

Effects of Laboratory Experiments on the Learning of Science by Visually Impaired Pupils: The case of Magwero Basic and Katete Integrated Schools

By

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TITLE

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DECLARATION

I Dereck Chiza Mtonga, do declare that this dissertation is my own work and has not been submitted for a degree award at this or any other University.

Signature:

Date :

DEDICATION

This report is dedicated to the memory of the late Gideon Kapunda Malandula Mtonga and Mary Zondani Mtonga my father and mother respectively.

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ACRONYMS

AAAS	American Association for the Advancement of Science
CSO	Central Statistical office
CSEN	Children with Special Educational Needs
CLASS	Creating Laboratory Access for Science Students
DEBO	District Education Board Office
DEBS	District Education Board Secretary
EPSSE	Educational Psychology, Sociology and Special Education
ESO	Senior Education Standards Officer
IEP	Individualized Education Program
JETS	Junior Engineering, Technicians and Scientists
PEO	Provincial Educational Officer
PS	Partially Sighted
RS	Residential School
SAVI	Science Activities for the Visually Impaired
TB	Totally Blind
UNZA	University of Zambia
VI	Visual Impairment (Visually Impaired)
ZAMISE	Zambia Institute of Special Education

ABSTRACT

This study investigated effects of laboratory experiments on the learning of science subjects by visually impaired pupils for grade nine (9) and twelve (12) pupils in the two selected schools (Magwero school for the Blind and Katete integrated Boarding school) in Eastern Province of Zambia. Data was analyzed by describing and explaining results from laboratory experiments and sixty (60) responses were analyzed using tables, graphs, means and percentages. The study results show that lack of vision, teaching and learning resources, poor or absence of laboratory infrastructures and lack of science trained and specialist teachers contributed to poor performance of the visually impaired students in laboratory experiments in the two (special and integrated) schools. The study revealed that the visually impaired pupils had problems in determining concreteness and unifying experiences of ordinary materials and apparatus used in laboratory experiments. As a result of the above findings the author made these recommendations:

1. The Ministry of Education should increase funding for special education from ten (10%) percent to forty (40%) percent.
2. The Ministry of Education should renovate and build laboratories.
3. The Ministry of Education should train non-special education teachers and specialist teachers in braille and science respectively.
4. Teachers of science should modify the existing ordinary materials to suit the visually impaired pupils.

CHAPTER ONE

INTRODUCTION

1.0. Introduction

The ability to perform laboratory experiments in science is an important determinant of success in the learning of science by visually impaired students. The reason for this is that manipulation and assimilation of all science learning materials depend on the learner's psychomotor skills. Research has also shown that in the 1940s and 1950s it was generally believed that the intelligence of children with visual impairments was not seriously affected by their condition, except for their ability to use certain visual concepts such as colours and three-dimensional space. For example, Samuel Hayes (1941) examined more than two thousand youngsters and the performance results showed below overall average Intelligence Quotient (IQ) for the visually impaired pupils. It can be assumed that lack of vision, is both a primary impairment and a condition that can hamper cognitive development of visually impaired children because it limits the integrating experience and the understanding of those experiences that the visual sense brings naturally to sighted children (Kephart, Kephart & Schwartz, 1974). These limitations (lack of visual images) are especially notable if the children do not receive early intervention in the pre-school years. The shortcomings may affect students' performance in laboratory experiments. According to the World Health Organization (WHO) report of 2002 there were 161 million people with visual impairments for which 124 million and 37 million were low vision and blind respectively. Thus, 90% of the World's population of whom 81% were adults of above 50 years and 19% were children of less than 15 years old and school going age respectively were blind. In this way, blindness remains a significant problem with an estimated 1.4

million blind children below the age of 15 years old while 5.6 million blind persons were between 15 and 49 years of age. This, previous research had shown that despite many world wide commitments to their education more visually impaired pupils still face problems in laboratory experiments. Effects of laboratory experiments on the learning of science by the visually impaired pupils have been extensively researched globally but no direct research has taken place in laboratory experiments in Zambia.

1.1. Global Perspective on the Effects of Laboratory Experiments

Effects of laboratory experiments on the learning of science by visually impaired pupils have been studied by several researchers in many western countries. Examples include United States of America, Russia, United Kingdom and Ireland (Lunney, 1994; Cetera, 1983 and Dottie, 1997). Through their ground-breaking researches, these scientists have made major contributions towards manipulative problems encountered by the visually impaired students in laboratory experiments (Fletcher, 1973). Studies in laboratory experiments have since shifted from the concentration on teacher attitudes and personality to emphasis in classroom events (Delmont, 1974).

1.2. Zambian Perspective on Laboratory Experiments

There have been no studies done on effects of laboratory experiments on the visually impaired pupils in Zambia. This, thus, is the first laboratory study. A look at the Education policy evaluation of Educating Our Future(1996) indicates that Zambia's vision to provide education in science subjects is possible and equitable to bring quality and relevance to the needs of the visually impaired pupils in the Zambian schools. However, a check on the final grades 9 and 12 national leaving examination results from the 2001, 2002, 2003 and

2004 at Katete integrated school and Magwero school for the Blind indicate poor performance for the visually impaired pupils in science subjects. For example in 2001 four (4) visually impaired pupils sat for grade twelve(12) examinations but only one (1) passed with a credit in Biology. The same year out of six (6) visually impaired grade nine(9) pupils only two (2) passed in Environmental Science with mere passing (grade 4) grades. A similar picture of poor performance persisted in 2002, 2003 and 2004 where school results for both grade nine(9) and twelve(12) indicate that 75% of the totally visually impaired pupils who sat for the examinations had either failed or obtained poor results in science subjects. This is according to the Examination Council of Zambia(ECZ) results recorded by the two schools(Katete and Magwero) careers department for 2001 to 2004.

1.3 . Statement of the Problem

From the poor results witnessed from the two schools in 2001 to 2004 in science subjects where 75% of the total visually impaired pupils had obtained poor results in science subjects, the results suggest that there could be a problem in the manner laboratory experiments are conducted in schools as most science subjects are laboratory taught. Because of this fact (poor results by visually impaired pupils), it was found necessary to conduct a research in this area to ascertain the effects of laboratory experiments on visually impaired pupils.

1.4 Purpose of the study

The purpose of the study was to investigate the effects of laboratory experiments on the learning of science by the visually impaired pupils at Magwero School for the visually impaired and Katete integrated boarding school in Eastern Province of Zambia.

1.5 Objectives of the Study

The objectives of the study were as follows:

- (i) To determine the effects of laboratory experiments on the learning of science by the visually impaired pupils.
- (ii) To establish whether different methods of conducting laboratory experiments had any effect on the learning of science to the visually impaired pupils.
- (iii) To determine whether laboratory experiments required special materials to teach science subjects effectively to the visually impaired pupils.
- (iv) To determine whether visually impaired pupils faced problems in laboratory experiments.
- (v) To ascertain whether differences in professional assistances between non-specialist teachers and specialist teachers for visually impaired pupils had an effect on the learning of science by visually impaired pupils in laboratory experiments.

1.6 Research Questions

Research questions for the study were as follows:

- (i) What effects do laboratory experiments have on the learning of science subjects by the visually impaired pupils?
- (ii) What effects do different methods in laboratory experiments have on the learning of science subjects by visually impaired pupils?

- (iii) Is there need for special materials to teach science subjects effectively to visually impaired pupils in laboratory experiments?
- (iv) What problems do visually impaired pupils face in laboratory experiments?
- (v) What effects do differences in professional assistance between non-specialist teachers and specialist teachers for visually impaired pupils have on the learning of science by visually impaired pupils in laboratory experiments?

1.7. Significance of the Study

It was hoped that the study would provide information on the effects of laboratory experiments on the learning of science by visually impaired pupils in special, Integrated and Inclusive schools. Secondly, it was anticipated that the findings of the study might influence the Ministry of Education, the Provincial Education officers, District Education Board Secretaries, Teachers and other Stakeholders to support the best practices in laboratory experiments to enable better academic performance in science by the visually impaired pupils. Further, it was hoped that the findings of the study would encourage curriculum specialists to develop suitable science curriculum for the visually impaired pupils especially in laboratory experiments.

1.8. Limitations of the Study

Inadequate funding did not allow conducting the study in more than two classes: namely grade nine (Environmental Science) and grade twelve (Biology) in more than two schools and districts.

1.9. Definition of Terms

Effects-Things that bring about the results or the consequences of implementing something.

Laboratory Experiment-A method of teaching science subjects that allow pupils to manipulate objects and conduct experiments.

Visually Impaired pupil-Is one who has difficulties in seeing things or has lost vision.

Science-A branch of knowledge in academic subjects specifically Biology, Chemistry and Physics.

Learning-Is the process by which we acquire and retain attitudes, knowledge, understanding, skills and capabilities that cannot be attributed to inherit behaviour patterns or physical growth.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0. Introduction

This Chapter explores literature related to the effects of laboratory experiments on the learning of science by the visually impaired pupils in schools. It also highlights on measures put in place to promote laboratory experiments in both Zambia and the western world.

2.1. Background Information

Blindness is understood to be “a condition of severe visual impairment, such as of sight as to result into measurable vision or vision which is so limited as to be of practical use, as a channel of learning “(Good, 1973:64). According to Barranga (1983:25), “a visually handicapped child is one whose visual impairment interferes with his/her optimal learning and achievement, unless adaptations are made in the methods of presenting learning experiences, the nature of the materials used, and/or in the learning environment”. The preponderance of visually oriented and visually complex concepts and information in science classrooms poses significant challenges to learning among the visually impaired pupils. According to Individuals with Disabilities Education Act (IDEA: 1977), without systematic instructional attention to these challenges, science may seem inaccessible to many pupils with visual impairments. A laboratory experiment is a rich context for enhancing the learning in a manner that supports the national education standards.

Laboratory experiment is naturally interdisciplinary, quantitative and technology intensive, integrating and reinforcing Ideas from fields of science such as Physics, Chemistry, Biology and Mathematics (Kirk, Gallagher and Anastasia1:1997).

The history of special education on the other hand both at international and Zambian level has undergone three main phases. These are Segregation, Integration and the Inclusion phases. The first concept related to the provision of education and placement of Children with Special Educational needs (CSEN) in segregated schools. Under this phase, such children were educated in special schools, separate from their colleagues who were called 'normal'. Kalabula (1991) laments that the attitude of people towards children and adults with disabilities affected the way the persons were treated and educated in schools. The second concept related to the integration of pupils with disabilities to some ordinary schools while the third related to the inclusion of Children with Special Education Need in ordinary schools.

Globally, the teaching of the visually impaired pupils dates back to 1784 when Valentine Hauy began the first school for the blind in Paris, France (Kalabula:1991). In 1832, Samuel Gridley integrated the first school for the blind. However, the first public school appeared in 1950's when the visually impaired population increased dramatically with the increased incidences of an eye disease called retrolental fibroplasias (Chalkley,1985). The first teachers for the visually impaired pupils realised that general education without teaching these pupils science would be incomplete. Since then the idea of including visually impaired pupils in education could be found in many International Policy documents on the rights of the child such as United Nations (1989), Commonwealth Secretariat (1972) and the Salamanca and Science Framework for Action adopted at the World Conference on Special Needs Education (1994). Zambia, too, had negative attitudes towards the blind as it could not provide informal education to the blind till missionaries arrived to provide formal education at the close of the 19th century of which Magwero School for the

Blind opened the first class in 1903 (Kalabula, 1989). Other schools for instance St. Jones for the Deaf in Kalulushi, Mambilima school for the blind in Luapula and Ndola Lions for the blind in Ndola also opened later. In 1971 the Zambian government took over the running of the schools from the missionaries and a number of efforts have been made in the provision of education to this group of citizens. Ministry of Education(MOE)1992 and 1996 policies emphasize the necessity to educate children with special educational needs. Ministry of Education (1996:66) particularly stresses that "Every individual, regardless of special circumstances or capacity, has a right of access to and participation in the education system ensuring that full quality of access, participation and benefit for all pupils necessitates interventions at all levels to support children at risk."

Although the teaching of science subjects to visually impaired pupils through laboratory experiments is not articulated, it can be read between the lines that the Ministry of Education supports the idea by saying that: "The ministry will improve and strengthen the supervision and management of special education across the country" (MOE: 1996:69). The establishment of Special Education Standards Officers at national, provincial and district levels is one such development. The Ministry of Education in endorsing further the international perspectives, has given substantial priority to the early intervention for children with Special Educational Needs through meaningful early intervention strategies. These strategies include the opening of in-service Special Education teachers certificate and diploma courses at Zambia Institute of Special Education (ZAMISE). Components of Special Education have also been introduced in all pre-school teacher training colleges. The University of Zambia also began offering degree courses in 1997.

2.2. The Importance of Science to the Visually Impaired Pupils

Bishop (1996) observed that the general goals for education were naturally the same for pupils with visual impairments as they were for children with sight. That is, to become independent enough to cope with situations in which they find themselves and to realistically select a satisfying career, in which they could perform, commensurate with abilities they needed to learn science. However, a report by American Association for the Advancement of Science (AAAS 1991) highlighted that learning science was vital because pupils with visual impairments had the same range of cognitive abilities but instruction typically relied heavily on vision. According to Lownefield (1973), one of the subjects in which visually impaired pupils could be trained to become independent was science. Lownefield (1973) also argued that education for the visually impaired children was incomplete if it did not include some acquaintance with natural phenomena, and physical laws met within our daily lives as science was an important subject to be omitted from education. He further argued that science could teach visually impaired pupils important laboratory skills which could help them think in a clear and logical way. Lownefield (ibid) further argued that, apart from being one of the core subjects for formal employment, science helped children to solve simple practical problems. Fletcher (1973) also stressed that laboratory experiments helped visually impaired pupils learn how to grasp concepts and, thus, contributed to its advancement as this was part of every child's life, body and surrounding. Coleman (1967), on the other hand, argued that science contributed to whole learning of the visually impaired pupil and called for skills from other parts of the curriculum to be applied. He further postulated that when pupils looked up for information about a thing in a book they were reading, when they measured and did graph changes in a growing plant, they used mathematics and language skills to organize and report their

findings in experiments and observations. Allan (1983), also pointed out that good science teaching developed in children the kinds of attitudes, ways of thinking and a solid knowledge base that promoted success in the real world. Allan (ibid) further argued that restricting the curriculum to arithmetic, reading and writing trapped visually impaired children into a narrow and superficial outlook that reduced their capacity to learn further and solve real problems.

2.3 Methods of Teaching Science

There are different methods used to teach science subjects. These are lecture, demonstration, discovery and field trip methods. According to Fletcher (1973) methods of teaching science were varied and open to teacher's personal imagination and ingenuity as the success of laboratory experiments depended on the type and the manner in which a particular method was applied. A report by Canright (2006) from National Association for Science Activities (NASA) missions also stated that laboratory experiments provided a particular good content for helping pupils understand the different methodologies of science research and how scientific theories were developed and tested. In a lecture method according to Boulind (1968), the teacher stood in front of the class and talked and did everything to himself/herself while the pupils were passive listeners. However, Boulind (1968) was quick to mention that though the lecture method was the mostly widely used method of teaching and was good because it gave great sense of satisfaction with pupils' progress, it was at times bad because there was no pupil initiative and participation which was required in laboratory experiments. Another report by Canright (2006) revealed that out of ten(10) visually impaired pupils who attended a lecture in a science lesson only two(2) were able to perform the experiment successfully. Boulind (1968) on the other hand

outlined that a demonstration method unlike the Lecture method was where a teacher demonstrated and allowed pupils to draw attention from what they had observed and discussed. Boulind (1968) also pointed out that a demonstration method differed from a lecture method in that while in a demonstration method the teacher really taught, pupils were active participants and were compelled to observe carefully as they had to describe each step of the demonstration. Another research by NASA (Canright, 2006) showed that this method was effective. Out of ten (10) visually impaired pupils who were exposed to an experiment by demonstration method six (6) were able to perform the experiment. Pupils had to draw inferences from what they had observed, and the inferences were discussed. Egelson (1995), however, stressed that all visually impaired pupils should develop their learning (manipulative) skills if laboratory experiments were to use the demonstration method effectively.

According to Young (1979) closely related to a demonstration method was a discovery method where pupils were made to conduct investigations in order to verify facts and principles. Young (1979), purported that pupils could be put in a position of an original investigator and made to discover the principle for themselves. Young (ibid) argued that the method involved placing pupils as far as possible in the place of the discoverer to make them find out instead of being merely told about things. Laboratory experiments, thus, according to Young (ibid) could be discovery in nature. According to NASA the method was better used to higher grades. A research by NASA produced similar results like for demonstration method.

Abrusco (1996) propagated that a field trip was also another method of teaching in laboratory experiments where the teacher of the visually impaired pupils could function as

stimulator and provider of plentiful opportunities where pupils could be taken to study excursions and museum visits. Abrusco (1996) emphasized that every individual was unique and therefore, the ideal field trip education scenario was expected to address the needs of individual learners in laboratory experiments. Abrusco (1996) further argued that every science teacher in the field trip should see that his/her teaching in the school laboratory room had a relation to large things which are continually taking place outside the school.

Polloway et al (1989) argued that though field trips for many teachers conjured up unpleasant memories the appropriate use of that type of learning activity could enrich the world knowledge of many visually impaired pupils with limited experimental background. Polloway et al (1989) further postulated that field trips did involve planning and separation and instruction objectives such as identification, looking for, and following up discussions as scheduled. In this way Polloway et al (ibid) argued that pupils would have experience to understand data studied, experiments as well as the concepts and generalizations found in science. A field trip has been acknowledged by many writers for example, Egelson(1995) as being important in laboratory experiments as the method made teaching real and practical. Fletcher (1973), acknowledged that visits for example, to factories would supplement work in the classrooms and laboratories and would help develop interest in the visually impaired pupils. Fletcher(1973)revealed that out of twenty(20)visually impaired pupils who had gone on a field trip to a local water plant factory five(5) out of ten(10) were able to remember and carry out a water purification experiment. This shows how important field trips are.

2.4. Equipment and Materials

Fletcher (1973) highlighted that most researchers had undertaken a general study on what materials and apparatus should be used in teaching science to the visually impaired students. Fletcher (ibid) postulated that in teaching science, models such as growing plants, materials such as meat from butcheries and other objects could be used to teach the visually impaired pupils for them to interpret and magnify dimensions and to realize the difference in texture. Fletcher (ibid) also pointed out that a model could show principles better than the real object. He emphasized that the visually impaired pupils should be trained in interpretation of drawings and teachers and pupils should be taught how to interpret embossed symbols in figures of plastic rulers, braille markers, scales and animal specimen to name a few. Judy (1998) echoed Fletcher by saying that models were also used as means of introducing realism in science as being three dimensional and had realistic quality. Judy (1998) also postulated that when pupils were involved in making models, their interest was aroused in making models as a purposeful laboratory experiment. Fletcher (op.cit) recommended that the visually impaired pupils should be able to touch objects and apparatus in the laboratory in order to observe them. He cited, for example, the study of the 'inner man' which should be strengthened by the use of animal specimen obtained from the butchery. Quirk (1978) on the other hand recommended that laboratory buildings should have modifications that were desirable. Quick (1978) postulated for example, the need for plenty room with adequate space for clear movement between the benches. He argued that benches should be wider as usual to accommodate equipment. Savage (1964) argued that the bench space should be one linear meter (three feet) per pupil, one meter and seven centimeters space between the ends of benches and walls to provide circulation. Savage (ibid) also argued that equipment

was partial solution to today's answers in teaching science, thus, large volumes of encyclopedia for science and magazines, books with embossed dots representing diagrams, photographs and Perkins Brailers for rapid braille of notes should be kept and filed. Quirk (1978) on the other hand argue that tape recorders, audio aides, embossed diagrams, Optacom machines and science apparatus with brailled marks such as spirit burners, tripod stands, test tubes, syringe barrels and talking calculators should be used in the modern world for teaching science in laboratories.

2.5. Laboratory problems Faced by the Visually Impaired Pupils

The problems the visually impaired pupils face in laboratory experiments in science have been studied by several researchers namely; Malone, De Luchi and Their (1981), Wagner (1956), Wohlers (1994), Ricker and Rodgers (1981). However, until recently, statistics related to effects of laboratory experiments on the learning of science by visually impaired pupils are based on studies carried out by developed countries with little or no applicability to developing countries like Zambia.

According to a report by IDEA (1977) the development of new opportunities for participation by the underserved and under-utilized groups has been adopted by an American organization called "Creating Laboratory Access for Science Students (CLASS)" as one of the operating principles of laboratory-science enterprise. Another report by IDEA (1977) postulated that one such "underserved" community, for which access to materials related to laboratory experiments had traditionally been difficult, were the visually impaired pupils who with a few notable exceptions, virtually no suitable laboratory experiments suited them.

Kirk, Gallagher and Anastasiow (1997), for example, argued that, pupils with visual impairments faced problems in determining concreteness especially where teachers gave pupils concrete experiences without explaining the relationships among those experiences. However, Lowerfield (1971) argued that though pupils had problems in determining concreteness they could still succeed in determining concreteness. He further argued that as long as laboratory experiments and learning materials were adapted to the needs of the pupil who relied on his/her acquisition of knowledge almost exclusively upon the senses of touch and hearing, the pupil would be able to determine concreteness.

According to Maple (2006) the 1996 study that was conducted by New Mexico City University students under a grant from the Regional Alliance for Science Engineering and Mathematics (RASEM) addressed barriers that college students with disabilities faced in the laboratory setting. In all the three subject disciplines the report highlighted that most courses required laboratory work which posed more challenges to those with disabilities and that instructors should be aware of individual needs of students with disabilities and make necessary accommodations. Although this may be true in certain cases, research does not indicate better results to that of sighted pupils. For example, Gattsman (1971) tested pupils of ages two(2) to eight (8) who were blind and sighted on their ability to identify by touch such things as a test tube, a pair of scissors, geometrical forms and cylinders to name a few but many. He found no difference between the groups. Gattsman (1971) propagated that it was, thus, necessary for teachers to encourage the development of the sensory compensation and perception adaptive skills for the visually impaired pupils if laboratory experiments were to be effectively performed. Warren (1994) also echoed Gattsman by saying that without personal and social adjustment of adaptive skills, a

visually impaired pupil, thus, may not perform laboratory experiments considering the nature of ordinary materials and manipulative experiments involved and this may be frustrating. Karen (2002) for example, also propagated that pupils with mobility problems had obvious difficulties manipulating equipment such as pipettes and gauges. Karen (ibid) argued that by being not able to perform laboratory experiments these pupils were discouraged from taking science courses and pursuing technical careers.

Kirk, Gallagher and Anastasia (1997) also observed that unifying experiences was another challenge faced by visually impaired pupils in laboratory activities. They argued that a sighted pupil, for example, who went into a laboratory saw not only shelves and objects, but also the relationships of shelves and objects in space. They further argued that this meant that pupils with visual impairments couldn't understand these relationships unless teachers allowed them the experience of a laboratory. They further argued that the teacher should bring the "whole scenario" into perspective, not only by giving pupils concrete experiences but also by explaining relationships. According to Quirk (1978) lack of vision, then, was both a primary impairment and a condition that could hamper cognitive development as it limited the integrating experience and the understanding of those experiences that the visual sense brought naturally to sighted pupils. These limitations were especially notable if pupils did not receive early intervention in the pre-school years and in turn may affect the way laboratory experiment were performed. Kirk, Gallagher and Anastasia(1973) also postulated that pupils with visual impairments had the ability to listen, relate and remember, and these skills could be developed to the fullest. They further argued that visually impaired pupils had to learn how to use time efficiently because the process of acquiring information or performing a task could be cumbersome and time-

consuming. For the teacher, this meant organizing materials, experiences and using sound principle of learning.

2.6. Qualities of Science Teachers for the Visually Impaired Pupils

Polloway et al (1989), observed that of all the subjects taught to visually impaired pupils, science may be one of the non - intriguing as well as one of the most feared by many teachers. Chibesakunda (1983) however, argued that teaching science could be exciting and rewarding though teacher's attitudes may be the most critical variable. Chibesakunda (1983) further argued that no matter how exciting the teacher was about teaching science, not every visually impaired pupil would share the enthusiasm. According to Kirk, Gallagher and Anastasia (1997), even though many visually impaired pupils were stimulated by an engaging science programme, others did not respond in such fashions and required motivation strategies. Cohen and Stanley (1982) postulated that teachers were said to harbour differing opinions about teaching science to visually impaired pupils. Cohen & Stanley (1982) also revealed that many teachers thought science was neither meaningful nor appealing to visually impaired pupils and as being beyond the capacities of lower-achievers. However, a research by stefanich and Norman (1996:51) in New Mexico University found that most school science teachers and college science educators had little or no direct experience in teaching disabled pupils and often held stereotypical views of what pupils with disabilities could and could not do. Nevertheless, 69.8% of those surveyed did not believe that it was unrealistic to expect a blind pupil to become a chemist (p.18). Ferrell (1986), for example, Ferrell (1986) argued that many published science materials and suggested laboratory experiments (most of them excellent) were not designed for the visually impaired pupils and must be changed if effective teaching was to

prevail. Ferrell (ibid) further argued that teachers for the visually impaired pupils should develop the ability to adapt materials proficiently and expeditiously.

Stefanich and Norman (1996) propagated that science teachers should have a solid background in science, including a broad general knowledge. They further said that science teachers should be well prepared, well organized and have a direction and purpose, for their laboratory teaching was almost as self-evident that they should understand science. Seattle (1996), however, argued that the effective science teacher should realize the importance of inter-personal relations as personalizing his/her relationship with pupils could include many things such as a greater understanding of the visually impaired pupils through learning braille, devising different tasks for different pupils, conducting individual evaluation, varying questioning technique or the use of different materials and equipment. Effective communication as supported by Fletcher (1973) was the idea that cover in one way or another, most of the important aspects of personalizing science teaching. Fletcher (1973) further supports that laboratory teaching was, thus, wide open to teacher's personal imagination and ingenuity as what was important was to provide much pleasure and excitement in the learning process though according to applicability true pleasure and excitement in the learning process for the visually impaired children could only take place when the class had a total number of ten pupils although Fletcher (ibid) recommended twelve pupils that included people with low vision.

Cetera (1983) looked at laboratory science environment as being more challenging to the visually impaired pupils. His study pointed out for instance, the issue of classroom and laboratory organization by science teachers as a matter of urgency for the visually

impaired pupils. Cetera (ibid) further postulated that teachers of the visually impaired pupils should be able to control the sizes of their classes. According to Palloway et al (1989), however, this objective could be achieved by establishing rules and procedures for specific tasks and appropriate functioning as that requirement was especially important for laboratory experiments that used potentially dangerous materials. Cetera (ibid) also points out that safety was the primary concern which teachers should anticipate and prepare for. He also suggested that all planned science laboratory experiments should be performed well ahead of time, equipment should be protected, fire extinguishers should be available, and safety instructions should be demonstrated and practiced regularly by science teachers and the visually impaired pupils. Lorenzo (1988) postulated that dangerous or potentially dangerous materials should be secured and off-limit signs posted to protect children from injury and the teacher from liability. Lorenzo (1988) further postulates that it was also advisable for science teachers to consult the safety guidelines of the school district.

2.7 Summary of Literature Review

Laboratory experiments are very challenging not only for the sighted but for the visually impaired pupils as well. They are not natural skills but require deliberate effort from both teachers and pupils. While sighted pupils learn adaptive skills easily, it requires some substantial amounts of struggle for the visually impaired pupils to perform such skills which relate to laboratory experiments due to loss of sight. Research (CSO 2000) indicated that out of the 9.9 million blind population as many as 18,883 of all school-going pupils in Zambia experienced blindness. The prevalence's of high levels of blindness among the learners indicate that the Ministry of Education has to double its efforts to mitigate the

effects of laboratory experiments on the learning of science by visually impaired pupils. One inevitable outcome over failure to perform laboratory experiments by the visually impaired pupils is high levels of poor results in science subjects (Fletcher, 1973; Simwanza 1992; ECZ 2001-2004). The foregoing argument underscored the importance of exploring the effects of laboratory experiments on the learning of science by the visually impaired pupils. Doing so would enable stakeholders to catch the visually impaired pupils through provision and adaptations of both materials and equipment needed to fully utilise the visually impaired pupils senses of hearing, touch, smell, residual vision and taste (Ricker,, 1981; Lowenfeld, 1973).

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This section gives information on how the study was conducted under the following sub-headings: research design, target population, sample size, sampling procedure, research instruments, data collection procedures and data analysis. Further, validity and reliability of instruments used are outlined.

3.1 Research Design

This study used a survey design. The survey was adopted because according to Cohen and Manion (1998) surveys gather data at a particular point in time with the intention of describing the nature of available conditions or identifying standards against which existing conditions can be compared or determining the relationship that exist between specific events or variables. Bless and Achola (1990) also argue that a survey focuses on facts, beliefs, opinions, attitudes and behaviour pertaining to the existing situations and allows for changes in the course of study. The survey, hence, is the most commonly used descriptive method in educational research. The research was carried out through, lesson observations, self-administered questionnaires and face to face structured interview schedules. The study was conducted in the two schools namely: Magwero school for the Blind and Katete Integrated school in Chipata and Katete districts respectively. Katete Boarding School was an integrated school with a unit for the visually impaired pupils while Magwero School for the Blind was a residential school for the visually impaired pupils.

3.2. Target Population

The target population comprised all visually impaired pupils, all Special Education teachers and all non-specialist teachers from the two selected special schools.

3.3. Sample Size and Sampling Procedure

Participants in this study consisted of 60 respondents. Details of respondents have been presented as follows: teacher respondents by gender, specialist, experience and type of school while pupil respondents were by gender, age, grade level, visual acuity and by type of school as displayed below:

Table 1: Teacher Respondents by Sex and Type of School

Type of school	Male		Female		Totals
	Specialist	Non- Specialist	Specialist	Non- Specialist	
Special School	10	0	4	0	14
Integrated School	2	10	0	4	16
Totals	12	10	4	4	30

As can be seen from table 1, there were thirty (30) teachers (22 males and 8 females) who took part in the research from the residential special school and integrated school. There were sixteen (16) specialist teachers; ten (10) males and four(4) females from Magwero School for the Blind and two(2) males from Katete boarding integrated school. On the other hand there were fourteen (14) ordinary teachers; ten (10) males and four(4) females from Katete Integrated School and no ordinary teacher from Magwero Basic School for the Blind. Thus, there were thirty (30) teachers (16specialist and 14 ordinary teachers) as respondents.

Table 2:Pupil Respondents by Sex and Type of School

Type of school	Male	Female	Totals
Special	10 (50%)	10 (50%)	20 (100%)
Integrated	5 (50%)	5 (50%)	10 (100%)
Totals	15 (50%)	15 (50%)	30 (100%)

From table 2, there were ten(50%) male and ten(50%) female pupils from the special school while five (50%) male and five (50%) female pupils were respondents from the integrated school. There were thirty (100%) visually impaired pupils who took part in the research (15 males and 15 females).

Table 3: Pupil Respondents by Age in Years and Type of School

Age Range	Special School		Integrated School	
	No.	%	No	%
15 - 17 years	6	30	4	40
18 - 20 years	12	60	4	40
21 above	2	10	2	20
Total	20	100	10	100

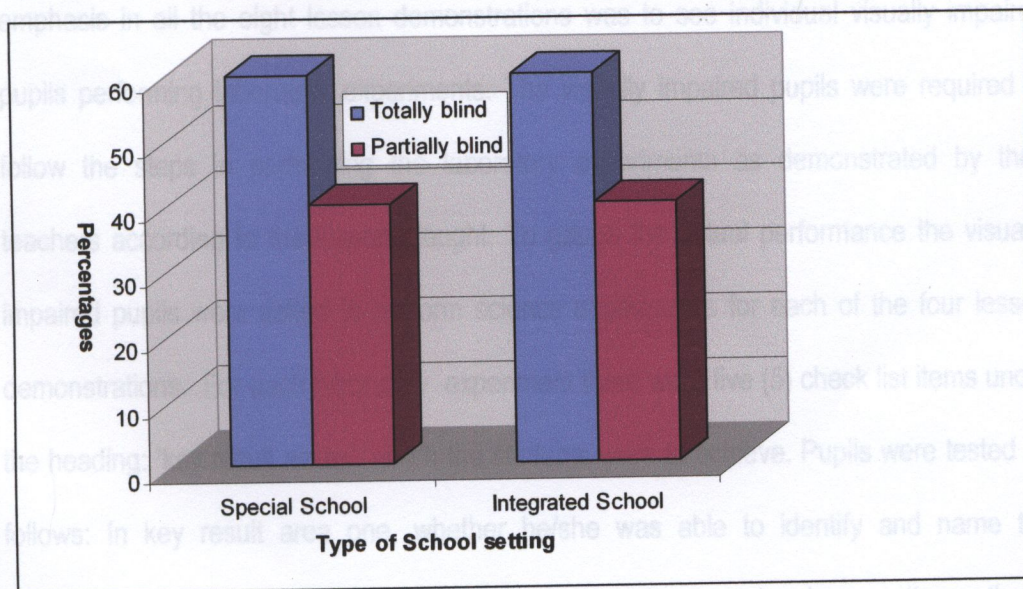
From table 3, there were six (30%) of the twenty(20)pupils in a special school and four (40%) of the ten(10) students in integrated school with ages ranging between 15 - 17 years. On the other hand, twelve (60%) of the twenty(20) pupils in special school and four (40%) of the ten(10) pupils in Integrated school had ages ranging between 18-20 years old while two (10%) of the twenty(20) pupils in special school and two (20%) of the ten(10)pupils in integrated school had ages above 21 years old.

Table 4: Pupil Respondents by Grade Level and Type of School

Grade	Special School		Integrated School	
	No.	%	No	%
8	4	20	0	0
9	8	40	0	0
10	8	40	0	0
11	0	0	2	20
12	0	0	8	80
Total	20	100	10	100

The grade level of twenty (20) students from the special school as seen from table 4 comprised four (20%) grade eight pupils, eight (40%) grade nine pupils, eight (40%) grade ten pupils and no pupil from grades eleven(11) and twelve(12) as these grades were not available. In integrated school out of ten (10) pupils no pupil was in grades eight (8), nine(9) and ten(10) as these grades were phased out by Reformed Church of Zambia(RCZ) the overseer of the grant aided school. There were two (20%) pupils in grade eleven (11) and eight (80%) in grade twelve(12) who took part in the research.

Figure 1. Pupil Respondents by Visual Acuity and Type of School



In terms of pupils' visual acuity, twelve(60%) were totally blind pupils, while eight(40%) were partially sighted pupils. In the integrated school, six (60%) pupils were totally blind, while four (40%) pupils were partially sighted.

The sample size represents ten (10%) percent of the total population of teachers and pupils. The respondents from the teachers were randomly selected from the two separate lists of staff by using number intervals 1, 5, 10, 15 to150. Each name that fell within these numbers was picked as a sample. On the other hand all the visually impaired pupils were automatically picked from the two respective schools as this was the only total number of pupils present in the grades found in the school.

3.4 Research Instruments

Data gathering techniques involved the actual lesson observations on eight (8) laboratory experiments while thirty (30) questionnaires for teachers and thirty (30) interview schedules for pupils were used as interview research instrument supplement. The emphasis in all the eight lesson demonstrations was to see individual visually impaired pupils performing laboratory experiments. The visually impaired pupils were required to follow the steps in performing the laboratory experiments as demonstrated by their teachers according to the lessons taught. To gauge the actual performance the visually impaired pupils were asked to perform science experiments for each of the four lesson demonstrations. For each laboratory experiment there were five (5) check list items under the heading: 'key result areas' which the students were to achieve. Pupils were tested as follows: In key result area one, whether he/she was able to identify and name the apparatus used, key result area two: ability to manipulate apparatus, key result area three: ability to be mobile, key result area four: ability to perform experiment and key result area

five: ability to follow instructions. For each of the four (4) laboratory activities there was a column for marking a tick (✓) where the pupil successfully completed a particular key result area. Each tick carried one (1) mark. A cross (x) denoted unsuccessful attempt. All the ticks were counted from each of the four laboratory-science experiments for each visually impaired student. Additions and calculations for averages and means were done in tabular form (see tables 5 and 6).

The questionnaires were distributed to teachers to fill in the information according to Achola and Bless (1990) this kind of questionnaire is preferred because the respondents could read and write on their own. A face to face schedule structured interview was conducted with the pupils to obtain oral information (see appendix 3). The instrument was used because it was fit for school going pupils which helped to minimise misrepresentation of facts by the pupil respondents. As a result, the answers given were as clearer, as possible.

3.5. Pre-testing of Research Instruments

All the instruments were not pre-tested due to congestion in the two schools' timetables. The researcher was not allowed to administer the instruments more than once. Katete Boarding School and Magwero Basic School for the Blind respectively were chosen because they taught visually impaired pupils.

3.6. Data Collection Procedure

Data collection lasted five (5) months from January to May, 2006. On the spot investigation was done to observe eight lesson demonstrations in laboratory experiments (four from each of the two schools). The researcher personally delivered, administered and collected all the questionnaires to and from the respondents. Written self-administered questionnaires and interview schedules were designed to investigate the effects of laboratory experiments in the learning of science by visually impaired pupils in the two schools. The questionnaires were given to both specialist and non-specialist teachers who taught the visually impaired pupils in junior and senior grades respectively. The interview schedules were administered on the spot on each student and notes were taken on each interview form. The interview took four days and on average five pupils were interviewed on each of the four days. Interviews had the advantage of allowing the respondents to express their opinions more clearly. Time, venue and content flexibility were tolerated on the part of respondents just like the researcher had chance to probe and seek clarifications on issues raised during interviews

Respondents' anonymity and confidentiality was assured as only alphabet letters and not real names and the secondary school names were written. To ensure prompt return of the questionnaires, the researcher had to wait for the subjects to complete the questionnaires. Responses were checked for clarity. One lesson demonstration per day was conducted and observed during normal science periods of the school timetable. Notes about the observations were written on the science lesson inspection reports adapted from the Standards and Evaluations department of the Ministry of Education.

3.7. Data Analysis

Data collected were analyzed by describing and explaining results from lesson observations for laboratory experiments and responses from participants using tables, graphs and percentages. Data from professionals (teachers) and pupils were presented as cross tabulations between the factors being investigated and the opinions and beliefs expressed by the respondents.

3.8. Ethical Concerns

Ethical issues were highly considered in this study. Permission was first sought from the Provincial Education Officer, Eastern Province, for using the schools in the study. At the district level, permission was sought from both the District Education Board Secretary and at school level the headteacher who had given consent for teachers and pupils to participate in the study. The aim of the study was clearly explained to both teachers and pupils before commencing the research.

3.9. Delimitation of the Study

The study only focused on two schools in Eastern Province. Initially the researcher intended to include at least one school from each district in Zambia to have equal representation of the population but due to logistical problems (financial constraints) this was not possible.

CHAPTER FOUR

PRESENTATION OF RESULTS

4.0. Introduction

This section presents findings of the study. The study was designed to establish the effects of laboratory experiments on the learning of science by visually impaired pupils. The results are presented in the following order: starting with scores in laboratory experiments ending with teachers' and pupils' responses. Data analysis on laboratory experiments was achieved through observations, descriptions and explanations of the laboratory findings. Responses from participants were accomplished using statistical package for Social Sciences (SPSS). This includes tables, graphs and percentages.

Each of the four laboratory experiments for each grade (9 and 12) were recorded on two separate tables bearing totals, percentages, averages and means. To supplement on scores from laboratory experiments the researcher distributed questionnaires to teachers and interviewed visually impaired students to come up with well-rounded information regarding the subject under study.

4.1.0. Laboratory Experiments

A total of eight (8) lesson demonstrations four from each of the two types of schools were observed. Two science teachers were observed: one from the special school and one from the integrated school. Both teachers were male and had served between six (6) and ten (10) years. Only grades nine (9) and twelve (12) from Magwero and Katete schools were observed respectively. All the lessons (except from the improvised classroom from the special school) were conducted in a (ordinary classroom) laboratory room. The fourth

was a field trip to the water plant. On the other hand all the four (4) lessons from the integrated school were conducted in an established laboratory room which catered for Physics, Chemistry and Biology.

On average attendance the special school had recorded eight (8) pupils of whom two (25%) were partially sighted while the six(75%) were totally blind. The integrated school had a total of 65 pupils (39 boys and 26 girls). Out of this number eight (8) were visually impaired pupils of whom five(62.5%) were boys and three(37.5%) were girls. In terms of visual acuity six(75%) were totally blind while two (25%) were partially sighted. However, only visually impaired pupils' results were recorded in laboratory experiments.

Table 5: Scores for Grade 12 Visually Impaired Pupils in Laboratory Experiments at Katete Integrated School

		Scores in Laboratory Experiments								Average Marks	
Pupil	Sex	Lesson 1		Lesson 2		Lesson 3		Lesson 4			
		Marks	%	Marks	%	Marks	%	Marks	%	Marks	%
A	F	3	60	1	20	2	40	2	40	2	40
B	F	2	40	2	40	2	40	1	20	1.8	35
C	M	1	20	1	20	1	20	1	20	1	20
D	M	3	60	3	60	2	40	3	60	2.8	55
E	F	1	20	1	20	1	20	2	40	1.3	25
F	M	2	40	3	60	2	40	2	40	2.3	45
G	M	1	20	1	20	1	20	1	20	1	20
H	M	1	20	1	20	1	20	1	20	1	20
Mean		1.75	35	1.6	33	1.5	30	1.7	33	1.6	33

Out of eight (8) pupils three (37.5%) were able to perform at least two or more test items of the total laboratory experiments done in integrated school. Pupil A managed to do on average two (40%) test items of the total laboratory experiments. Pupil D managed to do on average 2.8 (55%) of the total laboratory experiments and pupil F managed to do on

average 2.3 (45%) test items of the total laboratory experiments. The remaining four (50%) of the visually impaired pupils out of eight performed at least on average one (1) test items of the total laboratory experiments done. Pupil B managed to do 1.8 (35%) test items of the total laboratory experiments; pupil C managed to do one (20%) of the total laboratory experiments, pupils E managed to do 1.3 (25%) test items of the total laboratory experiments in each of the four lesson demonstrations, and pupils G and H managed to do one (20%) test items in each of the total laboratory experiments. The mean scores for the total laboratory experiments for lesson One, for eight (8) students was 1.8 (35%), for lesson two 1.6 (33%), for lesson three 1.5 (30%) and for lesson four 1.6 (33%). The average mean score for all the eight (8) pupils in all the four (4) lesson demonstrations in laboratory activities was 1.6 (33%).

Table 6: Scores for Grade 9 Visually Impaired Pupils in Laboratory Experiments in the Special School

		Score in Laboratory Experiments								Average Marks	
Pupil	Sex	Lesson 1		Lesson 2		Lesson 3		Lesson 4			
		Mark	%	Mark	%	Mark	%	Mark	%	Mark	%
A	F	2	40	1	20	2	40	1	20	1.5	30
B	M	3	60	1	20	2	40	1	20	1.8	35
C	M	1	20	1	20	1	20	1	20	1	20
D	F	2	40	1	20	2	40	1	20	1.5	30
E	M	1	20	1	20	1	20	1	20	1	20
F	M	1	20	1	20	1	20	1	20	1	20
G	M	1	20	1	20	1	20	1	20	1	20
H	M	1	20	1	20	1	20	1	20	1	20
Mean		1.5	30	1	20	1.4	28	1	20	1.2	24

Basing on the average scores all the eight(8) pupils in the special school were only able to do at least one (1) test item of the laboratory experiments for each of the four lesson demonstrations observed. On average thus, pupil A did 1.5 (30%)

test items of the laboratory activities; pupil B did 1.8 (35%) test items of the laboratory experiments; pupil C did one (20%) test items of the laboratory experiments; and pupil D did 1.5 (30%) test items of the laboratory experiments and pupil E, F and H did each one (20%) test items of the laboratory experiments. The mean scores for lesson one(1) for eight(8) pupils was 1.5 marks (30%), for lesson two(2) was one (20%), for lesson three(3) was 1.4 (28%) and for lesson four(4) was one (20%). The average mean scores for the eight(8) pupils in the four laboratory experiments was 1.2 (24%).

4.2.0. Teacher Responses

4.2.1. Effects of laboratory Experiments on the Involvement of Visually Impaired Pupils.

When asked in question 1 (Appendix 1 and 2 part B) whether teachers were aware of the involvement of the visually impaired pupils in laboratory-science experiments in school, all the fourteen (100%) teachers from the special school and all the sixteen(100%) teachers from the integrated school answered 'Yes' and no one answered 'no'

4.2.2 Kinds of Methods used

In question 3(Appendix 1 and 2 part B), Teachers in the two types of schools were asked to indicate whether the kind of Method(s) used in presenting laboratory experiments had an effect on the visually impaired pupils in laboratory experiments(Appendix 1part B). From the special school all fourteen (100%) of the total teachers answered "No". From the integrated school twelve (75%) of the teachers answered "Yes" while four ("25%) answered "No".

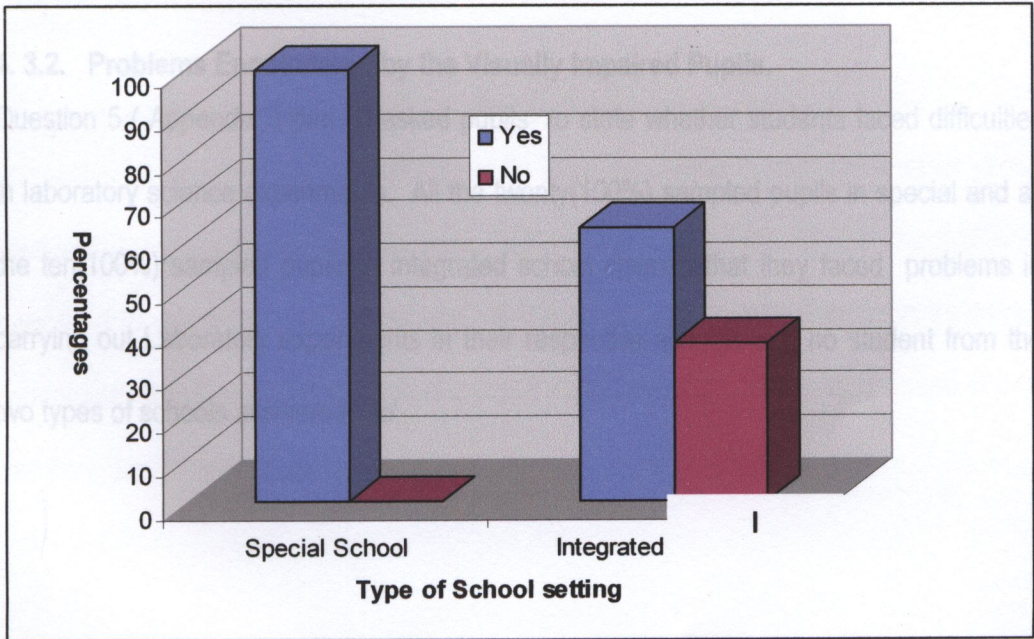
Table 7: Kind of Method(s) used.

Responses	Special School No.14	Integrated School No.16	Special School	Integrated School
Yes	14	12	100	75
No	0	4	0	25
Total	14	16	100	100

4.2.3. Provision of Special Materials

In question 5 (see Appendix 1 and 2 part B) teachers in special and integrated schools were requested to indicate whether laboratory experiments required special materials for the smooth presentation of the science subjects. From the special school fourteen(100%) of the total fourteen(14) teachers answered 'Yes' while none of the teachers answered 'No'. In an integrated school fifteen (93.75%) of the total sixteen(16) teachers answered 'Yes' while one (6.25%) of the teachers answered 'No'

Figure 2:Problems Encountered by Visually Impaired Pupils



In question 7 (Appendix 1 and 2 part B), teachers were asked to state whether visually impaired pupils faced problems in laboratory experiments in their schools. All fourteen (100%) of the fourteen(14) teachers in special school answered 'Yes' while none of the teachers answered 'No' while ten(63.58%) of the sixteen(16) teachers in an integrated school answered "yes" while six (37.5%) of the teachers answered "No"

4.3.0. Pupils' Responses

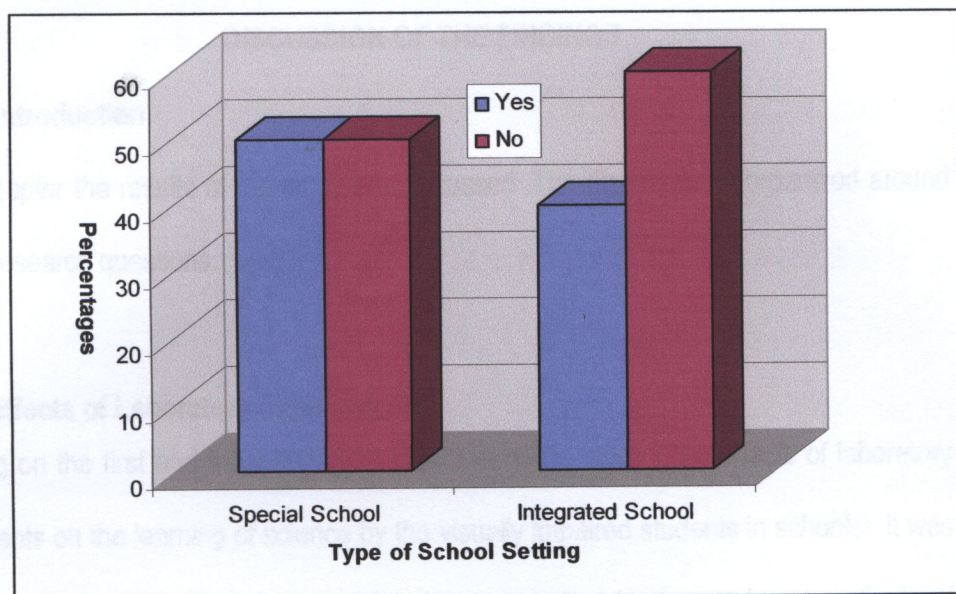
4.3.1. Provision of Special Materials

In question 3(Appendix 3, part B) pupils were asked to state whether the provision of special materials would help to improve their academic performance in laboratory experiments. From the special school twenty (100%) answered 'Yes' and none answered 'No'. In the integrated like special school, ten(100%) answered 'Yes' while none answered 'No'.

4.3.2. Problems Encountered by the Visually Impaired Pupils.

Question 5 (Appendix 3 part B) asked pupils to state whether students faced difficulties in laboratory science experiments. All the twenty(100%) sampled pupils in special and all the ten(100%) sampled pupils in integrated school claimed that they faced problems in carrying out Laboratory experiments in their respective schools and no student from the two types of schools answered 'No'

Figure3: Assistance from Teachers of Science



In question 7 (Appendix 3 part B) pupils were asked to indicate whether they got enough assistance from their teachers of science. From the special school ten(50%) answered 'Yes' while ten (50%) answered 'No'. From the integrated school four(40%) answered 'Yes' while six(60%) answered 'No' respectively.

4.3.3. Pupil Responses on Assistance from Specialist Teachers

In question 9 (see Appendix 3 part B) pupils were requested to indicate whether or not blind pupils received enough help from their specialist teachers. All the twenty(100%) sample of pupils in special school and all the ten(100%) sampled pupils in integrated school agreed that enough help was given by their specialist (or resource) teachers and no one from the two schools said 'No'.

CHAPTER FIVE

DISCUSSION OF THE FINDINGS

5.0. Introduction

In this chapter the results of the study are discussed .The discussion is organized around the five research questions.

5.1. Effects of Laboratory Experiments

Focusing on the first and most important objective of the study (The effects of laboratory experiments on the learning of science by the visually impaired students in schools), it was concluded from the findings that materials in use, student background and methods of experiments had positive effects on the performance of the visually impaired students in laboratory experiments. This was found out after observing lesson demonstrations on laboratory experiments and comparing participants' responses from the questionnaires and in-depth interviews. As already mentioned in the previous chapter, three quarters of the participants said there were no appropriate learning resources to cater for the visually impaired students and majority of them said their teachers helped them in a number of ways. The results of the laboratory experiments showed that not all participants who were helped by teachers performed two or more experiments and not all of them performed laboratory experiments independently. Generally most of them performed badly. Tables five and six in the previous chapter show that less than fifty percent of the visually impaired pupils could perform some of the test items in laboratory experiments while the majority could not. Both observation results and findings from respondents revealed that teachers

did not provide modified appropriate materials for the visually impaired pupils and ordinary teachers of science did not render adequate help as most of them had little or no knowledge of handling visually impaired pupils. This contributed in negative effects in laboratory experiments on the learning of science by visually impaired pupils.

Although all the participants in the two grades did have major problems in concretizing and unifying laboratory materials (apparatus) in laboratory experiments, there was room for improvement. All what was needed was more effort from the teachers of science and specialist teachers in encouraging visually impaired students to continue participating in laboratory experiments. Teaching methods, too, needed to be effective as the results indicate that teaching methods and teacher's assistance played an important role in Laboratory Experiment.

The findings of this study are in line with studies done by Settle (1996) and Low field (1973). The findings support Settle's (1996) which stipulate that the effective Science teacher realizes the importance of inter – personal relations. Personalizing the teacher's relationship with pupils can include many things such as a greater understanding of the visually impaired students through learning braille, devising different tasks and methods for different children, conducting individual evaluation, varying questioning technique or the use of different materials and equipment. From the findings of this study, it can be concluded that teaching methods and assistance which is required largely through laboratory experiments is linked to pupils' ability to perform laboratory experiments.

The findings of this study also support studies by Low field (1973) who argued that education for the visually impaired children is incomplete if it did not include some acquaintance with natural phenomena, the physical laws and properties of scientific

principles met within our daily life. Owing to this science is too important a subject to be omitted from education. It was concluded from all these studies that teaching methods and teacher's assistance were found instrumental in facilitating the participation of the visually impaired pupils in laboratory experiments. The other objective for the study concerned the exploration of laboratory materials to which visually impaired children were exposed. As already mentioned in this chapter, more than seventy-five percent of participants said there were no braille laboratory materials in their respective schools. A minority, however, said there were some. This suggests that most teachers and students were aware of the need for provision of laboratory appropriate materials in their respective schools. The value of availability of laboratory appropriate materials had also been found important by Quirk's (1978) who reported that providing appropriate laboratory materials to visually impaired children was essential in laboratory experiments.

Both the visually impaired pupils in a special and integrate school performed poorly in laboratory experiments. This can be seen from the scores they obtained in the four lesson demonstrations for grades nine (9) and twelve(12) as shown in percentages, averages and mean scores. The mean scores for all the eight (8) pupils in all the four (4) lesson demonstrations in laboratory experiments for grades twelve (12) and nine (9) was 33% and 24% respectively. The results indicate that there was no significant difference in laboratory performance in science experiments between grade 9 pupils in special school and their counter part grade 12 pupils in integrated school. Both the totally blind and the partially sighted pupils did the same experiments from their respective grade (grade 9 and 12) levels. The results show that both grade nine(9) students in the special school and their counterparts grade twelve (12) students) in integrated school regardless of vision

levels(between the totally blind and the partially sighted) had scored far below 50% as average mean for the four lesson observations respectively. Both results show poor performance in laboratory experiments. This means that both visually impaired grade nine pupils in the special school and their counterparts (grade 12) visually impaired pupils in the integrated school had poor results. Both schools lacked adequate teaching materials and equipment as well as specialized teachers. Although pupils were able to get and follow instructions from their teachers of science during laboratory experiments they nevertheless performed poorly due to inability to manipulate, identify and differentiate materials and apparatus used in the experiment. This inability would be attributed to lack of modified teaching and learning resources (without braille marks) to cater for the visually impaired pupils in schools.

Garvey and Krug (1977) believed that teaching was an exercise which a teacher performed in front of a room full of pupils within a specific time with specific suitable resources but was an ancillary activity by which one person helped others to learn. Garvey and Krug (ibid) outlined cognitive domains such as knowledge, comprehension, analysis and application acquired through activities like document study, text book study, not – making, experiment study and field trip study as some of the ancillary activities. The results show that 24% of the pupils scored two or more out of eight laboratory experiments performed. Out of these pupils three (3) were students of low vision. It is, thus, assumed that students' background may have positively affected pupils' performance since three (3) out of eight (8) pupils who scored two (2) or better in laboratory experiments on average were of low vision. A representative of only 33% of the students' in integrated school believed to be subjected to poor learning conditions, also scored two or more out of eight

laboratory experiments. On the other hand poor performance was also noticed among the grade 12 visually impaired pupils in integrated school since the school did not have teaching and learning materials in braille as well as specialist science teachers.

Answering the question "Are you aware of the involvement of visually impaired pupils in the learning of science subjects in laboratories in schools? All the teachers in Special school and in integrated school agreed. Specialist and non-specialist teachers argued that laboratory experiments were as important to the visually impaired as to the sighted students. They recommended that materials should be braille modified and provided to schools where the visually impaired students were found. The results are in line with Allan(1983)who argued that restricting the curriculum to Arithmetic, Reading and Writing(3Rs) trapped the visually impaired children into a narrow and superficial outlook that reduces their capacity to learn further and solve real problems. Evidence from this study has shown that ordinary teachers of science, specialist teachers as well as sighted pupils spend time helping the visually impaired pupils in special and integrated schools, though more help appears to come from the specialist teachers than non-specialist teachers. Majority of the pupils both in special and integrated schools felt that science could be among their easiest and favorite subjects if certain logistics (such as braille materials) were put in place.

5. 2. Methods used in Laboratory Experiments

Most teachers in both special school and the integrated school held the view that the kind of methods used in laboratory experiments helped greatly in the academic performance of the visually impaired students in science subjects. They argued that the use of

demonstration method, field trips (local area studies) and project methods contribute positively towards the attainment of better student's performance in laboratory experiments. Lecture method was described as not contributing enough towards laboratory experiments. The teachers, however, argued that this method could be used side by side with demonstration, discovery and field trips which were more laboratory inclined. On the sport check lesson observations revealed that though demonstration and local area methods were used by the teachers there was no better performance noticed from both schools as materials used were not brailled.

5.3 . Provision of Special Materials

The results from teacher responses show that the visually impaired pupils in the two types of schools used writing frames; styli and braille paper most of the time but lacked science braille materials for laboratory experiments. However, though some differences existed in both types of schools, they were not significant. The writing frames, braille paper, styli and laboratory apparatus such as tripod stand, burners and flasks to name a few were expected to be readily available to pupils because they contributed positively to pupils performance in laboratory experiments. On the contrary, one of the teachers in a special school and one of the teachers in integrated school indicated that braille perkins were in use. However, these were not enough to circulate among all students in the sampled schools. The visually impaired students write braille faster using braille typewriter (Perkins) than using the frame and stylus. Of the few braille perkins available, especially in special school, most of them were old while some needed servicing since they were out of order. This is in line with the findings by Quick who argued that tape recorders, audio aids, embossed diagrams, optacon machines, perkin braille's and laboratory apparatus should be readily available for use. Lastly, although braille typewriters are not easily portable as

writing instruments, they are essential to the visually impaired pupils as far as laboratory experiments are concerned because they write experimental results faster with perkins than the writing frame. All the pupils in special school and all the pupils in integrated school indicated that some brailled charts; brailled textbooks were used by their teachers during science lessons. No pupil both in special and integrated school mentioned braille computers, embossed science materials, braille science apparatus, radio cassettes and tapes as being in use during laboratory experiments. That is to say they were not used during laboratory experiments. This was a justified contention, as it had some negative bearing on the visually impaired students' performance in laboratory experiments. The above data shows that though some teaching aids were used in some schools, teachers of science in both types of schools generally presented lessons using the lecture(recitation) method where the teachers talked with no reference to special teaching aids. The pupils believed that the government should put more emphasis on laboratory experiments in material provision which should be modified in braille if visually impaired pupils were to equally participate in laboratory experiments.

5.4. Problems Faced by Visually Impaired Students in Laboratory Experiments

All the teachers in special school and over half of the teachers in integrated school stated that their schools lacked teaching equipment such as thermoform, braille perkins, ordinary typewriters, writing frames, styli, braille paper, braille computers and software. School activities such as buying of braille textbooks, gas cylinders, test tubes and tripod stands to name a few but many were not funded either. Although some differences were observed in the laboratory scores there was a similarity in respondent views. Both teachers in special school and those in integrated school were of the opinion that non-availability of teaching

resources such as embossed science apparatus, brailled materials, radios and radio cassettes posed a big challenge in the teaching of science in laboratories. Though there was a difference in the percentages (60% for special school and 94% for integrated school) non – availability of braille teaching aids was overwhelmingly noticed by teachers in the two types of schools, especially in the integrated school. On the spot check, observations also showed that special school and integrated school lacked laboratory buildings (special school only) equipment, apparatus, brailled textbooks and other materials. Clearly, these factors have a direct negative effect of laboratory experiments on the learning of science by visually impaired pupils in both types of schools.

All the pupils in the two sample schools, made reference to lack of brailled science textbooks and laboratory apparatus as major problems in their teaching of science subjects. Further, pupils from both types of schools felt that lack of writing equipment like braille perkins and braille paper, posed a problem. Chi bale a grade 12 blind pupil of Katete integrated school had this to say:

“As visually impaired pupils we are generally not active in laboratory experiments due to limited opportunities to do so. These include unfriendly laboratory environment, unmodified materials or laboratory apparatus and lack of qualified specialist teachers”

From on the sport check lesson observations revealed that their laboratory rooms (both improvised and standard) from special school and integrated school respectively had inadequate space and equipment. Both laboratory buildings were not designed for the visually impaired.

5.5. Assistance from the Teachers

From the positive responses from the two types of schools half (50%) of the pupils in special school and less than half (40%) of the pupils in integrated school were convinced that they received enough help from their teachers of science during laboratory experiments. The pupils in special school and pupils in the integrated school who responded positively, stated that their teachers of science explained difficult areas in the lesson as it progressed in both types of schools. The pupils also claimed that their teachers of science offered remedies after lessons, and taught with the help of teaching aids most of the time though the aids were not in braille. Another pupil in the integrated school felt that a particular teacher of science assisted him in his mobility in and outside classroom while nobody brought this point in special school. However, half (50%) of the pupils in special school and more than half (60%) from the integrated school did mention that they never received adequate assistance from their teachers of science.

From research findings of the pupils and on the spot check from lesson observations one may conclude that though assistance was rendered to visually impaired pupils that assistance was not readily available or adequate from the majority of the non-specialist teachers. From the sixteen (16) teachers in the integrated school only two (2) were Special Education trained while only two (2) were science trained. Little assistance, thus, could have been due to the fact that most science teachers had not received special training with the view to teaching the visually impaired pupils. The other explanation from the on the spot check reviewed that most non-specialist teachers thought science was only meant for the sighted pupils and that the visually impaired pupils were better educated in special schools. This probably, means that teachers were not psychologically prepared to handle visually impaired pupils such that little or no time was spared to them during lessons. One

of the strongest principles of teaching the visually impaired pupils is individualization' under which some minutes in every lesson must be allocated to an individual visually impaired pupil. This means that, for every minute spent on a needy sighted pupil the visually impaired pupil must be allocated about four (4) minutes in a given lesson. Unlike the special school (with fewer pupils) this did not apply in the integrated school where there were 65 pupils in total. Though special arrangement was made to test eight (8) visually impaired pupils in laboratory experiments only ten (10) minutes were allocated to each pupil to perform an experiment. This was inadequate.

The reality of the moment at Katete integrated school according to the on sport observations is that there is over enrolment which makes it difficult for the subject teacher to even attend to the needy visually impaired pupil individually during the science lesson. However, where a resource teacher has established awareness among the non– specialist subject teachers about the importance of assisting the visually impaired pupils in their learning, a subject teacher must be in a position to give remedies to visually impaired pupils during his/her spare time though he/she does not qualify for allowance for the extra work done. Specialization in secondary schools on the other hand makes it difficult for resource teachers to assist pupils in all the subjects. To improve on this problem, the resource teacher must attend some of the lessons together with the pupils.

All the sample pupils both in special and integrated schools strongly asserted that their resource teachers provided adequate help in terms of offering remedies after some difficult lessons, and giving of instructions in laboratory experiments. This is in line with findings of Allan from the literature. According to Allan (1983) laboratory experiments develop in pupils the attitude, ways of thinking and a solid knowledge base that promotes success in the real world. Both Allan (1983) and findings of pupils responses agree that the aim of

laboratory experiments was to enable a child to live normally and independently, taking care of himself/herself contributing to social development. The visually impaired pupils achieve the above through the agents like parents, relatives, peers, teachers and the whole society.

Additionally, the visually impaired pupils from integrated schools argued that their specialist teachers helped them in their mobility in and outside the class. Pupils in special school did not mention this as an issue because they had stayed in their school since grade one such that mobility training was already given to them during their early years of stay in such schools. On the other hand, visually impaired pupils who left their special school to go to integrated school after qualifying for grade ten secondary educations created a need to orient them to the new environment in terms of mobility. This was also noticed during on sport check during lesson observations. Specialist teachers, however, found it very difficult to assist pupils in science because they were not science trained. This also came out strongly from the pupils as well as from the lesson observations. However, visually impaired pupils generally rated their specialist teachers rightly in terms of schools. This may be a result of the nature of training received by specialist teachers where they are expected to be kind, tolerant and hardworking. Where schools are not provided with teaching aids by the government teachers are expected to make them during their spare time, outside working hours. That is, teachers are expected to be resourceful through improvisation. This is in line with findings by Ferrell (1986) who laments that most suggested laboratory materials were not designed for laboratory experiments for the visually impaired pupils and that science teachers should adapt materials proficiently and expeditiously.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.0. Introduction

The chapter presents the conclusions and recommendations of salient points emanating from the study's findings on the effects of laboratory experiments on the learning of science by visually impaired pupils.

6.1. Conclusion

In conclusion, it is worth mentioning that from the findings the type of school, teacher experience, pupils age and sex did not have any effect in laboratory experiments as there was similar performance between the visually impaired pupils in special school and their counterparts in Integrated school. On the contrary, data collected indicated that lack of braille science equipment and teaching resources, pupil background and methods of teaching had negative effect on the effects of laboratory experiments on the learning of science by the visually impaired pupils. The pupils generally experienced difficulties in manipulating (concretizing and unifying) ordinary science materials such as beakers and tripod stand to name a few. Also, although assistance was given to the visually impaired pupils by their teachers of science that assistance seemed not to be adequate. It appears from the results that most specialist teachers in both types of schools give their pupils adequate assistance inside and outside class activities. To improve the quality of education the general feeling from the respondents was that the government should provide appropriate teaching and learning materials in braille and provide incentives to all teachers.

6.2. Recommendations

Based on these findings, the following are recommended to enable the visually impaired pupils continue participating in laboratory experiments:

1. A range of advanced short courses specifically directed on special techniques for laboratory experiments appropriate for pupils with visual impairments be provided by the government for non-specialist teachers who have a professional commitment to teaching the visually impaired pupils found in schools where the visually impaired pupils have been included.
2. Teachers play a vitall role in promoting the learning of science subjects to visually Impaired pupils. It is highly recommended that training of teachers in science laboratory experiments be intensified at pre-service and in-service college levels to equip teachers with necessary science knowledge and skills to teach the visually impaired pupils.
3. The University of Zambia (UNZA) and the Zambia Institute of Special Education (ZAMISE) curriculum Should be modified in order to allow in-service trainee teachers take on additional teaching courses to enable them teach effectively science subjects to special schools.
4. Permanent and well-co-ordinated research groups for the education of the visually Impaired pupils should be established to develop a data bank fo practitioners in the area of laboratory experiments for teaching science subjects.

5. The Provincial Education Officers, the District Education Board Secretaries and Standard Officers (Education) should constantly monitor progress of laboratory experiments for the visually impaired pupils in special and integrated schools.

6. The Ministry of Education should increase funding to special education programmes such as those done at school from the current meagre ten percent (10%) on school grants to forty percent (40%) to facilitate the production and procurement of special education brailled materials and apparatus. Currently, there is erratic or no provision of braille science teaching and learning materials to special schools by government.

6.3. Suggestions for Future Research

More comprehensive research should be carried out in Special Education among the visually impaired pupils in areas such as:

1. The Problems Laboratory Assistants Face in Boarding Schools for the Visually Impaired Pupils in Laboratory Experiments in Zambia.

2. The Effects of Scientific Calculators on the Learning of Science by the Visually Impaired Pupils in Secondary Schools.

3. A comparative Study in the Academic Performance between the Totally Blind Boys and Totally Blind Girls in Laboratory Experiments.

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APPENDIX 1

Questionnaire For Specialist Teachers on Laboratory Experiments

A. Background Information

District:.....
School:.....
Address:.....
Type of School in (Ordinary/Special Residential/Special Unit):.....
Sex:.....
Age:.....
Years in service as an ordinary teacher.....
Years in service as a special education teacher

Type of training as a special teacher:.....
Academic Qualifications.....

Professional Qualifications (a) Certificate []
(specify):.....
(b) Diploma []
(specify):.....
(c) Degree []
(specify):.....

B. Questions

1. Do you involve the visually impaired pupils in laboratory experiments?

Yes [] No []

If the answer is 'yes' explain.

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.....
.....

2. What effects do laboratory experiments have on the visually impaired pupils if the answer to question one(1) above is “Yes”?

.....
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.....
.....

3. Are there any effects to different methods used in laboratory experiments on the learning of science subjects by visually impaired pupils?

Yes No

4. If the answer to question three above is 'Yes' what method(s) is or are needed to effectively teach visually impaired pupils science subjects in laboratory experiments ?

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.....

5. Is there need for special materials to teach science subjects effectively to visually impaired pupils in laboratory experiments? (Tick)

Yes No

6. If the answer to question five is 'Yes' what special materials are available and required?

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.....

.....
7. Do visually impaired pupils face problems in laboratory?
experiments? (Tick)

Yes [] No []

8. If the answer to question seven above is 'Yes', what problems do visually
impaired pupils face in Laboratory Experiments?

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APPENDIX 2

Questionnaire for Non - Specialist Teachers on Laboratory Experiments

A. Background Information

District.....

School.....

Address.....

Type of school(ordinary/special school/specialunit)

Sex.....

Years in service as a teacher

AcademicQualifications.....

Professional qualifications (tick)

(a)Certificate.....

(b)Diploma.....

(c)Degree.....

Subject Taught.....

B. Questions

1. Do you involve the visually pupils in laboratory experiments?

(Tick)

Yes []

No []

2. What effects do laboratory experiments have on the visually impaired in science subjects if the answer to question one (1) above is “Yes”?

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3. Are there any effects to different methods used in laboratory experiments on

the learning of science subjects by visually impaired pupils.? (Tick)

Yes No

4. If the answer to question three above is 'Yes' what method(s) is or are needed to effectively teach visually impaired pupils science subjects in laboratory experiments ?

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.....

5. Is there need for special materials to teach science subjects effectively to visually impaired pupils in laboratory experiments? (Tick)

Yes No

6. If the answer to question five is 'Yes' what special materials are available and required ?

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.....

7. Do visually impaired pupils face problems in laboratory experiments? (Tick)

Yes No

8. If the answer to question five above is 'Yes', what problems do visually impaired pupils face in laboratory experiments?

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APPENDIX 3

Questionnaire For The Visually Impaired Pupils On Laboratory-Science Experiments

A. Background Information

- District.....
- School.....
- Address.....
- Type of School
- Visual Acuity (totally blind/partially sighted).....
- Sex (male/female)
- Age.....
- Post of Responsibility

B. Questions

1. Do you like your school? (tick)

Yes [] No []

2. If the answer to question one is 'Yes' what do you like about your school?

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3. Is there need for special materials to teach science subjects effectively to visually impaired pupils in laboratory experiments? (Tick)

Yes [] No []

4. If the answer to question three is 'Yes' what special materials are available and required ?

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.....
.....

5. Do visually impaired pupils face problems in laboratory experiments? (Tick)

Yes [] No []

6. If the answer to question five above is 'Yes', what problems do visually impaired pupils face in laboratory experiments?

.....
.....
.....
.....

7. Do you get assistance from your teachers of science (non-specialist teachers) during laboratory experiments? (tick)

Yes [] No []

8. If the answer to question seven is 'Yes', what kind of assistance do you receive?

.....
.....
.....
.....

9.. Do you get assistance from your specialist teachers in laboratory experiments?

Yes [] No []

10. If the answer to question five is "Yes" what kind of assistance do you receive?

.....

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APPENDIX 4

Teacher Lesson Observations For Laboratory Experiments

1.0. Background Information

- 1.1. Name of school.....
- 1.2. Name of Teacher.....
- 1.3. Qualifications.....
- 1.4. Teacher Qualifications.....
- 1.5. Date of Lesson Observation.....
- 1.6. Purpose of Inspection.....

2. 0. Lesson Particulars

- 2.1. Grade Taught.....
- 2.2. Lesson Taught
- 2.3. Subject Taught.....
- 2.4. Time Lesson Taught
- 2.5. Attendance:
 - Boys:
 - Girls.....
 - Total.....

3.0. Teaching and learning materials used

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4.0. Introduction

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5.0 Lesson Development

Step One.....
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Step Two
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Step Three
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Step Four.....
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Step Five.....
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6.0. Student's Practice

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7.0. General Observations


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APPENDIX 5

Score Sheet On Laboratory-Science Experiments For Grade Nine (9) and Twelve (12) Visually Impaired Pupils

No	Key Result Area	Experiment			
		1	2	3	4
1	Pupil able to identify and name the apparatus used in the experiment				
2	Pupil able to manipulate the apparatus used in the experiment.				
3	Pupil mobility in the laboratory-science room or field trip was done with or without help from the teachers				
4	Pupil was able to perform the experiments with minimal help from the teacher or peers				
5	Pupil was able to get and follow instructions from the teachers.				
Total marks per experiment per pupil					

Key: Tick (✓) where a pupil is able to perform a laboratory experiment.

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