications around what professional and academic organisations might be interested in from the research findings. The study was undertaken due to the fact that Zambia and many other countries, appeared to have challenges in offering Mathematical principles to LVI. The knowledge of numbers appears to be very essential to the academic performance of learners, not just at school, but even for personal life in the society. Year-in and year-out, there have been outcries from different organisations with regards the type of education that was being offered to learners with SEN. Yet elsewhere, research was showing tremendous success with the use of the Abacus (Nongola, 2015). During the pre-test, the teachers and lecturers scored an average of about 20%. But after undergoing experimental treatments, their average score rose to 69% at post-test, suggesting that the Abacus could be an effective tool for computations in tactile Mathematics. This study made some recommendations to would be researchers and other professionals, who may be interested to further this study.

Recommendation 1: ***Compare Experiments to Non-experimental Approaches***

Most of the research articles that were found in the literature were those of surveys. Such research did not appear to have yielded more data that could have helped in the teaching of Mathematics to LVI. The survey by Simalalo (2012) for instance, indicated that teachers had a lot of challenges with regards the teaching of Mathematics to LVI. The study had recommended that schools needed to have a lot of teaching and learning aids. The study however, did not specify the exact teaching tools the schools needed. Her findings therefore, were of limited significance. In surveys, sometimes some respondents guess what to say or write. However, in quasi-experiments, one cannot easily lie as you are monitored very closely. If you cannot compute a problem, it will be noted. If you score 2 items out of 10, it will be observed. The behaviour of a participant can be closely monitored during Observation Protocols that often accompany experiments. Even individual challenges may easily be spotted out.

Additionally, to administer quasi-experiments, the researcher must be learned. In surveys, and for many cases, other participants can be requested to administer the tools on behalf of the researcher. Since the data collector in an experiment was the researcher, it suggests that the design was more objective. Experiments are very important, more especially at doctorate level. Most studies at doctorate level should be experimental in nature in order to be able to clear most controversies. It is therefore, important that future research in this discipline concentrates more on experiments, to be able to build on this research. This was a quasi-experiment, perhaps others can move it even to a true experiment.

Recommendation 2: ***Participants to be targeted for the Abacus Training***

At some of the higher institutions of higher learning, such as the University of Zambia and Nkwame Nkrumar universities, there appeared to be a dilemma. There were two distinct schools: Natural Sciences and Education. The former was the school for all students intending to specialise in Mathematics and other sciences. The latter was where trainee-teachers learnt methodologies for teaching in schools. Within the Natural Sciences faculty, the Mathematics opened to several branches. Such branches included Statistics, Linear Algebra and Calculus. For students intending to be teachers of Mathematics, they often started with the Natural Science courses for about two years, and in later years took some courses on teaching methodologies from the faculty of Education. The Education department also hosted the Special Education faculty, and the Mathematics and Statistics departments. The former dealt with Special Education methodologies for teaching learners with disabilities. The latter dealt with methodologies for trainee-teachers intending to teach Mathematics to learners who were sighted.

Since the focus of the Mathematics and Statistics department was for the sighted, they did not plan for the LVI. One would definitely conclude that it was the responsibility of the Special Education for hosting the adaptation of Mathematics. Unfortunately, this study found that, they too, thought it was for the Mathematics and Statistics department. The area of Adapted Mathematics for the VI appeared to have been overlooked. It sounded like a dilemma. Research needs to be constituted to determine where this highly specialised discipline should belong. Adapted Mathematics for LVI needed to exist somewhere for it to be taught to trainee-teachers.

In some Colleges of Education, there were usually two types of lecturers: for Special Education and for Mathematics. Just as the previous paragraph clearly elaborated, the Special Education teacher-trainees were trained to teach learners with disabilities. The Ordinary Mathematics teacher-trainees' training was focused on the sighted learners. Some Special Education teacher-trainees, did also take Mathematics as a teaching subject. They were trained pure Mathematics and Special Education but not in Adapted Mathematics for LVI. To effectively offer the course at school level, research should also target how teacher-trainees should be trained at the Colleges of Education. One or both of the two categories (Maths or Special Education) should be offered a course in Adapted Mathematics. The challenges at colleges of education appear to be similar to those at universities.

In a Special Education School, there were basically Special Education teachers. These teachers were responsible for teaching all the learners with disabilities in the school. However, in an inclusive education system, learners with sight and those without often learnt side by side within the same classroom. Such schools were often called inclusive schools. It was observed from Qs 10, 11A and 14A for the lecturers, the Ministry officers and teachers' questionnaires respectively, there was a lacking of specialised teachers in schools for the VI. From the findings to Q9B and Q15 of lecturers and teachers respectively, ordinary Mathematics teachers tended to depend much on the use of chalk and black board. This implies that LVI were not benefiting from their methodology. Special Education teachers were also in the inclusive schools, but could not handle the subject. They seemed not to have the mathematical skills. This suggested that no one was attending to the LVI in Mathematics. The LVI were therefore, just idling during Mathematics lessons. No one appeared to be held accountable between the Mathematics and Special Education teachers. There was need to undertake research in schools so that the Adapted Mathematics courses could go either to the ordinary Mathematics teachers or the Special Education teachers. There must be a department responsible for the provision of Adapted Mathematics in schools. Researchers should come on board to help schools, colleges and universities.

Recommendation 3: ***Search for Renowned Institutions***

In question 18B, the lecturers were asked as to which universities their institutions were affiliated to, it looked like some only knew the University of Zambia. It appeared that that answer had come from the colleges that were affiliated to the University of Zambia. The lack of adequate information by the teachers suggests that the area was not a priority. It was important that researchers brought to the fore institutions that appeared to have advanced in the discipline. This research has brought out a few of such universities as Akita University in Japan, Michigan State University and University of Georgia both in North America (BBB, 2020). In Osaka prefectural, LVI also learnt Mathematics, Chemistry, Biology and Physics (Nongola, 2015).

Recommendation 4: ***Assistive Devices for Teaching Mathematics***

The research had demonstrated that the use of the Abacus could greatly enhance the performance of LVI in Mathematics. However, the Abacus was mainly for computing the basic of operations: addition, subtraction, multiplication and division. It may not be used on other topics such as drawing a circle. There could be other assistive devices that could be used on other topics.. Research should therefore, be focused on finding out more user-friendly assistive devices and how they could be used. The functions of a tracing wheel for instance are different from those of an

Abacus. The former is for drawing and tracing circular-like shapes. The geoboard can be used for creating different shapes.

Recommendation 5: ***Length of Adapted Mathematics Course***

A university course has a course outline to be followed**.** This suggests that you need some space in the school calendar when to teach its content. An Adapted Mathematics course is derived from the Mathematics curriculum; hence, it must look at all the objectives of the mother course. A Mathematics course in Zambia takes about 3 and 4 years at diploma and degree levels respectively. If the Adapted Mathematics course was to be added, it suggests that more years were needed to complete the Adapted course. Research needed to be carried out as to whether the adapted course should be a different course at Post Graduate or squeezed within the 3 and 4 years of the diploma and degree programmes respectively. It should also be noted that a longer course unaccompanied by inceptives discouraged would-be trainees. At the same time, when you reduce the length just for the sake of attracting would-be students, the quality may be compromised. This required some research on how to have a clear balance on the length of the Adapted Mathematics Course. This may also depend on whether it was at diploma, degree level or post diploma.

Recommendation 6: ***Type of Motivation for Teachers of LVI***

From figure 5, it was noted that most of the teachers did not go beyond 5 years working in Special Education schools. This suggests that it was not attractive to work in such sectors. Teachers like any other workers, needed food and descent accommodation. They needed funds to take their children to school. They needed to buy cars. Therefore, being able to teach may not be enough for giving them total satisfaction. They also needed some incentives for meeting their various wants and needs. This was especially necessary in the sectors of disability where there appear to be so many demands. Many people may not want to venture into an area where they know that they will get away with very little benefits. There was need therefore, to motivate teachers wholesomely, perhaps paying them two to three times more than the ordinary teachers. That way they will likely exert their efforts to the satisfaction of their employers. However, higher salaries per see, may not be enough. Research should also look at whether accommodation and other factors could have an effect on the teaching fraternity.

Most schools for learners with SEN did not have descent accommodation that could attract teachers. Most of the schools were built in typical rural areas and shanty compounds. There was therefore, a question on what types of incentives that could attract a teacher to work in a rural setting vis-à-vis in a special education school. Research should be organised around the impact of better salaries and accommodation, and Special/Inclusive Education allowance, and their subsequent effects on learner achievements. Other motivating factors could examine the impacts of electrified houses and effective transport. The lack or absence of appropriate teaching and learning materials, can also be for future research areas. The lack of such services may not attract teachers in taking up most challenging jobs, especially in rural areas. Motivation should also focus on motivating expatriates to the sector.

Recommendation 7: ***Causes of Stigma, Stereotyping and Discrimination***

In figure 11, about 33% of the Ministry Officers had suggested that one of the major causes of failure among people with blindness was the disability itself. However, according to the Federal Communications Commission (2022), when there is a loss in one sense, the teaching methodology can be converted into another modality that may require the use of another sense. This suggests that education providers should not be preoccupied with stigma and stereotyping of PWD. Thinking takes place in the brain and not in the eyes. With support, someone with VI could actually perform better than the sighted. Future research should therefore, also be focused on how to be reducing stigma and stereotyping among the education providers. Stigma could lead to discrimination. Some could be thinking that because you are blind, you cannot be a lawyer. Researchers can find out whether labelling is caused by illiteracy among education providers, or it could be rooted from strong traditional backgrounds, or even religious beliefs.

Potential Limitations

When carrying out research, there were often some potential limitations that could affect the interpretations of the results. Muhammad (2023) argues that limitations in research referred to the factors that may affect the results, conclusions, and generalisability of a study. The author went on to give the common types of limiting factors as: limitations in theories, methodologies, empirical (validity or reliability) and in data analysis. Luo (2021) suggested that the sample sise needed to be large enough to be representative of the population being studied. Time limitations could mean that the study was unable to be conducted for a long enough period of time to be able to observe the long-term effects of an intervention. The selection bias can occur when the selection of participants in a study was not random (Muhammad, 2023). The author further indicated that there could also be confounding variables, which were factors that can influence the outcome of a study, but were not being measured or controlled. There could also be measurement errors that may come from inaccuracies in the measurement of variables, such as the use of a faulty instrument. Ethical limitations if not considered in certain studies may not allow the study to be conducted as such studies may involve harm to participants.

This study was not spared from the above limiting factors. The first limitation was because it was conducted during the COVID-19 pandemic (International Disability Alliance, 2022) , where unnecessary movements and contact with each other were restricted. Instead of using interviews, the study had to use questionnaires. This could have negatively affected the results. Furthermore, the study only included lecturers from a single college in the quasi-experiment. Teachers came from various schools, but for the Special Education college, the nation only had one College. The use of one institution to generalise the findings to other colleges and universities could have limited the results. There were however, a few other colleges and universities that offered some courses in Special Education who participated in the survey. The focus of this research was on teachers, hence the results from the college just supplemented the findings from the teachers.

Additionally, the study only tested a specific methodology strategy, the Abacus, and did not explore the effectiveness of other assistive devices. The Abacus was not the also mechanism that could have been exploited. There could be other assistive devices other than the Abacus, that could have produced much better results. By using the Abacus alone, it may limit the findings of the ability by teachers to teaching Mathematics to LVI. Additionally, though the study was intended to explore the effectiveness of the teachers, it should have also have explored the willingness of LVI to learn the subject. Lack of such data could limit the generalisation of the findings.

The sources of reference materials about quasi-experiments in Mathematics for LVI were also limited. Sources that have been referred to were mainly from surveys. Surveys were limited in terms of objectivity and accuracy of results (Creswell, 2014). It was also argued that quasi-experimental research had limitations of not being able to control and manipulate some variables. For instance, the participants could have been discussing with other people after the lessons. In order to determine the actual cause (independent variable) and effect (dependent variable) relationships, a control group is very important. The challenge was that the respondents were limited in number, hence, all those that were found had to be engaged in the quasi-experiments. In order to offset this, the presumed independent or predictor variable (knowledge of the teachers) were measured both at pre-test and post-test. Such limitations could have created challenges with internal and external validity.

There was also the issue of time. Quasi-experiments demanded a lot of time to collect data. Some of the research institutions were far away, and at times the respondents were busy with their primary responsibilities. The researcher, being on self-sponsorship, had limited funds for movements and other logistics. Unicaf University in Malawi used to provide partial sponsorships, however, it was not enough. All these factors could have impacted negatively on the research.

Conclusion

The theme of this study was based on the fact that LVI in schools were not being offered Mathematics despite the subject being a compulsory subject. However, the methodologies with the help of the Abacus were reported to be quite effective (Derrick, 2012). This researcher therefore, was indented to test their efficacy. From Chapter 1, ‘the Introduction’, it was learnt that, it was the responsibility of the Ministry of Education to provide quality education to all learners. It was surprising to note that some learners, in particular, the LVI, were learning a curriculum that was devoid of key subjects. They were not being offered Mathematics and Sciences, yet others, ‘the sighted learners’ were noted to be learning the entire curriculum. This was despite the fact that Zambia had asserted to various conventions and protocols that promoted education as a right for PWD (UN, 2023; ACBRAN, 2017; UNESCO, 1991). The Ministry sector analysis (MoGE, 2018) has been reiterating that it will not leave anyone behind, which appeared to be the opposite on the ground. The nation also adopted the Vision 2030 Agenda, Sustainable Development Goal (SDG) 4. It also reaffirmed to the provision of quality and equitable education to children with disabilities (ACBRAN, 2017), but the seemingly like discrimination tendencies appeared to have continued. Zambia domesticated the UNCRPD of 2006 through a National Policy on Disability of 2015, which was the guiding policy to the provision of education to PWD in Zambia. Despite all these seemingly good policies, LVI were being denied some subjects. The Zambian Education Curriculum Framework (CDC, 2013) guided that learners with SEN shall be provided with an 'adapted and/or alternative' curriculum. However, up to the time of drafting this dissertation, about 10 years later, an Adapted Curriculum in Mathematics and Sciences had not been put in place. Lack of such innovations have likely led to too many challenges being faced by PWD. Barriers and misgivings seemed to have led them to untold suffering. Furthermore, the Ministry has always been emphasising that education was an equaliser (MoE, 2007). It was therefore, not very clear why the Ministry was not putting in place measures to ensure that the VI also received their entitlement to quality education. Research was necessary to guide the education providers.

Efforts however, have been made in trying to develop special education. Zambia has been offering Special Education to CSEN since 1971 (MoE, 1996). A college by the name of ZAMISE was established to train teachers for CSEN. Since then, there have been great achievements, especially in areas such as Braille, Sign language and Social Sciences. Despite having several projects such as the Sightsavers Zambia project of 2009 – 2013 (Sightsavers, 2015), very little effect appear to have been done in the sector of Mathematics for LVI. The purpose of Education, according to Kelly, M. (1999, p127) was the achievement of pupils. According to the World Bank (2020**)**, learners with disabilities were being discriminated by not being provided with some basic needs. However, the quality of education in key subjects such as Mathematics and Sciences were yet to be realised. Teachers appeared to be very much concerned with methodologies for the sighted. The presentation of topics that graphical in nature appear to be a big challenge. There has also been a lot of reforms in the education sector.

According to D'Agostino (2020), these challenges were not only in Zambia, but the world over. There was very little evidence of countries or institutions, especially in Africa, that had successfully introduced Mathematics and Sciences to the VI. Additionally, it was in the public domain that many institutions of higher learning have been awarding various types of certificates to their graduates in Special and Inclusive Education, but they were unable to effectively teach Mathematics to the VI. This therefore, definitely called for a lot of research in the sector. The researcher wandered why it was difficult to offer Mathematics to LVI. The purpose of sending learners to school may not be realised if they did not benefit from the programmes offered. There was need to review the training programs.

Chapter two was on Literature Review. It examined various theories. The prominent ones were the Gestalt theory by Fredrick Peris (Bustamante, 2023). This theory postulated that the attributes of the *whole should not be deduced from analysis of the parts in isolation*. This suggests that the lacking of one sense should not be an issue. We should be focussing on all the senses in totality. The World Vision (2020) stressed that disability in itself was not an inability. Another theory, the Connection Theory, argued *that individual neurons have very little power on their own,* but when interconnected, could do great works (Edward, 2023). The theory suggests that if Special Education departments were to be working in collaboration with the Mathematics departments, it could be relatively easier to offering Mathematics to the VI. The former understands Braille that is used for writing by the VI, and the latter were mathematicians. If the two collaborated effectively, they could easily learn the Adapted Mathematics Curriculum together. This is of course, with the help of experts in Adapted Mathematics. The theory of *didactical situation* argued that situations should be set up to allow learners to be creating their own discoveries (Brousseau, 2022). This study however, anchored very strongly on the theory by Howard Gardner, who postulated that there were different types of intelligence (Kendra, 2023). The LVI were thought to benefit so much from body-kinesthetic. This suggests that tactile methodologies needed to be explored so much. Adapted Mathematics for LVI needed to be recognised as a specific discipline. That is, it should have been a branch of Mathematics, just like Statistics, Algebra and Calculus. If such a thing had happened, the field could have attracted funders and researchers. The Scientific World (2018) argues that Mathematics was a powerful tool for global understanding. For this reason, most of the countries had made it a compulsory subject for all learners. In Zambia, the *1996 Educating our Future* policy (MoE, 1996) recognised Mathematics as a key subject in learning and declared it a compulsory subject for all learners. The Ministry, through its 2013 Zambian Curriculum Framework reiterated the concept of making the subject compulsory even for learners with disabilities. There was need to work towards removing the barriers and misgivings that negatively affecting the education for LVI. The tactile methodologies as expounded by Howard Gardner's theory need to be fully investigated (Kendra, 2023).

Chapter three brought out the research methods that were followed. This study had used a mixed research concurrent nested approach. It mixed quasi- experimental designs (quantitative) and a survey (quantitative and qualitative). The quasi experiments started with a pre-test and ended with post-tests. The *predictor variable* (or independent variable) was the inadequate knowledge by teachers. The *dependent variable* was the teachers' ability to teach Mathematics to the VI. The sample participants for the quasi-experiments was 26 (17 teachers, 3 lecturers & 6 learners). The experimental schools were selected through probability sampling (through simple random sampling). The quasi-participants, were selected through purposeful and convenient sampling techniques. The '*mechanism*' or methodology that was applied as an intervention strategy was the 'Use of the Abacus'. Sample items for the experimental tests were as follows: 37 + 45, 73 – 18, 54 x 67, 654 x 897, 1,764 ÷ 68, 28.2 + 678.57 & 4/5 x 3 2/5. Participants were not to use pencils or pens, but assistive devices such as abacuses in solving the problems. The survey questionnaire tools were also pre-tested in order to clear syntax and typographical errors, and to be able to measure the intended objectives. The sample size for the survey was 100 (60 teachers, 24 lecturers and 16 Ministry Officers). The survey sample for the survey was selected through probability sampling, by picking shuffled papers from a hut.

Chapter four of the Findings, started by considering the first main research question: What challenges, if any, could be associated to the lacking of Mathematics by LVI, if they did not learn the subject? From responses to Q11B, the officers from Ministry thought that blindness contributed to LVI not being offered the subject. According to scholars, such were negative stereotypes and deep lying prejudices about their lack of abilities (Nganwa, et al, 2017). The findings also revealed that in general, learners with disabilities were not performing so well even in the rest of the other subjects. That could be one of the reasons some parents did not trust that their children with disabilities could succeed if taken to school (UN**,** 2023). From Table eleven, 75% of the teachers and 62.5% of lecturers had indicated that year-in and year-out, many learners with disabilities in Zambia did not perform well in national examinations. The learners were not taking Mathematics, and that had reduced on the numbers of subjects being learnt. This is as Jitka, and David (2016) put it, that the lack of Mathematics had an effect on other subjects.

The second research question was: What teaching strategies were effective for the teaching of Mathematics to LVI? The research found that most of the Special Education teachers were not well qualified to teach Mathematics to LVI. The reasons given were that they did not learn both the content and methodologies for teaching Mathematics. They did not learn how to adapt the subject for the purpose of those who could not see. Their curriculum in colleges and universities was mainly in subjects related to psychology such as neuropsychology, sociology, and guidance and counselling (see appendix C). Teachers did not appear to have received much training in the writing of such mathematical symbols in Braille formats (Adelakun, 2020).

A closer look at the curriculum for teacher training for Special Education teachers at appendices B and C suggest that areas of specialisation for the teachers were in the disability areas of VI, hearing impairments (HI) and learning/intellectual disabilities. In schools, there were no subjects on the school curriculum that were referred to as VI, HI nor intellectual disability. These were just categories of disabilities. In schools, learners with disabilities were expected to learn the same subjects as the so called ‘able bodied’. They were expected to learn English, Biology and/or Geography. This suggests that areas of specialisation should have been related to the subjects in the school curriculum, and not to their disabilities. Since most of the subjects needed to be adapted, they should have been given different names such as Adapted Science, Adapted History, Adapted Biology, Adapted Geography and Adapted Science. This could make the teaching and learning processes for LVI to be well focussed. Schools simply had challenges with pedagogical skills. It appeared that the teachers of Mathematics were only specifically trained to handle the sighted learners.

The third research question was: What was the effect of using abacuses to the teaching of Mathematics to LVI? This was identical to the *null* hypothesis (H_o) that, there was no relationship between the use of the Abacus and learner effectiveness for persons with VI. In order to measure this presumption, that the Abacus could overturn events, the teacher-educators were pre-tested on basic problems such as 5 + 7, 73 – 18, 1,764 ÷ 6, and 4 2/3 ÷ 3/7. They were expected to use the strategies used by LVI in computing Mathematics, such as the use of assistive devices. The inferential statistics for the null hypothesis (H_o) was: The null hypothesis, or presumed population mean (H_o): μ >25%: that is, the knowledge of teacher-trainers, according to the sample population, was that the teachers can score better than 25%, and the alternative *hypothesis*, was (H_a)**:** $\mu \leq 25\%$). That is, the knowledge of teacher-trainers to the teaching of Mathematics to LVI was not better than 25%. The SD was 5.62. That is, the participants' scores at pre-test was in the range of 20 ± 5.62, or 14.38% to 25.62% as in percentages. These results were on tasks at primary school level, suggesting that, the teachers did not have much knowledge in Adapted Mathematics. The pre-test results definitely exposed the teachers and lecturers. Had it been a survey study alone, it could have been very difficult to tell whether the teachers also had challenges. From the quasi results, it was easy to tell the incompetence of the education system. The quasi-experimental tests began with a few examples on each topic. The first topic was on Abacus Addition. A few examples were given, and the teachers were given an exercise. It went on quite well. The second topic was on Abacus subtraction. It also progressed well. The third question was on multiplication. This topic was met with some challenges. Some teachers had challenges with mental multiplication. They could not outright give answers to questions like: 6 x 7, 9 x 6, 7 x 4, etc. From further interrogation, it was discovered that the teachers did not learn Mathematics while in institutions of higher learning. They had diplomas and degrees in Special Education, but Mathematics was not there teaching subject. On the other hand, a few of the teachers were doing quite well during the experimental tests. Such teachers were mainly the ordinary Mathematics teachers, who had received training that targeted the sighted learners. Some of them had ordinary degrees in Mathematics, while others had the Special Education Degree, with Mathematics as the teaching subject. For teachers at primary school, Mathematics was a compulsory subject. These teachers, though they were understanding during the experimental treatments, the rate at which they were grasping the concepts was slow.

Mathematics teachers at secondary school were getting the ideas much easier. This suggested that they could be the ones to be capacity built to spearhead this program. Unfortunately, most of the regular Mathematics did not learn Braille. Learners who were blind mainly expressed their knowledge in writing through braille. This suggests that if you cannot write nor read Braille, you may not be able to read what they write. You may also not be able to mark and correct your students' work. This means therefore, that ordinary school Mathematics teachers may not be the right target to be trained on the use of the Abacus. Something appeared not to have been well planned from their college/university curriculum. The Post-Test results, following the several experimental treatments, for using the Abacus, were as follows: The Null Hypothesis (H_0) or presumed population Mean was 88%. By using Microsoft Excel 2013, Sample Mean ($\bar{x}$) and SD were 69% and 11.65 respectively. This suggests that most of the participants scored in the range of 69 ± 11.65 (or 57.35% – 80.65), which appeared to be a good improvement. If the training had been prolonged, the teachers could have likely gained more knowledge. The findings had shown that the mechanism, or Abacus was a very powerful tool in the methodology for teaching Mathematics to the VI. The SD was however, much higher at Post –Test, implying that that could have other personal and school factors that could have contributed to the imbalance in the results.

The third research question also included Observation Protocols that were considered during the quasi-experiments. They boardered on the teachers' behaviours that were critical to the learning process. The teachers' behaviours such as the amount of time taken to complete exercises was critical during the quasi-experiments. It also considered the time for reporting for work, their morale, willingness, proficiency at understanding, and even the head teachers' support to the teachers. These behaviours were initially recorded per participants, and later summarised for all. Most of them used to observe the time for reporting and knocking off during the experiments. The schools appeared to have embraced the new methodology. Many wanted the program to continue for months so that they could understand fully. There were however, some challenges. The teachers were more cooperative than the lecturers. Most of the lecturers did not want to participate in the research. It took a lot of time encouraging the college management to participate in the quasi study.

Another area of interest during the survey were school observations on standardised checklists. This was about whether the schools had stocks of assistive devices or not. There was some evidence in a few schools of having a few stocks. Additionally, the stocks were more prevalent in the private schools compared to government schools (Special Education schools and the colleges of Special Education). There was almost nonexistence of assistive devices in inclusive education schools, unless such schools had a special education unit. For those who had some, they did not seem to know how to use them. Another aspect that was measured during the quasi-experiments was the willingness by the participants to adopt the use of the abacuses. The schools appeared to have embraced the teaching methodology. There were questions on where they could source abacuses.

The fourth research question had focused on differences on performance among teachers within the same schools, and also with other from schools. The T- and ANOVA tests were calculated. The results indicated that the teachers did not differ much in the knowledge of adapted Mathematics. They all had limited knowledge. However, after the ten treatment tests, the teachers of Mathematics had greatly improved compared to the Special Education teachers. This suggested that they could be the ones to be greatly targeted for detailed training. If Mathematics was very important for the VI, there should be some deliberate efforts on how to be offering it. The impediments that made it difficult needed to be removed. The Ministry needed to find ways of capacity building Special Education and Mathematics teachers in Adapted Mathematics ccurriculum. Before that happened, an Adapted Mathematics curriculum should have been put in place with the help of specialised people. The subject could be offered gradually as an option subject before rolling it out in full. The State Parties must ensure that they have stocks of assistive devices for teaching, and not depend on the use of blackboard and chalk. During the implementation, teachers should be monitored regularly to ensure a smooth implementation. This shall reduce on attrition rates. It was also recommended that the education system should stop seeing the ‘disability’ but focus on the ‘ability’ for PWD (Malungo, et al, 2018). The programme of capacity building teachers and lecturers required funding, it was important that Co-operating Partners worked with the Government. Intensive Media Sensitisation should also have been embarked on for people to be aware of the programme. In order to have maximum benefits, it was necessary that early intervention strategies were started at elementary grades.

As a synopsis of the research, the research was undertaken in an effort to reduce on the challenges encountered by people with VI. It was thought that one of the contributing factors was could be the inadequate training of teachers. The ministries of education did not appear to be offering LVI key subjects that could help them in finding better jobs. A mixed research design that included both quasi experimental and survey designs were undertaken. The respondents were Special and Classroom teachers, college and university lecturers, and Ministry officers. It was found that much of the challenges teachers were encountering in relation to the teaching of Mathematics could easily be resolved with the help of the Abacus.

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APPENDICES

Appendix A: Examples of Quasi-Experimental Lesson on Addition

Instructions: Use of assistive devices to solve. No pencils and pens are allowed

Examples: 1). 48 + 67

1. Place 48 beads by placing 4 in the tens and 8 in the units columns.
2. Place 67 by adding 7 beads in the units columns. Note that you cannot find the 7 as the maximum number of beads is 10. In this case, just have the 7 at the back of your mind, and add it to 8. You get 15. Place 5 beads in the units, and carry the 1 (this 1 is actually a ten) to the tens column.
3. Add remaining 6 of 67 in the tens column. Do as you did for the 7 in the units column.
4. Your answer is 115

Adapted from International Council for Education of People with Visual Impairment (2005). Mathematics Made Easy for Children with Visual Impairments. The Nippon Foundation. www.nippon-foundation.or.jp

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Appendix B: 2020 Training Courses offered for Special Education at ZAMISE

- Braille, Sign Language
- Early Child Education, Mobility
- Development Psychology

- Behaviour Intervention Management Strategies (BIMS)
- Subject Area (Mathematics, Science, Business Studies or Home Economics, Industrial Arts, Home Economics)
- Curriculum Studies
- Devices and material development
- Educational audiology
- Speech correction
- Behaviour management
- Physical Education
- Neuro – psychology

Source: Zambia Institute of Special Education (ZAMISE)(2020)

Appendix C: 2020 Training Courses offered for Special Education at the University of Zambia

- Developmental outcomes;
- Introduction to special education;
- Content subject such as History;
- Educational Psychology;
- Sociology of Special Education;
- Teaching Children with developmental disabilities (skills to identify, assess & teach

- children with developmental disorders);
- Introduction to Research in Special Education;
- Learning processes - Sociological perspective;
- Working with families of children with disabilities;
- Teaching children with hearing Impairments;
- Teaching Children with Visual Impairments;
- A Teaching Subject such as History, Mathematics, Science, Geography, etc
- Special Education Research project;
- Counseling in Child Disability

Source: University of Zambia (2020)

Appendix D: **Letter for Authority to use have access to ICEVI Math Made Easy** YouTube Channel.

ICEVI Secretariat <oficevi@gmail.com>

Wed, Sep 25, 2019 at 9:12 AM

Dear All

Greetings!

We are glad to share the news that Larry Campbell, President Emeritus ICEVI and Todd Reeves, CEO, Overbrook School for the Blind (OSB), Philadelphia jointly inaugurated the ICEVI

MATH MADE EASY YouTube Channel at the OSB on 4th September 2019. You can access the channel by clicking the link

https://www.youtube.com/channel/UCrmcpSzNg_9EXLbqExtVlAQ and view 30 instructional videos on mathematics education for visually impaired children.

Please subscribe to the channel and also share this news with teachers of visually impaired children, parents, teacher educators and all those who are interested in the education of children with visual impairment. We will be uploading another 20 videos in September and more videos will be uploaded on regular basis. We hope teachers will find these instructional videos useful to make mathematics easy for visually impaired children. We hope to receive your comments and suggestions for improving the video instructional materials.

With kind regards

Mani, M N G

CEO, ICEV

Appendix E: Guidelines on Writing Questions by QuestionPro

Richard Rached, QuestionPro richard.rached@questionpro.com

Thu, Jan 13 at 3:57 AM

To: nongolad@yahoo.com Thu, Jan 13, 2022 at 3:57 AM

Hi Donald,

Congratulations! We’re so excited you created a survey! A survey is only as good as the questions being asked. Are you asking the right questions, and does it make sense to your target audience? Here are 10 quick survey writing tips that will help you avoid making crucial mistakes that result in unusable data, or worse, the wrong direction for the organization.

1. Start with the end goal in mind - what is the purpose of your survey?
2. Write questions at your audience's comprehension level
3. Avoid leading and biased questions and answers.
4. Make questions casual and approachable to evoke trust and confidence
5. Avoid double negatives in a single question. Ask for feedback on one item at a time.
6. Add an 'other' or 'n/a' option so respondents can let you know when your answer options don't apply to them.
7. Don't overlap ranges on answer options. Use cleanly separated ranges.
8. Answer options should be balanced. (ex: strongly disagree to strongly agree).
9. Keep response choices simple and short.
10. Collect profile and demographic information last.

Got questions about writing surveys? Schedule a 1-1 meeting with me by replying to this email and let's make sure you have the right tools for your project. Don't have time for a 1-1 session? Explore our how-to guides here, or sign up for live training; to walk through step by step setting up your first survey and if you still have a question reach out to our 24/7 email support.

Best,

Richard Rached

Onboarding Manager - QuestionPro

+971 528825082, sales@questionpro.com

https:www. questionpro.com

Appendix F: Questionnaire for Teachers of Learners with Visual Impairments

1. **A**. Name of School/Institution: …………… District ……….. Province ……………

   B. What is your gender? 1) M 2) F

   C. Kindly tell me your qualifications **………………………………………**

2. Who decides on the subjects to be offered to learners with visual impairments?

   ……………………………………………………………………………

3. **A**. Are all subjects in the school curriculum offered to learners with visual impairments? 1. YES 2. NO

   B. Explain your answer to 3A. ……………………………………………………………

4. A. Are learners with visual impairments offered Mathematics?

   1. YES 2. NO

   B. To what extent can learners with visual impairments learn Mathematics? (You may select more than 1) 1) Up to ECE to Primary

   3. Up to Junior Secondary Up to Senior Secondary

   5. Up to College/University

   C. Explain your answer to 4A. …………………………………………………………...

5. A. What do you think should be the qualifications of teachers of learners expected to teach Mathematics to visual impairments at secondary school?

   ……………………………………………………………………………………………

   B. Explain your answer to 5A.

   …………………………………………………………

6. A. When learners with VI do not perform so well in Mathematics, who is to blame? (you can tick more than once)

	Cause of Poor Performance for VI in Maths	Frequency		
		Ministry Officers	Lecturers	Teachers
1	Blindness disability in them	5	3	5
2	Universities/Colleges	4	4	20

3	The Ministry of Education	4	8	25
4	ECZ	3	1	8
	Other factors		1	2
	Sample Sise	16	24	60

B. At which institution(s) of higher learning in Zambia are such teacher-educators mentioned in 5A trained from? ……………………………………………………

7. Do secondary schools in Zambia offer Mathematics to visually impaired learners?

   1. YES ☐ 2. NO. ☐

8. A. Do you know of any institution of higher learning globally where teacher-educators are trained in Mathematics for teaching learners with visual impairments at secondary school?

   1. YES ☐ 2) NO ☐

   B. If YES to 8A, which one(s) ………………………………………………………

9. A. Have you ever heard of assistive devices for teaching Mathematics to learners with visual impairments? 1. YES ☐ NO ☐

   B. If YES to 9A, above, what are some of these assistive devices?

   ……….……………………………………………………………………………….

10. A. Is there an institution of higher learning in Zambia that offers training in the use of the named assistive devices? 1. YES ☐ 2. NO ☐

    B. If YES to 10A, which one(s)? …………………………………………………

    C. Are assistive devices readily available in Zambia? 1. YES ☐ 2. NO ☐

11. A. How important is Mathematics to persons with visual impairments?

    ……………………………………………………………………………………………

    B. In case Mathematics was not offered to persons with visual impairments, how can this impact on them on:

    1. Their education at school? ………………………………………………………

    2. In Life in general? …………………………………………………………………..

12. Is Mathematics a compulsory subject for all learners at secondary school?

    1. YES ☐ 2. NO ☐

13. A. Is it mandatory by the Ministry of Education that all learners take Mathematics at Secondary? 1. YES ☐ 2. NO ☐

B. Explain ………………………………………………………………………

14. Do schools have challenges with regards the teaching of Mathematics to learners with visually impairments? A) 1. YES ☐ 2. NO ☐

B. Explain …………………………………………………………………

15. A. Can learners with visual impairments do all topics in Mathematics that are offered in the regular stream? 1. YES ☐ 2. NO ☐

B. Explain ……………………………………………………………………………

C. What is the performance of learners with visual impairments in Mathematics in National Examinations in your country?

1. Excellent ☐ 2. Very Good ☐ 3. Good ☐ 4. Poor ☐ 5. Not Sure ☐

D. Explain your answer to C ………………………

16. In your opinion, how can the teaching of Maths to learners with visually impaired be enhanced? ……………………………………………………………………………

17. Do you have any other comments? ……………………………………………………

Appendix G: Questionnaire for Lecturers

TITLE: Teaching of Mathematics to Learners with Visual Impairments. Use of Abacus to enhance Learning

Please answer the following questions.

DEMOGRAPHICS

1. Kindly fill in the following: Name of your Institution/School: …………………………

2. What is your gender? (Please tick in the appropriate box). Male ☐ Female ☐

3. What is your age? (Indicate your age in years). …………………………………..
4. What qualifications do you have? (Tick all of them in the corresponding box below)

PhD	Master	Bachelors of Education	Bachelor of Education with Special Education	Diploma in Education	Diploma in Education with Special Education	Certificate in Education	Other

If other, please specify……………………………………………………….

5. How many years have you served as a lecturer of student teachers for the visually impaired? (Indicate number of years) ……………………..

6. Is Mathematics one of your subjects you train teacher-trainers for the visually impaired?

1. YES ☐ 2. NO ☐

7. A. Do you think Mathematics as a subject should be taken by learners with visual impairments?
1. YES ☐ 2. NO ☐

B. Explain your answer in 7A.

……………………………………………………………………………………..…

8. A. In your opinion, what kind of jobs are persons with visual impairments trained in?
………………………………………………………………………………………

B. What subjects at Secondary school level should they learn in order to qualify for the named jobs in 8A? ………………………………………………………………………

9. A. Should learners with visual impairments be taught all topics in the Mathematics curriculum that are offered to regular stream learners? Explain

…………………………………………………………………………………………………

B. What is the performance of learners with visual impairments in Mathematics in National Examinations in your country?

1. Excellent ☐ 2. Very Good ☐ 3. Good ☐ 4. Poor ☐ 5. Not Sure ☐

C. Please Explain ……………………………………………………………………………..

10. What challenges do you think learners with VI face due to lacking Mathematics in their school curriculum? ………………………………………………………………

11. Kindly indicate some of the challenges Persons with Visually Impaired face as a result of lack of Mathematics in their school curriculum? You may be guided by A and B below:

A). Their progress at school? …………………………………………………………..

B) Life in general? ……………………………………………………………………….

12. A) Assistive devices, have been known to be more effective in teaching Mathematics to the Visually Impaired? What are some of these assistive devices?

……….……………………………………………………………………………

B) Does your training package for trainee-teachers include the use of Abacuses?

13. One of the assistive devices is the abacus, list down the topics in the Maths curriculum you think:

A. I) The Abacus may be used for in computations …………………………………..

II) The Abacus may not be used for in computations …………………………….

B. One of the assistive devices is the Abacus, are trainee-teachers in your institution trained on how to use this tool? 1. YES ☐. NO ☐

C. Can your trainee-teachers solve the following problems using assistive devices?

Code	Trainee -Teachers' Ability to Solve	Response by Lecturers	Please tick.
1	73 – 18	YES	
		NO	
		I do not Know	
2	54 x 67	YES	
		NO	
		I do not Know	
3	764 ÷ 68	YES	
		NO	
		I do not Know	
4	43.002 x 8.351	YES	
		NO	
		I do not Know	
5	0.021 x 1.41	YES	
		NOT	
		I do not Know	
6	5 6/7 + 7 4/51	YES	
		NO	
		I do not Know	

14. Please fill in the following gaps with one or a few words:

A. The VI use ……………………. when taking measurements.

B. The VI use ………………………when drawing circles.

15A. Some teachers have been trained in Special Education but some opt not to teach Mathematics to learners with VI. Please explain

…………………………………………………………………………………………

…………………………………………………………………………………………

B. In your opinion, how can the teaching of Maths to learners with visually impaired be enhanced? ……………………………………………………………………………

C. When learners with VI do not perform so well in Mathematics, who is to blame? (you can tick more than once)

Code	Cause of Poor Performance for VI in Maths	Frequency		
		Ministry Officers	Lecturers	Teachers
1	Blindness disability in them	5	3	5
2	Universities/Colleges	4	4	20
3	The Ministry of Education	4	8	25
4	ECZ	3	1	8
	Other factors		1	2
	Sample Sise	16	24	60

16. A. Is your institution affiliated to other universities with regards the teaching of Maths to the VI?

Code	Please tick
1	YES
2	NO
3	I do not Know

B. If YES to 16 A, please list down the universities ………………………………….

17. Do you have any other comments?

……………………………………………………………………………………………

Appendix H: Questionnaire for Ministry of Education Policy Officers

TITLE: Teaching of Mathematics to Learners with Visual Impairments. Use of

Abacus to enhance Learning

Kindly answer the following.

1. In which Department in the Ministry of Education do you work from?:…………………
2. What is your Job Title ………………………………………………………………..

3. What is your gender? (Please tick in the appropriate box). YES NO
4. What is your age? (Indicate your age in years). ……………………………………….
5. What qualifications do you have? **(**Tick all of them in the corresponding box below)

PhD	Master	Bachelors of Education	Bachelors of Education with Spec Education	Diploma in Education	Diploma in Education with Special Education	Certificate in Education	Other

If other, please specify……………………………………………………………….

6. How many years have you served as a policy maker in the area of special education? (Indicate number of years) ………………………………………………..

7. A. According to the Revised Curriculum of 2013, some subjects such as English, Mathematics and Science are compulsory. However, some learners such as those with visual impairments are not offered subjects like Mathematics, especially at secondary school**?** Do you agree with this statement?

I) Yes I agree II). I am not sure III). No I do not agree

B. Explain your answer to 7A. ..……………………………..…………………

8A. In your opinion, do you think Mathematics as a subject should be taken by learners with visual impairments? 1. YES . NO

B. Explain your answer in 8A. ………………………………………………………………

9A. In your opinion, what kind of jobs should persons with visual impairments be trained for? …………………………………………………………………………………

B. What subjects at Secondary school level should they learn in order to qualify for the named jobs in 9A? ……………………………………………………………

10A. Should learners with visual impairments be taught all topics in the Mathematics curriculum that are offered to regular stream learners? Explain

…………………………………………………………………………………………………

B. Do secondary schools in Zambia offer Mathematics to visually impaired learners?
1. YES 2. NO

11A. What are some of the challenges teachers encounter in the provision of Mathematics to learners with visually impairments?……….……………………………………………………

B. When learners with VI do not perform so well in Mathematics, who is to blame? (you can tick more than once)

Cause of Poor Performance for VI in Maths	Frequency		
	Ministry Officers	Lecturers	Teachers
Blindness disability in them	5	3	5
Universities/Colleges	4	4	20
The Ministry of Education	4	8	25
ECZ	3	1	8
Other factors		1	2
Sample Sise	16	24	60

12. Kindly indicate some of the challenges Persons with Visually Impairments face as a result of lack of Mathematics in their school curriculum? You may be guided by A and B below:
    A). Their progress at school? …………………………………………………………
    B) Life in general? ……………………………………………………………………..
13. Assistive devices, have been known to be more effective in teaching Mathematics to the Visually Impaired? Name some of these assistive devices?
    ……….……………………………………………………………………………………..
14. One of the assistive devices is the abacus, list down the topics in the Maths curriculum you think the Abacus may be used for computation?
    …………………………………………………………………………………………….
15. On which topics in the Mathematics curriculum do you think the Abacus may not be used for in computation? ……………………………………………………………………

16. A. Some teachers have been trained in Special Education but some opt not to teach Mathematics to learners with VI. Please explain.

B. Do you have any other comments?

……………………………………………………………………………………

End of Questionnaire

Appendix I: Unicaf University in Malawi Provisional Research Ethics Committee Decision

UREC Decision, Version 2.0

Student's Name: Nongola Donald Nongola

Student's ID #: R1705D2729313

Supervisor's Name: Dr Marios Ioannou

Program of Study: UU-PhD-EDUC-900-3

Offer ID /Group ID: O29131G30040

Dissertation Stage: DS 3

Research Project Title: Teaching Mathematics to Visually Impaired Learners: The use of Abacuses.

Comments: NO Comments

Decision*: A. Approved without revision or comments

Date: 14/10/2021

*Provisional approval provided at the Dissertation Stage 1, whereas the final approval is provided at the Dissertation stage 3. The student is allowed to proceed to data collection following the final approval

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Appendix J: Unicaf University in Malawi Approval Research Ethics Committee's (UREC) Decision

(Provisional Approval)

Student's Name: Nongola Donald Nongola

Student's ID #: R1705D2729313

Supervisor's Name: Maria Efstratopoulou

Program of Study: UUM: EdD - Doctorate of Education

Offer ID /Group ID: O12940G12312

Dissertation Stage: 1

Research Project Title: Teaching Mathematics to Visually Impaired Persons: The use of abacuses.

Q.6: Please delete the subheading

6.6 Expected Risks and its content as it is irrelevant to this section.

Q 9: - Please correct - Dr Maria Efstratopoulou is the supervisor of this research.
- Please delete Supervisor's personal email and telephone number.
- The questionnaire should be in a separate document (currently it is on the same page with consent form)

Comments

Decision: B. Approved with comments for minor revision

Date: 10-Mar-2020

Appendix K: List of Institutions for the Population Sample

TYPE OF RESEARCH	Name of Institution	District	DEPARTMENT
QUASI – Experiment	ZAMISE College	Lusaka	Special Education & Mathematics
	UTH School for VI	Lusaka	Special Education
	Munali Girls Sec	Lusaka	Special Education & Mathematics
	Sisabelo Sch for VI	Lusaka	Special Education
	Sefula Sch for the VI	Mongu	Special Education
	Sefula Sec School	Mongu	Mathematics
SURVEY	ZAMISE College	Lusaka	Special Education & Mathematics
	UTH School for VI	Lusaka	Special Education
	Munali Girls Sec	Lusaka	Special Education & Mathematics
	Sisabelo Sch for VI	Lusaka	Special Education
	Sefula Sch for the VI	Mongu	Special Education
	Sefula Sec School	Mongu	Mathematics
	University of Zambia	Lusaka	Special Education & Mathematics
	Nkwame Nkrumar University	Kabwe	Special Education
	Zambia Open University	Lusaka	Special Education
	Rockview University	Lusaka	Special Education
	Mongu College of Education	Lusaka	Special Education & Mathematics
	Bauleni Sp Edu.	Lusaka	Special Education
	St Mulumba Sp Ed	Choma	Special Education
	Maguero Sp Ed	Chipata	Special Education
	St Mary's Sp Ed	Kawambw	Special Education
	Kasempa Sp Ed	Kasempa	Special Education
	Examinations Council of Zambia	Lusaka	Special Education
	Curriculum Development Centre	Lusaka	Special Education
	Standards & Evaluation	Lusaka	Special Education
	Teacher Education & Specialised Services	Lusaka	Special Education
	District Education Board Secretary	Lusaka	Special Education

	District Education Board Secretary	Mongu	Special Education

APPENDIX L: OBSERVATION CHECKLIST OF SCHOOL ENVIRONMENTS

Name of School: …………………………………………………………………

1. Assistive devices present in the school ………………………………………
2. Assistive devices from the school …………………………………………....
3. The presence of Adapted Mathematics on the school curriculum …………
4. Randomly attending classes to find out if LVI were learning Mathematics lessons ………………………………………………………………………………………
5. Randomly attending classes to find out if learners with VI were participating in Mathematics assessments …………………………………………………………

Adapted from Creswell, J. & et al (2014)

APPENDIX M: OBSERVATION PROTOCOLS CHECKLISTS OF TEACHERS' BEHAVIOUR

To be filled-in by the Researcher

A. DEMOGRAPHICS

1. Name of Participant (Use Pseudo Name, letter A) …………………..
2. Institution/School: ………………… District ……… Province …………
3. Status of the Institution/School?

ECE	PRIMARY	JUNIOR SECONDARY	SENIOR SECONDARY	COLLEGE

4. What is the participant's gender?

Male	Female

B. OBSERVATION PROTOCOLS CHECKLISTS

Take note of each of the participants's behavious as they solve problems using the Abacus on the following topics: Addition, Subtraction, Multiplication, Division, Decimals & Fractions. Thereafter make a summary for all the participants

1. **Teachers' Morale**

A. Time Management in using the Abacus

Sub Topic	Takes much short time	Takes Average time	Takes much longer time
Amount of Time	1	2	3

B. Rate of Attendance

No. of days present for lessons for each participant	1 Day	2 Days	3 Days	4 Days	5 Days
Please/code tick	1	2	3	4	5

2. **Adoption of Use of Abacuses**

A. Efforts to Source Abacuses

Efforts to Source Abacuses	Poor	Good	Very Good
Comment (Tick/code wherever applicable)	1	2	3

B. Willingness to Introduce Mathematics to LVI

	Not Willing	Willing	Not Sure
Participant makes efforts to source abacuses for learners	1	2	3
Participant makes efforts to introduce Maths to LVI	1	2	3

3. **Support from College/School Management**

		No Efforts	Yes, make efforts	Not Sure
A.	School Management makes efforts to observe lessons	1	2	3

B.	School management hope to implement the program	1	2	3