EFFECT OF APPLIED ORIENTATION AND MOBILITY PROGRAMME ON ATTITUDE AND ACHIEVEMENT IN GEOMETRY OF LEARNERS WITH VISUAL IMPAIRMENT IN ABUJA AND GINDIRI, NIGERIA

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CERTIFICATION

This is to certify that this thesis has been examined and approved for the award of the degree of **DOCTOR OF PHILOSOPHY in SPECIAL EDUCATION (VISUAL HANDICAPS).**

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DECLARATION

I hereby declare that this work is the product of my own research efforts; undertaken under the supervision of Professor Emeka Desmond Ozoji and has not been presented elsewhere for the award of a degree or certificate. All sources have been duly distinguished and appropriately acknowledged.

ISUWA JIKUKKA JURMANG	DATE

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ABSTRACT

Geometry and on larger scale mathematics was not taught to learners with visual impairment and so they do not write public examinations in the area of mathematics (geometry) in Nigeria. This study is on effect of applied orientation and mobility programme on attitude and achievement in geometry of learners with visual impairment in Abuja and Gindiri. The specific aim of the research is to find out if applied orientation and mobility programme as an adapted teaching strategy will give access and enhance task performance of learners with visual impairment in geometry; and its effect on the attitude and age at onset of the impairment of the learners towards geometry. The research design used was experimental design. The pre-test post test design was used. Two schools were used; schools for blind children Jabi-Abuja and Gindiri with the population of one hundred and fifty seven children. Proportional stratified random sampling method was used. The sample size was ten in classes four and five of each of the schools making a total of 20 samples. The samples were stratified based on age at onset of impairment and grouped into experimental and control groups. Two instruments were used: Attitude to Geometry Scale (AGS) and Adapted Geometry Task Performance Test (AGTPT). Three research questions and five hypotheses were used. The research questions were analysed by the use of simple percentage and mean. An independent t-Test was employed in testing the hypotheses. The findings of this study were that the new adapted teaching strategy developed; applied orientation and mobility programme gave access to learners with visual impairment to participate in geometry and it enhanced task performance of the learners in geometry. The high performance in geometry tasks changed from negative to positive attitude of the learners towards geometry. The study showed that the adapted strategy had no effect on task performance and attitude towards geometry on the basis of age at onset of visual impairment. The implications of the

findings of this study are: Access and high task performance in geometry and mathematics in general will qualify the learners' entrance into tertiary institutions since today mathematics is used as a filter for entrance into tertiary institutions. Some will read mathematics as a course of specialisation and obtain certificate in it and many will read science, technology and engineering courses or professions in future as a result of skills in geometry and mathematics. Much of the working of the adapted teaching strategy involved interaction with the environment thereby resulting in skills in spatial concepts. Therefore the adapted strategy will enhance skills and knowledge in most of the subjects taught in school which involve spatial process and its applicability cuts across all subjects. The study revealed that age at onset in learners does not matter in task performance and attitude towards geometry. This disproof the deficiency inefficiency theory or controversy that has existed in special education for long which states that congenitally visually impaired persons perform lower in spatial concepts than adventitiously visually impaired or sighted persons.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The teaching and learning of mathematics and especially geometry to learners with visual impairment in Nigeria has remained a great challenge to both the teachers and their children. Learners with visual impairment (LWVI) in most cases are exempted from offering mathematics and the case of geometry is worse. The few schools that attempted teaching the subject to learners with visual impairment faced a lot of problems. The main problem faced is that teachers lack the adapted strategy or methodology to use in teaching the learners geometry. They also lack adapted materials or assistive devices they would use in teaching the subject and the skills to operate the devices. These materials include adapted geometry kits with embossed protractors, T-Squares, rulers, rubber mat and polythene sheet for drawing. This has resulted in low participation or non participation in mathematics especially the geometry aspect by learners with visual impairment in Nigeria.

What learners with visual impairment require in their education is the modification or adaptation of the strategies or teaching methods and devices their teachers apply on them to enable them develop their full potential. This group of learners live in a three Dimensional world. Even their system of writing the Braille, has to be three dimensional in nature. The traditional oral method of instructions and writing on the board in mathematics lesson are difficult to be used with them.

In comparing the results of learners with visual impairment with their sighted peers in Nigeria, the West African Examination Council (WAEC) (2013) reported that although learners with visual impairment had better results than their sighted peers, in its 2012 examinations, learners with visual impairment did not write mathematics in the examination. Similarly in November/December 2012 results, WAEC reported that only 37.97% (150,615) sighted candidates pass with five credits including English and mathematics. Their peers with visual impairment in the same year and the same examination had 46.93% (49) pass which was a higher percentage result than their sighted peers. These 46.93% (49) candidates with visual impairment who obtained five credits including English language unfortunately did not sit for mathematics and science practical in the WAEC examination (Research Development Institute Inc [RDII], 2013). This situation of learners with visual impairment not writing mathematics in such a national examination has been on for quite some times in the country. When teachers omit learners with visual impairment from offering mathematics as is the case often, they have omitted them from the regular syllabus.

Mathematics is one of the prominent subjects in school. It has a lot of use-values with respect to life in its totality. Mathematics is a daily experience or actions exercised on things in the environment. Geometry as a subset of mathematics is more practical than most aspects of mathematics. It involves a lot of mental constructions which are derived from actions performed on or with materials which may be concrete, semi-abstract or abstract progressively as the learner matures and the concept becomes complex (Gupta, 1992). What learners with visual impairment experience are that they are often fed with symbolic materials through text-books where available or the teacher talks. The consequence is that concepts are not properly formed. Learners with visual impairment in Nigeria, therefore, have not been given the proper, relevant and adequate exposure to teaching and learning of geometry that will enable them to have concepts and skills especially in descriptive geometry. The researcher is of the view that applied orientation and mobility programme (APOMP) as an adapted strategy full of geometry concepts that could first be presented practically via orientation and mobility skills gives the learner the opportunity to access the environment and objects around it to obtain information about the characteristics of the objects through other sensory modalities and eventually transfer these information through embossed form to abstract form or mental imagery for better task performance in geometry/mathematics.

It was becoming normal expectation in Nigeria for children with visual impairment not to offer mathematics. To suggest teaching geometry to learners with visual impairment was like talking about impossibility. This situation became a cause of worry to the Nigerian federal ministry of education. The federal government had to send letters to all heads of special integrated primary and secondary schools and teacher colleges stating that mathematics had been made compulsory for "blind" students (Federal Ministry of Education (FMOE), personal communication, February 27, 1987). This was to compel teachers and learners with visual impairment to take deliberate steps to teaching and learning mathematics. The letter further stated that learners with visual impairment must have a pass in the subject before they were admitted into any tertiary institution. After many years now this order from federal government could not be complied with.

The initial concept of learners with visual impairment not offering mathematics was first conceived because the first Nigerian with visual impairment to enter secondary school did not offer mathematics. Subsequent students with visual impairment in the country followed his footsteps by not offering mathematics too. The late Professor Bitrus Gani the pioneering learner with visual impairment in secondary school wrote WAEC in 1962, came out with "Division One" he did not offer mathematics at that time, it became normal for others with visual impairment in the country not to offer mathematics. This became a belief that learners with visual impairment do not offer mathematics in Nigeria. It became an attitudinal problem which as usual has a wider implication on performance in mathematics and is difficult to change.

Attitude could be seen as the major root cause of problems of learners with visual impairment in life and in learning mathematics and geometry in particular. Historically, they have been viewed negatively. People believe that learners with visual impairment cannot do mathematics especially geometry and some of the learners with visual impairment equally think that they cannot cope with the subject. The possibility of learning of mathematics or geometry by learners with visual impairment is often questioned. Worse are areas in mathematics like geometry which demand for so much visual tasks. However many of such visual ideas can be converted into tactual practical experience to get the required learning experience in geometry.

Worried also by none participation in mathematics by learners with visual impairment, the Gindiri material centre for visually impaired (GMCVH) embarked on a five year programme of visit to schools. They interacted and encouraged learners with visual impairment to offer science and mathematics and practically engaged them with some geometry drawings. They organized series of workshops for the teachers, parents and the students. During that time, they found out that in some states, teachers, parents, the public and the learners with visual impairment in Nigeria saw the inclusion of learners with visual impairment in the teaching and learning of mathematics as complete impossibility. Therefore the attitude of the public and especially the learners with visual impairment themselves seem to make the teaching and learning of mathematics challenging in special schools. The same attitude if not worse is shown to teaching geometry to learners with visual impairment.

In a nationwide research, National Education and Research Development Council [NERDC] (2009) found out that in twenty-four selected special residential schools, mathematics was not offered by learners with visual impairment. By implication geometry is not taught or offered by learners with visual impairment in special residential schools. Special residential school is a special school that caters for the needs of special kind of learners. It considers visual impairment as requiring special attention so it has the best experts usually with the best experience and skills in teaching them.

Special school imparts not only academic education but also aims at developing compensatory or self help skills. The school is supposed to handle tougher areas that regular teachers cannot handle like special subject areas including: Science, mathematics, Braille, rehabilitation skills, sports and recreation or leisure. Special attention is provided them in the area of feeding, provision of special materials and specially trained or experienced teachers who also are often provided residential quarters within the school premises together with them. It gives room for involving them in extracurricular activities like sports, clubs, and time for preparation yet mathematics is found not taught in many of such schools. Gindiri and Abuja are residential special schools solely for learners with visual impairment. The rests are either units in regular schools and the learners are day students or they are special residential schools that cater for other types of disabilities too. The Abuja and Gindiri residential special schools have no definite adapted strategy of teaching and learning of mathematics in the schools.

Recently learners with visual impairment that were newly admitted into the University of Jos were refused registrations into their departments for lack of mathematics either at a pass or credit levels. The learners complained either to national university commission (NUC) or the minister of education in Abuja saying that they had never been taught mathematics. Either the minister or NUC pleaded with the university for exemption since learners with visual impairment were never taught the subject let alone write a national examination in the subject. An education without mathematics in this century will cause some hardship to learners with visual impairment especially now that mathematics is demanded in science, technology and social science related professions. Instead of excusing them from offering mathematics, there is the need to search into adapted strategies that will make it possible to teach them mathematics/geometry. Applied orientation and mobility programme is one of the strategies that enabled learners with visual impairment access geometry in particular and mathematics in general but has never been used.

Mathematics is simply concerned with the science of structure, order, numbers, space and quantity. It is concerned with the elementary practice of counting, measuring and describing of shapes and objects. Descriptive geometry is a branch of mathematics which deals with the study of properties of figures and shapes, and the relationship between them. Basic geometry allows us to determine properties such as the areas and perimeters of two-dimensional shapes and the surface areas and volumes of three-dimensional shapes. However such concepts can only be known to a person with visual impairment through direct contact.

There are people who are congenitally visually impaired. There are those that are adventitiously impaired. The difference at the onset of visual impairment can affect both orientation and mobility skills and mathematics concepts and skills especially in geometry. Those who are born totally visually impaired may not have any previous concept on which to build on in the area of orientation and mobility and mathematics particularly in geometry concepts and skills. Incidentally most school age children are congenitally visually impaired. In such a case it may be more challenging teaching the child geometry or even orientation and mobility skills. Orientation and mobility like geometry is about order, space, shapes, measuring, counting of objects etc in space as the individual manoeuvres through the space.

People giving and undergoing training in orientation and mobility started suspecting mathematical concepts embedded in orientation and mobility. This led to a strong speculation that there is a relationship between performance in orientation and mobility skills, which are more within the psychomotor domain, and achievement in academic subjects like mathematics for learners with visual impairment. The researcher in search for evidence of geometry in orientation and mobility went through primary school mathematics textbooks and books written on orientation and mobility and found out that there were geometry concepts in orientation and mobility concepts and skills in quite a number of mathematics textbooks and books on orientation and mobility which could be used as strategy for teaching geometry to learners with visual impairment.

1.2 STATEMENT OF THE PROBLEM

The teaching of geometry/mathematics can take several forms and can be carried out through different experiences and situations. Unfortunately sometimes lessons depend too much on exposition from the teacher's part and a passive style of learning from the part of the students which promotes rote learning or non participation in the subject (Tanti, 2012). We experience mathematics in our daily activities and the application of the simplest operations and results in mathematics are many. Therefore Tanti stated that to teach geometry/mathematics to learners with visual impairment, it requires experience with concrete objects for manipulation with hands and fingers, the use of embossed diagrams and the opportunity to experience the concept in real life. This involves the use of adapted strategies or methodologies and devices. Unfortunately the restriction visual impairment imposes on the life of learners with visual impairment makes their contact with the environment difficult. Teachers hardly understand or take the risk of exposing the learners to the environment to experience and manipulate concrete objects for the purpose of teaching and learning geometry/mathematics.

Similarly teaching method can cause mathematics anxiety in children. Learners with visual impairment like their sighted peers have negative attitude towards mathematics and perform poorly in the subject. This was due to the fact that they were exempted from offering the subject. They also strongly believe that they cannot do mathematics since as earlier stated; the first student with visual impairment to write a national examination made a Division 1 in his West African School Certificate (WASC) did not offer mathematics. However he did not escape geometry because he eventually read physiotherapy in Britain, a profession full of geometry concepts and skills.

An earlier experience of not offering mathematics by learners with visual impairment or any earlier encounter of difficulty in teaching mathematics especially geometry to learners with visual impairment results in attitude problem thereby thinking that learners with visual impairment will not be able to offer the subject. A missionary mathematics teacher in Boys Secondary School (BSS) Gindiri attempted involving learners with visual impairment in her mathematics class. One of the learners with visual impairment in the school was overheard saying that a mad white woman wanted to introduce them to mathematics. He further added that “blind boys’ brain can’t do mathematics, everyone knows that”. The attitude of believing that learners with visual impairment cannot offer mathematics has hindered the learners from opening up their minds to offer the subject.

Mathematics anxiety which is an attitude issue simply refers to feelings of tension and fear that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations.

Mathematics anxiety could also be seen as the feeling of tension, nervousness, or fear that disrupts mathematics performance (Jain, & Dowson, 2009; Ma & Xu, 2004). Mathematics anxiety is related to negative attitudes towards mathematics. It is related to mathematics avoidance and poor mathematics performance. Highly anxious mathematics learners avoid mathematics which in turn results in less competency, exposure and mathematics practice and mathematically unprepared to achieve (Hembree, 1990).

Anxious mathematics students feel negative towards mathematics. This affects confidence and motivation negatively in mathematics (Ashcraft, 2002). In a research after using brain scans, scholars confirmed that the anticipation or the thought of solving mathematics actually causes mathematics anxiety. The brain scans showed that the area of the brain that is triggered when someone has mathematics anxiety overlaps the same area of the brain where bodily harm is registered (Harms, 2012). To look into geometry (mathematics) issues, mathematics anxiety which is an attitude problem cannot be left out.

Orientation and mobility has basic concepts that are related to concepts in descriptive geometry. It is concerned with shapes and objects in space, their positions, quantity, distances, locations, angles etc and how one can identify or locate them through the senses, and how to move around those structures in the space safely and gracefully. Basic orientation and mobility relates to the knowledge of space and the relationship of objects to each other and to the person. Example of the use of concepts in orientation and mobility that are geometry related include: maintaining directional orientation using perpendicular or parallel alignment for straight line travel; executing 90^0 and or 180^0 turns; recognizing characteristic of objects around the space or landmarks eg shapes, horizontal sides, vertical sides, parallel sides etc

At the conference of international council for people working with visual impaired (ICEVI) held in Malaysia, 2006, one of the issues discussed was the need to research into the possibility of using orientation and mobility skills and concepts to teach mathematics to learners with visual impairment. There was a plea for people to increasingly do empirical research in special education and especially on the relationship between mathematics for the learners with visual impairment and orientation and mobility concepts and skills. Unfortunately, there is no curriculum developed in Nigeria for teaching learners with visual impairment orientation and mobility. There is no regular or consistent teaching of orientation and mobility skill in special schools that teach the subject as to expose them to some of the experiences of geometry skills that are embedded in orientation and mobility.

In a similar situation, the national council for teachers of mathematics (NCTM) in America admonished that the field of orientation and mobility (O&M) can provide experiences that help students with visual impairments and blindness to develop the conceptual framework for understanding mathematics (as cited by Smith, 2006 p. 161). Unfortunately this admonition has not been taken seriously as to use orientation and mobility skills as intervention programme to activate the skills dormancy that exist in teaching and learning geometry with learners with visual impairment. The problem of the study therefore is: Can applied orientation and mobility programme be used as an adapted strategy or teaching method enhance tasks performance and change attitude of learners with visual impairment towards geometry? Can it affect attitude direction and task performance based on age at onset of visual impairment? Can there be any utility value in the use of applied orientation and mobility programme as is used to enhance skills in geometry of learners with visual impairment?

1.3 PURPOSE OF THE STUDY

The purpose of this study is to examine the effects of applied orientation and mobility programme (APOMP) on the attitude, task performance and utility value in geometry of learners with visual impairment in residential special schools for blind children in Jabi-Abuja Federal Capital Territory (FCT) and Gindiri in Plateau state of Nigeria. Specifically the objective of the study is to:

1. Analyse the extent to which the task performance of learners with visual impairment in geometry using applied orientation and mobility programme will be.
2. Compare the task performance in geometry of learners with congenital visual impairment and learners with adventitious visual impairment using applied orientation and mobility programme.
3. Determine the usability value of applied orientation and mobility programme in enhancing task performance in geometry to learners with visual impairment.
4. Identify the nature and direction of attitude of learners with visual impairment towards geometry.
5. Compare the nature and direction of attitude of learners with congenital and those with adventitious visual impairment.

1.4 RESEARCH QUESTIONS

The following research questions were investigated and answered in this research study:

(1) What is the nature of geometry task performance of learners with visual impairment?

(2) To what extent can Applied Orientation and Mobility Programme (APOMP) be of utility value to learners with visual impairment in learning geometry?

(3) What is the nature and attitude direction of learners with visual impairment to descriptive geometry aspect of mathematics?

1.5 HYPOTHESES

The following hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference in extent of geometry tasks performance of learners with visual impairment trained in the use of applied orientation and mobility programme skills and those not trained.
2. There is no significant difference in extent of geometry tasks performance of learners with congenital visual impairment and those with adventitious visual impairment trained in applied orientation and mobility programme skills.
3. There is no overall significant difference in value in the use of applied orientation and mobility programme skills in training learners with visual impairment in geometry tasks and those not trained.
4. There is no significant difference in the attitude towards geometry tasks of learners with visual impairment trained in applied orientation and mobility skills and those not trained.
5. There is no significant difference in attitudes towards geometry tasks of learners with congenital visual impairment and those with adventitious visual impairment trained in applied orientation and mobility programme.

1.6 SIGNIFICANCE OF THE STUDY

This study was conducted to benefit learners with visual impairment, the government, and the educational system. Others are parents, teachers, curriculum experts; examination bodies, orientation and mobility experts and textbook writers.

The result of the study showed that learners with visual impairment achieved high in geometry tasks performance which is an aspect of mathematics through the use of applied orientation and mobility programme (APOMP). Applied orientation and mobility programme therefore could be used to open doors for job opportunities for learners with visual impairment in the fields of science, technology and engineering and to achieve various economic and domestic benefits both at home and abroad. Applied orientation and mobility programme has just been developed and has never been used. It could serve as one of the convenient methods for teaching geometry/mathematics to learners with visual impairment to impart in them the skills, habit and knowledge of geometry/mathematics.

Attitude determines performance in mathematics. Equally when learners perform poorly in mathematics, they develop negative attitude towards the subject. When applied orientation and mobility was used as an adapted method of teaching geometry for learners with visual impairment, it enhanced task performance in mathematics and the learners achieved highly. This resulted in developing positive attitude towards geometry (mathematics).

The study is significant to teachers and learners with visual impairment because the need was seen for the learners to offer mathematics and orientation and mobility. Teachers were trained in the area of using adapted methods and materials to teach learners with visual impairment geometry/mathematics and also in the area of orientation and mobility. The applied orientation and mobility skills taught broke the barrier of restriction in the life of a child with visual impairment due to the effect of blindness. It gave the child access to the environment and the opportunity to explore things in the environment.

The research findings will help curriculum experts in developing and adapting curriculum for learners with visual impairment. This will lead to planning better to meet both regular and unique curricula to meet the special needs of children with visual impairment. The result of the study involving orientation and mobility concepts and skills revived the teaching and learning of orientation and mobility and skills in daily living skills.

The result of the research will hopefully prepare examination bodies like west African examination council (WAEC), national examination council (NECO), and joint admission and matriculation board (JAMB) etc to understand the unique needs of learners with visual impairment in the area of giving extra time, use of adapted materials, provision of embossed diagrams and graphs and brailing of mathematical and science examination questions. Learners with visual impairment will participate in national examinations in mathematics as currently they do not write mathematics. Textbook writers also will be encouraged in integrating orientation and mobility concepts in writing and illustrating books for children with visual impairment. They would produce books on the effect of psychomotor skills on the academic areas.

It is however disturbing that in many special schools and integrated institutions in Nigeria and in many other developing countries academic pursuit receives great emphasis while the teaching of orientation and mobility receives peripheral or casual attention. The study will make the teaching and learning of orientation and mobility important in Nigeria such that curriculum might be developed for it since it could be adapted and used to enhance teaching and learning of geometry and mathematics in general.

1.7 THEORETICAL/CONCEPTUAL FRAMEWORK

The theoretical framework for this study is derived from two theories. The Piaget’s theory of genetic epistemology also referred to as theory of cognitive development. The second theory used is the theory of deficiency and inefficiency derived from John Lock’s theory which states that child mind is a 'blank slate' (tabula rasa). Piaget identified four basic stages in the development of mental structures.

The first stage is the sensori-motor stage. This is pre-verbal and pre-symbolic period. The child does not use words or symbols to represent things, instead it uses action. (eg. sucking, looking, grasping etc). The actions are uncoordinated, inherited reflexes and gradually the actions become coordinated habit gradually converting to cognition or intelligence. The environment for the actions or activities is the child’s own body and later the child extends the actions to the environment. Applied orientation and mobility programme (APOMP) is concerned with the environment of the child both within his body and his surrounding environment. Activities of APOMP within the body includes identifying and naming the learner’s different body parts and using non standard means of measuring the body parts which include the use of arm span, finger pacing, waist height, leg pacing etc. The non standard measurement starts from the different parts of the body and is extended to objects around the environment. APOMP eventually uses standard measurement of body parts using adapted rulers, measuring tapes and meter rules. APOMP activities within the environment involve taking and reading of measurement of lengths, distances or circumferences, identifying length of various shapes. Therefore basic concepts in measurements start with using non standard measurement involving the child's body parts and objects in the environment.

The second stage is the preoperational stage. This is the stage of representation or symbolism. The child presents his thought through the use of words to represent things through imagining. Applied orientation and mobility programme (APOMP) involves identification of landmarks within the environment. Landmarks refer to objects within the environment so that the child will hold, feel, touch, grasp, smell, identify their features and characteristics and manipulate them by either weighing, measuring, identification of shapes, sizes, distances eventually construct the mental images of the objects and their features or characteristics.

The third stage is the concrete operational stage. The child at this stage is said to be operational in his thinking. It is concrete operational because the necessary logical thought is based on the physical manipulation of objects in the environment. Basic mathematics concepts are better introduced to children first through manipulating objects around the environment.

The fourth stage is the Formal Operation. The child hypothesises with symbols or ideas rather than needing objects in the physical world as a basis for his thinking. Applied orientation and mobility programme based on the various contact with the environment, gives chance for the child with visual impairment to practically and theoretically be involved with geometry activities. The child identifies characteristics of objects within the environment eg shapes. The child identifies embossed shapes in two dimensional forms and draws embossed lines, quadrilaterals, polygons, angles, cardinal points, using rubber mat etc.

Piaget's theory of cognition covers the whole complex system of human mental abilities. Cognitive areas are: perception, attention, learning, memory, and reasoning.

Others are conception, imagery, assimilation and accommodation (Advani, 1992). Perception is an important part of cognition that helps in variety of tasks. Cognition involves the use of knowledge in reasoning and problem-solving tasks.

Piaget stated that intellectual development takes place through the process of assimilation and accommodation. Assimilation is when an already learnt stimulus brings to mind a respond, and accommodation on the other hand is when a child adds a new activity to his repertoire. Memory is an important part of cognitive process. There is short- term memory which Baddeley (1990) refers to as working memory. The short term or working memory has a limited capacity system being responsible for the manipulation and storage of information during the performance of cognitive tasks such as comprehension learning, problem solving, and reasoning. When one is under taking an activity, such an activity is also held in the mind. At the same time, there is manipulating, and integrating information in memory. Short term or working memory refers to the ability to hold information in mind while manipulating, and integrating other information in the service of some cognitive goal (Kane & Engle, 2002; Roberts & Pennington, 1996).

There are some considerable evidences suggesting that short term memory may be important for geometry or mathematics learning and problem solving. In solving a geometry/mathematical problem often it involves remembering the totals of certain calculations while performing other mathematical operations and then combining the outcomes. For example, Adams and Hitch (1998) suggested that mental arithmetic performance relies on the recourses of short term memory. Holmes and Adams, (2006) reported a significant association between children's short term memory ability and their mathematics attainment. Holmes and Adams further found that there was no significant difference between short term memory capacity of children with visual impairment and their sighted peers. Geometry/mathematics tasks executed through applied orientation and mobility programme (APOMP) involves short term and long term memory. In another study, Pooryal, Hassan and Farzad (2011) discovered that students with low short term memory have less achievement in mathematics performance. Geometry/mathematics tasks executed through applied orientation and mobility programme (APOMP) require short term and long term memory which eventually result in high task performance in geometry/mathematics.

Stephens noted that Piaget stresses the importance of the child's interaction with his environment in all his stages of cognitive development (as cited by Advani, 1992, p. 32). The interaction with the environment leads to perception and perceptual interaction with the environment is necessary for cognitive growth. No child skips any of the stages. This is a normal progression of cognitive development, and any deviation from normal development may impede an individual's cognitive growth (Hupp, 2003).

According to Copeland (1979) concrete operation stage is important mathematically. Many of the operations are mathematical in nature. Piaget lists some of the operations to include: classification, ordering, construction of the idea of number, spatial and temporal operations and conservation. Others are elementary logic of classes and relations of elementary mathematics and geometry and physics. This is the stage of mathematical structure, Piaget calls "grouping" putting objects together to form a class, separating a collection into subclasses, ordering elements in some way, ordering events in time etc. All these forms of classifications depend on sensory experience. Applied orientation and mobility programme (APOMP) avails the child with the opportunity of grouping objects within the environment as stated by Piaget based on their contact with objects within the environment through the use of their remaining senses.

Conception is basic to cognitive development. Concepts are building blocks of thought. A fundamental ability required for concept formation is classification too. This involves noting similarities, disregarding insignificant differences and also ability to note significant differences. Classification depends to a very large extent on sensory experience. Any deficit in sensory experience produces deficit in concept formation. Most often learners with visual impairment receive a great deal of information through words, it is found that their object concepts are defective due to lack of contact with objects in the environment. They use a number of words in the wrong context. They also may use words of whose meaning they do not know precisely (verbalism). Verbalism is the use of words without knowing the precise meaning (NIVH, 1992). Applied orientation and mobility programme (APOMP) prevents defective object concepts and verbalism through concrete presentation of the objects from the environment to the learner with visual impairment.

Piaget's theory of cognition seems to outline a lot of complications in the life of learners with visual impairment. They tend to have problems with cognitive development. According to Lowenfeld (1974) visual impairment imposes three general restrictions in the life of children with visual impairment in relation to cognitive development. They are range and variety of experience, ability to get about control of environment and self-in-relation to environment. All of these have effect on cognitive development. Warren is of the view that there could be delay in the process of cognitive development of a child with visual impairment due to limited critical interaction with the external world (as cited by Advani, 1992, p.32). The child will lack the sensory continuity afforded by visual stimulation. This lack of continuity hinders the integration of the child's sensory motor experience. Although auditory cues help learners with visual impairment in attaining a degree of spatial orientation, their inconsistency must make the process exceedingly difficult. Applied orientation and mobility programme (APOMP) makes contact with the environment and uses all the remaining senses in the child with visual impairment. Therefore the child with visual impairment will have better concept development and spatial orientation.

Contrary to the views that visual impairment encounters problem with the process of cognitive development, there are researches that have shown that interaction with the environment as emphasized in Piaget’s theory of cognitive development is important with children with visual impairment. Easton, Greene, and Svinis (1997) found a child with visual impairment with a much better developed ability to “link” information. They referred to it as structural priming. The child was able to semantically link information in the process of concept formation and it resulted in ability to think divergently, or in a creative manner. Wyver and Markham (1999) defined divergent thinking to mean “the ability to find multiple solutions to a single problem”. They considered this ability to be an important component in creativity and cognitive flexibility. Morgan (1999) described how a sample of learners with visual impairment was able to form a three-dimensional cognitive map based on auditory information. These individuals used this cognitive map to assist them in moving about, or orienting, to the physical world. Morgan concluded that learners with visual impairment often compensate for their lack of vision with over-developed abilities in other sensory functions. Learners with visual impairment need to make the best possible use of their non-visual senses like in the case of applied orientation and mobility programme (APOMP) which results in the learners with visual impairment developing cognitive map due to much development of their remaining senses as a result of opportunity to interact with the environment.

There are instances where learners with visual impairment were able to solve geometry/mathematical problems, although their approach and way of solution was a bit different from approach of the sighted persons. Where it involves geometry, most sighted learners draw a picture by solving given problems of analytical and Euclidean geometry. On the other hand, learners with visual impairment had to use imagination and objects (solids and plane figures). They first touched and then stored the images before they drew the pictures. Geometry is for them a kind of adaptation to the environment. This research work uses applied orientation and mobility programme (APOMP), as an adapted strategy, first to provide an avenue for the child with visual impairment to have access to the objects in the environment and interact with the environment thereby breaking the initial consequence of visual impairment which is restriction. Applied orientation and mobility programme uses all the remaining senses in the child with visual impairment to interact with the environment an act which Piaget emphasises for cognitive development.

Attitude is an important concept for learning mathematics; also it is a mental set or disposition of readiness to respond to the subject. Hembree (1990) found that mathematics anxiety is related to poor performance on mathematics. One of the components of attitude is cognitive component. This is opinion information or strength of belief or disbelief of the subject (Guimaraest, 2005). Therefore attitude is an aspect of cognitive constructs, and cognition is about Piaget's theory. Mathematics anxiety has been directly or indirectly, affecting all aspects of mathematics education as one of the most commonly investigated constructs in mathematics education. Some of the symptoms of mathematics anxiety are a 'blank' mind, inability to hear the teacher or lack of noise sensitivity, and inability to concentrate (Kitchens, 1995). All these are within the characteristics of cognitive process. When applied orientation and mobility programme (APOMP) enhances performance, there is the possibility of mathematics anxiety being reduced in the life of persons with visual impairment. This simply means that APOMP can change negative belief of learners towards geometry/mathematics to positive attitude (cognitive aspect of attitude) which often results in high task performance or achievement in geometry/mathematics.

According to Poorya1, Hassan, and Farzad (2011) they found out that a lot of failure in the previous mathematics examination and inferior achievement which are products of intelligence cause the feeling that achievement of good mathematics result is not so important. Attitude can influence performance in mathematics and performance in mathematics can in turn influence performance too. Intelligence quotient an aspect of cognition and motivation are said to be variables that determine the outcome of mathematics attitude and achievement (Kabiri & Kiamanesh, 2004; Bull & Scerif, 2001; Yunus & Ali, 2009). Applied orientation and mobility programme (APOMP) can serve as a motivation for doing geometry/mathematics which leads to achievement in the subject thereby resulting in high mental performance and the product is high intelligence quotient.

The second theory used in this work is the theory of inefficiency and deficiency. John Locke believed that our minds originated as a 'blank slate' (tabula rasa) and that all concepts we have are derived from our sensory experiences. Thus a congenitally blind person would only have tactile impressions of objects, and these could not automatically allow him to recognise the same objects by sight. It is only by integrating experiences from different senses that we build up abstract concepts. In view of this assertion by Locke, Millar asked; If one perceptual modality (i.e. vision) is missing, what (if any) effect does this have on our knowledge of the world? Three answers were proposed for this question resulting in three theories. They are theories of deficiency, inefficiency and difference in spatial tasks of congenitally visually impaired learners (Andrews, 1983; Fletcher, 1980). The first theory the deficiency theory states that lack of visual experience may result in a total lack of spatial understanding. The second theory is the inefficiency theory. The theory states lack of visual experience may result in spatial abilities which are similar to, but necessarily less efficient than, those of sighted people. The third theory, the difference theory may result in abilities which are qualitatively different from, but functionally equivalent to, those of sighted people. The first of these positions came up from the work of von Senden in 1932 who argued that spatial concepts are impossible in people who have been blind from birth, and that visual experience during some early period is essential for even a minimal understanding of space (Ungar, 2000). This research work compares task performance or achievement and attitude direction of learners who are congenitally visually impaired and those that are adventitiously visually impaired.

In a study by Hupp (2003) on cognitive differences between congenitally and adventitiously blind individuals, the findings suggested that congenitally blind individuals develop alternate methods of cognitively processing nonverbal, abstract, or complex information, especially information involving a high degree of spatial orientation. Ungar (2000) in review of literatures in spatial concepts with learners with visual impairment revealed that there are factors to consider when dealing with spatial cognition of learners born with visual impairment. There are environmental spaces or objects that are presented to them that are referred to as near or far spaces. Near space refers to small – scale or manipulatory space or areas that can be explored without changing the location of the body. Far space relates to medium or large scale space; areas in which movement is required for exploration.

In small scale, both tactile and haptic exploration with the hands and arms is used. In any task the learner can perform based on spatial relation that has been directly experienced and will require only coding or task that can require inferring the new relation based on direct experience task that will require transformation of the coded information. Applied orientation and mobility programme (APOMP) involves the use of the concept of both far and near space (environmental exploration and tactile drawings) as found by Ungar. There is the need for environmental experience and providing models or tactile maps for learners with visual impairment especially those that are congenital.

External cues could be of advantage when experiencing complex task with a learner born blind. (1988) working on spatial development called convergent active processing in interrelated networks (CAPIN) stated that information from each of the different senses is specialised, and are complementary and overlapping. Because of this, spatial information is not the exclusive domain of one sensory modality. Spatially relevant information is available through senses other than vision (e.g., through hearing, touch and movement) and this information can form the basis for spatial coding. Congenitally visually impaired learners tend to code spatial relations egocentrically because this type of strategy generally works best for them (Ungar, 2000).

Processing of spatial information by congenitally visually impaired learner may not be less efficient than sighted or adventitiously visually impaired as the inefficiency theory proposes. According to Ungar, it is misleading looking at efficiency rather than on the nature of coding used by the learners. Tactile maps in conjunction with direct experience of the environment will optimise spatial knowledge in both congenitally and adventitiously visually impairment learners (Millar, 1988; Ungar, 2000). The use of applied orientation and mobility programme (APOMP) creates the opportunity for direct experience of the environment which gives opportunity for both congenitally and adventitious visually impaired to have contact with the environment to optimise spatial knowledge in them and also excel in geometry and mathematics.

1.8 DELIMITATIONS OF THE STUDY

The study was carried out in only two residential special schools. The schools were school for blind children Jabbi in Abuja and school for blind children Gindiri. The school in Abuja belongs to the Federal Capital Territory administration while the school in Gindiri belongs to the Church of Christ in Nations (COCIN). While the school in Abuja is located in the nation's capital, the school in Gindiri is located in Gindiri a rural town in Mangu Local Government area of Plateau State. Gindiri is renowned for hosting many educational institutions from primary, secondary to tertiary levels since the 1950s. Gindiri School for blind children was the first school for blind children to be established in 1953 in Nigeria.

The study did not look at all aspects of orientation and mobility and geometry. In the area of orientation and mobility, the study only looked at aspects of concepts and skills that are embedded with geometry concepts and skills. For example, there is measurement in orientation and mobility skills involving ascertaining the exact or approximate dimensions of an object or space, using a given unit. In basic sighted guide, one of the skills is for the learner's upper and lower arm form an angle approximately 90^0 with the forearm pointing forward. The study is only concerned with descriptive geometry. This aspect of geometry is concerned with the study of the angles, shapes, lines, surfaces and solid objects in space.

The study did not involve all categories of children with visual impairment. It did not involve children with multiple disabilities. For example learners with visual impairment that have deafness in addition (deafblind). They are referred to as Multiply

Disabled Visually Impaired (MDVI). It did not involve learners with additional intellectual impairment.

Although the world talks much of inclusive setting today, the research work could not be done under such setting. This is because inclusive programme in Nigeria has not taken off officially. The special residential schools are used for the research.

1.9 OPERATIONAL DEFINITIONS OF TERMS

Achievement: In this study, achievement refers to task performance in geometry

Age at onset of visual impairment: This refers to when learner with visual impairment first acquired the impairment or damage to the organ of vision. It can occur before or at birth call congenitally impaired or later in life known as adventitiously impaired. The age range as used in defining congenitally impaired in this study is (before, during and immediately) after birth is 0-7 years. Adventitious visual impairment as applied to this study is 8 years and above but within the primary and secondary school age.

Applied Orientation and Mobility Programme (APOMP): This refers to a programme/adapted strategy (teaching method) designed with geometry concepts and skills embedded in orientation and mobility concepts and skills. It is used for training in geometry skills to enhance task performance in geometry concepts and skills. It is used as a treatment (intervention) for awakening dormant geometry skills that are found in orientation and mobility skills for learners with visual impairment which they could use in geometry task and enhance their task performance in geometry. The geometry skills and concepts can be demonstrated practically with orientation and mobility methods or skills which are then transferred through embossed form practically. Some of the geometry concepts in applied orientation and mobility programme APOMP include: Spatial concepts, turns, shapes, measurement etc.

Attitudes toward Geometry: This simply refers to the beliefs, feelings and behaviour of learners with visual impairment towards the study of geometry as a subject. It includes geometry or mathematics anxiety which influences task performance in geometry of learners with visual impairment. It shows the direction of the attitude as being negative or positive which eventually influences their task performance in geometry, as measured by attitude to geometry scale (AGS) in this study.

Effects of Applied Orientation and Mobility Programme: This refers to the outcome or results of the use of applied orientation and mobility programme (APOMP) as an intervention to change attitude and also to enhance task performance in geometry of learners with visual impairment. It refers to changes that may occur in their attitudes and task performance in geometry that may be exclusively tied to exposure to applied orientation and mobility programme.

Geometry: This refers to descriptive geometry concepts and skills that are found embedded in orientation and mobility skills which are also found in spatial process within the environment. The descriptive geometry can be practically demonstrated in the cause of demonstrating skills in orientation and mobility in space and translated in written form as tactile or embossed diagrams or shapes for learners with visual impairment. The descriptive geometric concepts include: spatial concept by establishing and maintaining direction and maintaining distance and straight line and locating specific objects. This involves concepts like: Spatial concepts: parallel, perpendicular, around, diagonal, horizontal, vertical. Spatial concepts dealing with action: Turns, 45^0 turn, ¼ turn, right angle turn, whole turn etc. Concepts of Shapes: Primary shapes: round, triangle, circle, rectangle, square, Secondary shapes: Octagon, hexagon, pentagon, parallelogram etc. Concept of measurement: distance, amount, time, weight and volume and their presentations in tactile forms.

Learners with Visual Impairment: This refers to those who lost their sight either totally or they have some remaining sight, they may be born (congenital, 0 – 7 years) with it or they acquire it (adventitious, 8 and above years) at later age. They are studying in primary or secondary institutions. They can use all the apparatus involved with applied orientation and mobility programme.

Adapted Geometry Task Performance Test: This refers to skills in orientation and mobility embedded with geometry task performance of learners with visual impairment in geometry test developed and validated by the researcher. It is one of the two instruments used; it was used as pre-test and post-test in the study

Residential Special School: Learners with visual impairment are considered to need special care so residential special schools are provided where they have hostel accommodation, equipment and teaching and learning materials are provided and trained or experienced teachers and supportive staff are provided. It has wide environment for demonstrating applied orientation and mobility programme. The residential special schools referred in this study are the ones in Gindiri and Jabi-Abuja which are solely for learners with visual impairment.

Treatment: This simply refers to interventions given to learners with visual impairment in the study.

CHAPTER TWO
REVIEW OF RELEVANT LITERATURE

This section aims at reviewing relevant literature on basic topics on the research study. The literature review is in the following areas: visual impairment, its meaning, nature, causes, problems, challenges, types and attitude of people towards learners with visual impairment. The literature was reviewed on children with visual impairment; signs of visual impairment; and development of children with visual impairment in the area of cognitive, perceptual and conceptual development. Others are mathematics (geometry) with learners with visual impairment; interest and performance of learners with visual impairment in mathematics (geometry); challenges and how learners with visual impairment learn mathematics (geometry) and materials for learning mathematics. The literature review looked at orientation and mobility, meaning, basic concepts, training and relationship between orientation and mobility and mathematics (geometry) and methods or reading and writing for learners with visual impairment.

2.1 VISUAL IMPAIRMENT

2.1.1 Meaning/Nature

There are many terminologies that have to be handled with care in special education. Some words connote negativity. Some label the persons they are attached to and are derogatory. For example the use of the word “blind” is derogatory. Therefore opinions are that the most dignified term to use is “visual impairment”. In view of that, World Health Organisation [WHO] (1980) defined the word impairment as any loss or abnormality of psychological, physiological, or anatomical structure or function, which may result from a disease, accident, or other genetic or environmental agents. This definition simply refers to damage to body organ or tissues thereby affecting its function. However in education, the concern of the damage is where it affects learning. The question is whether the damage to the visual organ is such that the children will depend solely on Braille as their medium of reading and writing. Has the child any residual or remaining sight to use so that he or she could use large print or magnifiers? At what age did the child become visually impaired, congenitally or adventitiously? The concept of impairment in this study is about children who have damage to their organ of vision such that it affects their learning there by resulting in adaptation of teaching methods, materials and learning process. Abang (2005) opined that impairment can prevent an individual from functioning in a particular or given situation. This view supports the view that educationally impairment is seen towards issues of restrictions in functioning educationally, socially, and in doing certain activities in life.

Caroll defined visual impairment as the measurement that the visual acuity does not exceed 20/200 (6/60) or less in the better eye with the best possible correction or field of vision that is restricted to an angle extending an arc of 20 degrees or less (as cited in Abang 2005, p.45-46). This is also referred to as blindness. This is a legal definition. Legal definition is used in rehabilitation. It is referred to as definition for eligibility for services. This definition is needed for allocating resources for states in America who provide rehabilitation services to persons with visual impairment. Unfortunately such approach is not available in Nigeria. Legal definition is not well comprehended in our special residential schools in Nigeria. No school is provided equipment or materials based on the degree of impairment of its children based on visual acuity measurement.

Medical established definitions measure the need for medical services. It includes visual acuity, extent of visual field, aetiology or the causes of the impairment and used to specify medical procedure to restore vision and enhance the residual vision functions (Dickerson, Smith, & Moore, 1997). A person is considered to have low vision or is partially sighted if the visual acuity is 20/70 (6/18) in the better eye with the best possible correction (Berdine, & Blackhurst, 1985).

According to Dutton (2003) visual impairment is defined as a reduction in visual acuity (age-adjusted) or field loss as a result of a problem within the visual pathway (a problem within the eye, optic nerve, or occipital cortex). The eye is considered as an extension of the brain by so many authors. Visual impairments that are related to the optic nerve or occipital cortex or the brain are usually not seen on the eye of the child. It is difficult for many teachers to believe that such a child does not see because the eyeballs seem intact. The problem is often deep inside the brain. The researcher observed that most children with mental retardation also experience visual problems.

Educationally visual acuity of 20/200 can tell the teacher to which group the child belongs amongst the various groups of children with visual impairment. Visual acuity and visual field tests do not measure visual function which is the aspect of visual impairment teachers desire to know most in the life of the child with visual impairment as earlier stated. Functional vision describes how the eye functions. It describes how the person functions in vision-related activities. For example: reading, mobility, employment, activities of daily living and quality of life (Sardegna, & Paul, 1991). Erin, Fazzi, Gordon, and Isenberg (1994) found out that two children with identical diagnoses and visual acuities may function differently.

Educationally the child with visual impairment is one whose visual loss indicates he or she should be educated chiefly through the use of Braille and other tactile and auditory materials. The low vision child is defined as one who has some remaining useful vision and can use print and other visual materials as part of the educational programme (Ejukonemu, 2006). Therefore visual impairment refers to heterogeneous group of people who are wide range of types and degree of visual impairment. The concept of visual impairment in this study refers to children with damage to their visual organs who are either totally blind or those that fall within low vision. There are children with visual impairment who rely on Braille as their medium of reading and writing. In most cases the schools treat the children with low vision as though totally blind and have no educational provision for low vision.

2.1.2 Causes of Visual Impairment

World Health Organization [WHO] revealed that the control of visual impairment in children is considered a high priority within the World. The reasons given are that any child, who is born with visual impairment or acquires it at an early age, will have a lifetime of blindness ahead of him (as cited in Gilbert, 2001, p.53). For example if a child is born with visual impairment and will live for seventy years, that means the child will be blind for seventy years. The child will suffer the emotional, social, educational and economic costs of being blind for that length of time in his life.

WHO (1999) opined that many of the causes of visual impairment in children are found to be easily prevented (avoidable) or treated. Many of the conditions that cause blindness in children include: measles, congenital rubella, syndrome, vitamin A deficiency, and meningitis which are preventable. WHO suggested that if immunization is taken seriously; if there should be provision of vitamin A to children always and surgery where demanded, it can prevent so many cases of childhood visual impairment. Gilbert and Foster (2001) warned that if there is failure of normal visual maturation in a child, it cannot be corrected in adult life. Therefore there is a level of urgency about treating childhood eye disease which does not necessarily apply to adult conditions. Gilbert and Foster further revealed that children’s eyes cannot be considered as smaller versions of adult eyes, because they respond differently to medical and surgical treatment. There are conditions that must be treated at childhood or else they cannot be treated at adulthood. Teachers often do not know that the eye of the child is different from that of an adult. When you point at a direction to show a child something from a distance, your visual acuity and that of the child cannot be the same. What an adult sees clearly at a distance of five hundred meters, the child will need to be moved closer to may be only two hundred meters before the child sees the object clearly like the adult. The situation of a child with visual impairment where the residual or remaining sight is small will be worse. In such a case, the child may need to be moved even closer to one hundred meters before the child will view the object.

Foster (1998) found that the number of children with visual impairment in the world is estimated to be 1.4 million. W.H.O (1999) found that the cost of being blind is huge on the individual, family members and communities. The economic cost indicates that blindness cost community that has blind persons billions of dollars in lost productivity, in caring for people with visual impairment, in providing for rehabilitation and in provision of special education. The cost is usually huge.

Today this has a huge implication on the educational provision for persons with visual impairment. The attention of the whole world has turned towards blindness prevention. The world came out with several programmes towards childhood blindness prevention which are dominantly medically oriented. There is vision 2020 Global effort for childhood blindness prevention and there is Sight Right Act in many countries. Unfortunately educational provision for children with congenital visual impairment has never been considered as part of blindness prevention. The researcher who is an Advisor and a Consultant to Christian Blind Mission (CBM) of Germany and Sight Savers International (SSI) of Britain respectively observed that attention and money are channelled more towards medical activities on prevention of blindness globally. Support to educational and rehabilitation programmes have been slowed. International None Governmental Organisations (INGOs) spent more money in training more ophthalmologists, ophthalmic nurses, optometrists and hardly any for special education teachers. The INGOs used to donate educational materials like Braille machines, Thermoforming machines, Braille papers, calculating devices like abacus and drawing kits for children with blindness to residential special schools for blind. Some of the INGOs went to the extent of liaising with manufacturing companies to manufacture teaching and learning materials like slate and stylus for learners with visual impairment, and linked the special schools with the companies for possible supply of the equipment and materials. This has reduced. Their attention is on providing eye drugs, surgical equipment and financial top ups on the salaries of eye medical personals. Schools do not have the required equipment to use in teaching children with visual impairment in subjects like mathematics (geometry).

In one of the CBM's meetings in their regional office in Lome Togo, the researcher complained of dwindling support (resources) to education. They said their priority for now is blindness prevention. Unfortunate it is not understood even by experts in the field of disability that providing education to children with visual impairment is also part of blindness prevention. Education provides children with visual impairment skills in life. It prevents the devastating effect of blindness on them and they live a normal life as they never had any impairment.

Thorburn (1994) showed three ways of classifying causes of disability. They are etiological, developmental and epidemiological classifications. Etiological classification includes: infectious agents (bacteria, viruses, protozoa); nutritional (or lack of nutrition) – malnutrition; vitamin deficiencies and anoxic factors (oxygen deprivation). Others are traumatic factors e.g. accidents; toxic factors-poison; genetic factors and stimulus deprivation.

WHO (1999) pointed out that the single largest cause of childhood blindness is corneal scaring related to vitamin 'A' deficiency, cataract, and Retinopathy of Prematurity (ROP). Congenital cataract is avoidable through genetic counselling. However WHO is worried about cultural barriers that are against the counselling. Retinopathy of Prematurity (ROP) occurs in pre-term babies. Other commonest causes of childhood blindness are measles and traditional practices. Dealing with children with visual impairment is dealing with children who acquired the impairment due to different disease conditions.

Erin, Fazzi, Gordon, and Isenberg (1994) discovered that causes of visual impairment in children can be categorized into acquired and congenital impairment. The acquired conditions include trauma. This can be incurred by forceps delivery. Maternal drug intoxication can cause trauma too. Fazzi, Gordon, and Isenberg added that infection can cause visual impairment. They stated that an inflammatory infection, ophthalmic neonatorum is caused by bacteria present in the birth canal such as gonorrhoea, herpes and rubella. This can cause scarring in the retina leading to visual impairment. Ward and Johnson (1997) made reference to Retinopathy of Prematurity (ROP) as due to the administration of high concentration of oxygen for extended periods of time to newborn infants of low birth weight. It results in retinal disorder which causes changes in the retinal blood vessels and in some cases proliferation of the retinal blood vessels into the vitreous. Fibrous tissues also develop through the retina and vitreous. The abundance of blood vessels and fibrous tissues cause stretching in the retina, which may lead to eventual detachment from the pigment epithelium, the outer layer of the retina (Erin, Fazzi, Gordon, & Isenberg 1994). There are children that are born without eyeballs. It is known as Anophthalmia. The absence of eyeball is usually in both eyes. Eyelids and lashes are present but may close. The eye lid appears sunken because of the absence of the eye ball (Abang 2005). When children have impairment that is as a result of disorder of retina and complete absence of the eyeball, definitely such a child will rely on Braille as his medium of reading and writing. These are categories of children that orientation and mobility and Braille reading and writing are main for.

Cataract is the opacity or clouding of the lens that causes reduced visual acuity. Cataract is a Latin word for "waterfall" It blocks the passage of light rays through the pupil to the retina. There is a senile cataract which is age related and there is a congenital cataract which occurs in infants and may require surgery and eyeglasses or contact lenses are prescribed (Ward & Johnson, 1997). Many children have benefited from surgery of cataracts and they read print normally. Such children their visual impairment is easily preventable. Optic Atrophy is when the optic nerve damages which lead to occlusion of the central retinal artery, degeneration of the retina, direct injury to the optic nerve or pressure against the nerve from a tumour (Ward & Johnson, 1997). Optic Nerve known as Hyperplasia manifests itself in the form of an underdeveloped optic nerve in one or both eyes is one of the visual impairment experienced by children (Erin, Fazzi, Gordon, & Isenberg 1994).

Retinistic Pigmentosa (RP) is a hereditary condition that progressively affects peripheral and night vision and can lead to tunnel vision or blindness. Ward and Johnson (1997) warned that RP typically manifest itself in the early teenage years.

Erin, Fazzi, Gordon, and Isenberg (1994) listed visual impairments that congenitally occur to include: Albinism which is a hereditary deficiency in the pigment of the retina, iris and choroid. It is due to absence of pigment in the hair, skin and eye. Ocular albinism allows light to pass through the iris, causing photophobia (light sensitivity). It is also associated with nystagmus and lack of depth perception. Amblyopia is called lazy eye. It results in poor vision, some loss of depth perception and visual field. According to Ward and Johnson (1999) aniridia is when the iris does not form, creating light – control problems. Coloboma is a congenital cleft due to failure of some portion of the eye to complete growth during development.

Erin, Fazzi, Gordon, and Isenberg (1994) opined that cortical visual impairment is vision loss caused by damage to the visual cortex of the brain. Other causes are Microphthalmia a condition marked by abnormally small eyes and Nystagmus involuntary, rhythmical oscillating movement of one or both eyes from side to side, up and down in a rotary pattern or in combination. These are ways in which children become visually impaired as early as before birth, during birth or immediately after birth. When discussing children with visual impairment. It is discussing different children with different visual disorders. In an ideal classroom situation, each child is attended to as an individual. Educational needs or provision for each child should be different from another child. However, the binding word is “blindness”. They are all treated as blind children irrespective of the differences in them.

In a survey of schools for blind children in Madurai in India, by team of experts to find out the types and causes of visual impairment, they came across different cases of visual impairment in the schools. There were children with high myopia, macular dystrophy, congenital nystagmus (involuntary rhythmic oscillation of the eyes), microphthalmos (unilateral or bilateral small, malformed eye), albinism (lack of pigment cells in skin, hair eyes) coloboma (involving of iris, ciliary body, choroid retina optic nerve), cone dystrophies (Vijayalakshmi, 1998). Abang (2005) came out with the commonest causes of visual impairment in Nigeria: Onchocersiasis, measles, trachoma, malnutrition (nutritional blindness), poliomyelitis, schistosomiasis (guinea worm), iodine deficiency, tuberculosis, meningitis, leprosy, road accidents, accidents at work, consanguineous marriages and vitamin A deficiency (p.20).

There is a strong belief amongst disability experts in the world that poverty causes disability and disability too causes poverty. From the list of causes of visual impairment in Nigeria above by Abang, it could clearly be inferred that most people become impaired in the country due to poverty. When you check the condition in which these people are living in Nigeria, you will find out that they are living in abject poverty. To find the poorest of the poor anywhere, it is commonly found amongst those with disability. Most often many of them depend on begging for a living. Even with education, sometimes finding job could be difficult.

The visual functioning of these different cases differs. Although children with visual impairment are grouped as a group of those with visual impairment, in real sense they are of different children with so many types and causes of visual impairment. They will react and perform differently in geometry tasks.

A team of experts in the field of visual impairment covers quite a large range of experts in various fields. Some of these experts include: Ophthalmologist, Optometrist, Paediatrician, Developmental Paediatrician, low vision specialist, classroom teacher(s), teacher of the visually impaired, technology consultant, and certified low vision therapists. Others are; Parent(s), student, early childhood specialist, occupational therapist, orientation and mobility specialist, physical therapist, Child Psychologist/Psychiatrist, speech/communication specialist. The implication of this on the study is that impairment is often only limited to total blindness, and children with low vision in Nigeria due to lack of proper investigation. The lack of all these team of experts in the field of special education in Nigeria makes it impossible to come across the many causes and types of visual impairment in residential special schools as Vijayalakshmi (1998) came across in their team work in India.

There is no doubt that these causes and types of visual impairment found in India are also found in Nigerian special residential schools. Most times the children are in the school without any medical records as to know their visual acuity or visual field. Some of them the causes of their impairment are unknown and some are attributed to some superstitious beliefs.

Unfortunately medical and educational experts do not communicate well in Nigeria. They hardly collaborate as a team in work or in researches. There is the need to form such a team in Nigeria. All professionals on the team are important partners to ensure best outcomes. The implication of this on the education of learners with visual impairment is that every child is provided the type of education that is mainly for children that are totally blind. Braille facilities are used which are difficult to learn both on the side of the teachers and the learners and Braille facilities are very costly and difficult to come by.

The researcher consults for Otana integrated school in Jos. This is an inclusive school. The school collaborates with the eye department of Jos University Teaching Hospital (JUTH) and Vision 2020 of CBM in Jos where they have an Optometrist. All the children with visual impairment including those with additional impairment have been attended to either medically or through provision of optical devices. The result in the school is that none uses any educational provision meant for those with total blindness for example Braille and orientation and mobility skills. A visitor to the school once remarked that it seems the school does not admit children that are totally blind. A case of a boy with visual impairment that would have been handled as a totally blind child was prevented. He went through surgery and had intra ocular lenses (IOL) (lenses were inserted in his eyes). One of the lenses later collapsed, and was beginning to have problems; he was examined by an optometrist again and was prescribed eye glass. Upon the eye glass, he was given additional hand lens for reading. Today he reads print with the lens inside his eye, the eye glass prescribed and the hand lens he uses in addition during reading. This has reduced the huge cost and the difficulties experienced if he had been educated as though totally blind.

2.1.3 Problems of Children with Visual Impairment

Hyvarinen (2003) revealed that visual impairment has a lot of problems when it happens at childhood. It occurs during the first year of life. Hyyarinen lamented that at that age, visual acuity and visual field cannot be assessed. It is difficult to measure visual acuity and visual field properly in infants and children. This can have implication in terms of placement and categorization of children with visual impairment into where they belong and the type of education they should be given. The children find school to be too difficult to cope with.

Similarly it is common finding that children with visual impairment have other additional impairment. Hyvarinen further revealed that more than 60% of visually impaired children have one additional impairment or chronic disease and many have several impairments. There are children who are visually impaired and have cerebral palsy; children with visual impairment with Syndromes (Down, CHARGE, and Ushers); there are those that are having hearing and visual impairment or deaf – blind, (Multiply Disabled Visually Impaired MDVI), those with visual impairment with Seizures etc (Erin, Fazzi, Gordon, & Isenberg 1994). Assessing these children with the various disorders is difficult to do therefore diagnosing such problems in children will be difficult. According to Hyvarinen (2003) children with severe motor impairments and children with profound intellectual disabilities may not have command of eye movements to respond in testing acuity or in test situations that require fixation of gaze on a target of certain size and contrast. This will affect their performance academically. Sometimes lack of knowing that the child has additional problem can be quite frustrating for the teacher, the child and even the parents. A case of a child with visual impairment in Gindiri was that the teachers did not know that he had hearing problem in addition. Everyone thought it was rudeness. He was given instructions and most often he never carried out the instruction. The child was punished for those several times. It was when an expatriate teacher who came to the school for some times that discovered that the boy was also deaf. Every teacher regretted their actions over the boy.

Sacks, Barrett, and Orlansky (1997) showed that people who have multiple disabilities have difficulties that generally cannot be effectively remediated through educational or rehabilitation programmes solely for people with only one disability. When one has one disability and has another does not equal two disabilities. Sacks, Barrett and Orlansky stated that sometimes one disability could be considered as primary and the other secondary. Sometimes the disability may be severe such that it is not possible identifying which one is more disabling than the other. Sometimes the effect of one disability in a person may be more severe than one disability in another person.

Children with visual impairment usually experience inappropriate behaviours due to feelings like boredom, anxiety, frustration, isolation and anger (Peters, 1994). Peters stated that one of the inappropriate behaviours exhibited by learners with visual impairment is tantrum. This is a highly frustrating behaviour exhibited by some learners with visual impairment. A child can become angry and unreasonably difficult to control. Under such condition, it will be difficult teaching the child geometry. However, there are a lot of measures used to control such behaviours. Peters revealed that when the tantrum is not destructive to property or person, then ignoring the behaviour is the best answer. Time-out can be used. A safe area can be created so that at the onset of tantrum the child is taken there. Such children hardly pay attention to school work when they are undergoing such behaviour.

Rai (1999) stated that visual impairment goes with mannerism also called blindism. These are behaviours that are seen as habits, tricks, personality problems, self stimulatory activities and repetitive behaviours. Peters (1994) stated that eye poking is one of the mannerism found in children with visual impairment. Eye poking goes on because the child has discovered eye poking provides him or her with visual sensation that will become central point of enjoyment for the child. Rai (1999) listed different forms of mannerism to include: Head movement in the form of nodding, rolling and shaking; Face contortion by twisting or mis-shaping of the face; Tongue Wagging involving movement of the tongue in alternative or opposite direction and clapping hands or to head. Others are Eye Poking and Rubbing. This is frequent contact of the eye with the fingers or back and forth movement of the open or closed hands over the eye. There is finger manipulation; arm shaking and flapping one or both arm backward and forwards or sideways. Others are thumb sucking and nail biting. In residential special schools, children with visual impairment are seen jumping, rocking their bodies and shaking their foot.

These behaviours are unsightly. They disturb parents and others and may lead to suspicions of mental retardation or severe emotional disturbance. They may lead to teasing by other children with consequent social segregation. This may further handicap the child (Rai, 1999, p.73). Children who exhibit these behaviours are often absent minded. They have less concentration in the classroom and it causes backwardness.

2.1.4 Challenges of Children with Visual Impairment

Visual impairment has multidimensional challenges. The challenges can be social, medical, psychological, educational, and vocational (Raychaudhuri, 1992). To educate children with visual impairment, certain factors must be considered. Some curriculum areas can be made accessible through a proper care in the presentation of materials. The main difference in method of teaching visually impaired children is in the use of materials.

Over the years, learners with visual impairment (LWVI) have not shown any problem with art-base subjects (English, reading, history, religious studies etc). NIVH (1992) stated that English language to large extent has shaped the mental and emotional make up of personality and psyche of LWVI. There are four aspects of English that care must be taken of while teaching LWVI and any other children. They are: listening, speaking, reading and writing.

Curriculum areas that involve practical activities create more challenges to teaching and learning by LWVI (Best, 1992). Sometimes they require whole adoption, adaptation, substitution and in rare cases deletion of some of the content. These areas include science, technology and mathematics (STM), arts and craft and physical education. They are not impossible but they require high level of attention and expert teaching support especially for those that are totally blind (Hill & Jurmang, 1993).

Apart from the academic subject content they are taught as their sighted peers, specially created bodies of knowledge and skills for the children with visual impairment are made available to augment the academic subjects. They are taught orientation and mobility to enable them move around to attend their classes (Pavey, 2006). The teaching and learning of Braille enables them read their notes and daily living skills enables them take care of themselves. They use tape recorders to take down their notes and use typewriters to communicate with their sighted teachers and friends in particular and the sighted world in general.

In assessing learners with visual impairment (LWVI) the followings are considered: age at onset of visual impairment, level of intelligence, presence of other handicapping conditions, nature (etiology) of the visual impairment and emotional stability of the child. The most important to consider are the etiology and the age of onset. Etiology is crucial because some eye conditions require the use of a particular teaching methods and materials. The experience that a child had before a loss of vision and the age at which the loss occurred are important. An early visual loss obviously limits what was learned through seeing to a much greater extent than a later visual loss. The knowledge of how much a visually impaired child knew when the vision became impaired can help a teacher decides what the child needs to learn and how it should be taught.

To plan properly, teachers of children with visual impairment should consider the effect of blindness on physical, mental and emotional development of children. Visual impairment has indirect effects on the all round development of children with visual impairment. This is because vision is the primary system of sensory input for human beings. When vision loss occurs during early childhood, the development of cognition, concepts and language are affected during sensitive stage of development (Finello, Hanson, & Kekelis, 1994 P. 35). To compensate for that, the child should be engaged with a lot of activities in the environment. Unfortunately that is not the understanding in handling children with visual impairment. Their physical activity is severely limited and they become passive. Some are over protected or neglected by parents and have no opportunity to move about (Pathak, 1992). These children are not able to observe physical activities of others. They cannot develop certain physical skills through imitation as seeing children do (Ribero & Silva, 2005). They therefore must be allowed the freedom to move about in their environment and to participate in the physical skills normally learned through visual observation. They can be taught directly many of the physical skills normally learned through visual observation. This is the purpose of teaching orientation and mobility to children and in the process of doing that, they experience practical skills in geometry.

Intellectual development of children with visual impairment is not directly affected by visual loss. Concept development is affected by the restrictions that result from visual loss, rather than by the visual loss itself. A child with visual impairment has a smaller range and variety of experience, has trouble moving about freely and has a more difficult time interacting with the environment (Lowenfeld, 1974). These are sources of concept development in children.

Children with visual impairment are further handicapped by their inability to learn through imitation of what they see. They must learn through direct experiences, which they often do not have. The restricted environment involvement of the child causes his delayed conceptual development and not his visual impairment itself. Therefore if there is any underachievement in children with visual impairment it is not as the result of the impairment but it is as a result of indirect results of impairment (NIVH, 1992).

Most of the social and emotional problems of the children with visual impairment are caused by the attitudes and reactions of those who can see. Society's negative attitudes were entirely responsible for their social and emotional problems (NIVH, 1992). Children with visual impairment either accept the opinions and expectations conveyed to them by society or suffer isolation as a result of rejecting them.

Lack of contact between sighted and persons with visual impairment causes negative reaction by sighted persons to persons with visual impairment. This results in misunderstanding and formation of unrealistic ideas about the effects of visual impairment on children with visual impairment. This misconception causes social and emotional problem in visually impaired children (NIVH, 1992).

The most challenging life of persons with visual impairment is the vocational aspect of their lives. The demands for jobs are greater than the number of employment available and the result is then unemployment. Occupations are graded. Some are gratifying and highly regarded and well paid, others are more or less ill thought of and displeasing to the individual. Irrespective of qualifications obtained, many visually impaired persons end up in Local Government craft rooms in some states.

In vocational placement, emphasis is laid on competition between individuals. It is highly harmful to persons with visual impairment. Unless at each level compensatory arrangements enables them either to compete on an equal, higher or different footing or to stand clear from competition through specially reserved employment, recruitment priorities or other devices. Mathematics goes with prestige. When learners with visual impairment read courses like mathematics, perhaps the society will give them that prestige and higher jobs will be offered to them. As earlier stated employment opportunities to visually impaired persons could also be limited due to negative public attitude, prejudiced attitudes of employers, lack of confidence and constrain in persons with visual impairment themselves.

2.1.5 Types of Visual Impairment

Visual impairment can be classified based on age at onset. Welsh and Tuttle (1997) stated that there are two classifications of visual impairment based on when the impairment occurred in the life of the individual. There are those that are congenitally visually impaired and those that are adventitiously visually impaired. Those that are congenitally visually impaired are those that the impairment occurred at birth or it occurred at an age that the person cannot have memory of things he saw at the time the sights were lost. Welsh and Tuttle warned that an individual whose visual impairment happened before ages 3 or 4 may not retain any visual imagery or visual memory, which provides important building blocks for the development of many basic and important concepts.

In view of lag in development of children in developing countries compared to those in developed countries, the researcher is adopting ages from 0 – 7 as fallen within the congenital ages. From experience most of the children with visual impairment in our residential special schools when you see them physically, they look like children of six years, but their real ages are ten or more when you enquire. This may be same with their concept development.

There are children that are adventitiously visually impaired. Welsh and Tuttle (1997 p.60) define them as children who at one time were sighted but who have subsequently lost some, if not all, of their vision. There are individual differences amongst people who have visual impairment. In determining the age at onset of an individual person with visual impairment can strongly influence the types of rehabilitation services that he or she may need. Also individuals who are congenitally visually impaired have some different experiences, and therefore different needs, from those that are adventitiously visually impaired. Those individuals who have lost part or all of their vision as young adults or as adults have in general already learned basic life skills as sighted persons. The age at onset is so important that other professionals consider it in their professional assessment or examination. Rahi (1998) stated that in ophthalmic examination of a child, one of the essential information needed is the age at onset of the child. It forms part of the visual function and educational needs of the child. This shows how age at onset is important for professionals that have to do with disabilities.

Simply put, Werner (1999) classified visual impairment into mild, moderate and severe. When children are completely blind; they see nothing. They cannot see anything. Despite that, most blind children can see a little. There are those that can see but they can only differentiate between light and darkness. They are not able to see shapes of things. Sardegna and Paul (1991) explained that those that are legally blind have a visual acuity of 20/200. Sardegna and Paul further added that there are those who have sight loss in one or both eyes but are not legally blind. Therefore there are two broad groups of visual impairment, those with total blindness and those with low vision. Xiaguang and Qingzhong (2007) found that there are many low vision children in residential special schools for the blind. The totally blind children learn Braille while children with low vision learn print characters which are enlarged or magnified and use the same teaching materials that are used by sighted children. The only difference is that the print has to be enlarged either by font size or the use of a magnifier.

There are several types of visual impairment. There are children that are born with no eyes at all. The children are said to have anophthalmia. Those that are born with small eyes have microphthalmia. A lot of children have refractive disorders. They include Hyperopia (farsightedness). This occurs when the eye is too short and the rays of light from near objects are not focused on the retina. Myopia (nearsightedness), this occurs when the eye is too long and the rays of light from distant object (Ward & Johnson, 1997).

Colour blindness, defect of vision affecting the ability to distinguish colors, occurring mostly in males. Color blindness is caused by a defect in the retina or in other nerve portions of the eye. Total colour blindness, in which all hues are perceived as variations of gray, is known as achromatopsia or monochromatism. Partial colour blindness, called dichromatism, consists generally of the inability to differentiate between the reds and the greens or to perceive either reds or greens; infrequently, the confusion may involve the blues or the yellows. The vision of most colour-blind people is normal in all other respects. In addition, colour-blind people can generally learn by experience to associate certain colours with varying sensations of brightness. Consequently, many victims of the defect are unaware that they are colour-blind. Several types of tests have been devised for the rapid diagnosis of colour blindness and of the particular variations of the condition (Ward & Johnson, 1997).

2.1.6 Attitude of People towards Persons with Visual Impairment

Attitude issues in the life of people with visual impairment are of great importance. Both those who are disabled and those who support people with disability face attitude problem. For example, the researcher's friend on a visit could not accept drinking water in the house because it was an environment of a school for blind children. The friend is a teacher by profession. Supposing he is to teach the child with blindness geometry, definitely he would not cope.

Sardegna and Paul (1991) found that cultural expectations of "normality" have put pressure on impairment. National Institute for Visual Handicapped [NIVH] (1992) found that a lot of literature review showed that the maladjustment of persons with visual impairment is not due to actual visual impairment but due to the attitudes of the sighted toward the blind and due to the emotional stress placed on them by the sighted in social situations.

Any person with visual impairment who wants to read mathematics especially geometry has never been whole-heartedly accepted at any level that he indicated interest in reading the subject. He is often met with resentment by the school authority or the department. As Nemeth (2006) confirmed, that such people are often of the view that person with blindness cannot cope with the subject.

2.1.7 Nature of Attitude

According to Ozoji (1991) attitude is a tri – element concept. This simply means attitudes are made up of three inter – related parts (Ozoji, 1996). They are our beliefs, our feelings and our behaviours or actions towards a person, or object.

Webster dictionary defines attitude as a measured disposition, feeling, and position with regard to a person or thing. It is a learned predisposition to behave in a consistent evaluative manner towards a person, an object or a group of objects. This evaluation can be favourable or unfavourable, positive or negative directed to certain people, issues or institutions (as cited by NIVH, 1992, p.83). From the history of the education of children with blindness in Nigeria, people have come across the educational provision of the "blind" without mathematics. Therefore any thought of teaching mathematics to the "blind" in Nigeria will be met with negative attitude. This is because attitude can be a relative enduring organisation of beliefs around an object or situation predisposing one to respond in some preferential manners (Ozoji, 1991). Someone who once heard a nasty story about or had a nasty encounter with a person with blindness would always respond to people with blindness nastily. This is because of an earlier exposure or experience. The earlier educational provision without mathematics to children with blindness is seen as the normal. Also any little experience of difficulty in trying to teach mathematics to the children with blindness would be concluded that it is impossible teaching them mathematics.

Attitudes are social but not static. They are formed in social groups and are about other people and can affect our relationships with others. Some societies are more accommodating to persons with blindness than others. This depends on their thinking and feeling based on their beliefs. Attitude may involve a prejudice in which we perceive an issue or person without giving unbiased consideration to all the evidence. This prejudice leads to an unrealistic judgment based on inadequate grounds (NIVH, 1992). Just because people have never seen a person with blindness offers mathematics that means people with blindness cannot offer mathematics.

2.1.8 Attitude Formation

There are several ways by which people form attitudes. Ihenacho (1985) stated that attitudes can be learned from our cultural heritage, which is transmitted as part of socialization. A proverb amongst the Ngas people of Plateau state states that “A le gyem Zhi ba wak ale gyem po wat bul” This simply means “For you to give birth to a Mentally Retarded child, it is better to give birth to a child that is a thief” This is an expression of rejection of children with mental retardation that is socially propagated through a proverb. A child that steals is preferred to the one with mental retardation. This expresses how worst the situation of a child with mental retardation is amongst these people. There are numerous beliefs about people with blindness such as that they are musical, dependent, and helpless or beggars. Some of these beliefs originated from our cultural heritage, rooted in mythology and religious beliefs while others are related to limited experience with persons with blindness.

Obani (1982) collected and synthesised the beliefs of many Nigerian cultures regarding people with disabilities. Some of these beliefs are that the child is born with disability because of a curse on the family or the wider community for offences against God or the gods. It could be as a result of anger of the ancestors or ancestral god for neglect or breached promises. The child could be punished also for offences committed in a previous incarnation. Other beliefs are that people become disabled because of offences against the laws of the land or breaches of custom, and also due to wicked acts of witches and wizards. Therefore the child with disability is denied access to education and the few that gain access; they are denied certain parts of the curriculum like mathematics. Many parents do not want to mix their children in the same school with children with blindness let alone solve mathematical problems with them.

In contrast some cultures have a more positive attitude towards persons with disability. Ogbue (1981) stated that the Yorubas see the child with disability as EMERE a representative sent by the gods for brief period. In such cultures great care is taken of the EMERE both to prolong his life as long as the mother is of child bearing age, thus preventing his reincarnation to the same mother. They prevent him from begging, as this would bring down the wrath of the god he represents on the whole community. Obani (1982) referred to Levine's statement that in traditional Igbo society titles and status are earned by accumulating wealth and by merit. An Igbo, thus is what he is on his own merit, so if a person with disability achieves success in business or other spheres of life he is absolved from his disability. If he fails, then his family must provide for him, as it would disgrace the whole family if any member of it were reduced to begging.

Ojo – Eweka (1974) stated that in the Midwestern state of Nigeria the extended family has a traditional responsibility for "disabled" members. In rural areas the whole community will help a farmer with disability to clear, plant, weed and harvest his farm. Ojo – Eweka feels that although this might look positive, there is the danger of the person being pampered and over protected. Therefore the attitude of people in Nigeria ranges from being negative to positive. There are instances of neutral attitude. The researcher in an experience to support a "blind" candidate read mathematics, in every institution that the student went indicating that he wanted to read science or mathematics despite strong objection by majority of the staff, there were usually a handful that tend to support the idea. Sardegna and Paul (1991) revealed that other ways in which the society develops and maintains stereotypes about disabled people are through superstitious beliefs, fairy tales, folklore, comic books, literature, religious beliefs, the media and many charity organisations that serve persons with disabilities.

NIVH (1992) listed a number of ways the formation of attitude occurs. Many attitudes including prejudices begin in childhood and often are not adopted through personal experiences with the object or event in question. Such attitude could be learned through instruction. Attitude can be learned through imitation of others. If parents have a positive attitude towards something and the child identifies with his parents, he is likely to adopt a similar attitude even without being told that the activity is agreeable, and even without direct experience. Human beings learn much behaviour by observing others and noting the consequences of their actions. Observational learning is an important influence on attitude in many situations (p.85).

Generally the societal attitudes towards persons with blindness can be summarized in two perspectives. There are those that conjure up a picture of helplessness, hopelessness and misery. There are those that endear the blind with extraordinary intellectual and spiritual powers. The first attitude is negative. It focuses on what persons with blindness cannot do rather than what he can do. This category includes people who consider persons with blindness as: helpless, hopeless, useless, foolish, miserable, living in a world of darkness, to be feared, avoided and rejected (NIVH, 1992). Others are immoral and evil beings living in a world of darkness, to be feared, avoided and rejected. Coping with such negative attitudes is often a greater challenge to the person with blindness than coping with the impairment itself.

The second societal attitude towards blindness is a positive one. The persons with blindness are often considered heroic and admirable. This category includes people who believe that the lack of vision endows an individual with supernatural abilities, such as sharpness of hearing, and touch or some artistic ability. In ancient times people were viewed and revered as prophet and interpreters of dreams. Most often children with blindness who offer mathematics are seen in the same manner. This attitude works to the disadvantage of persons with blindness when they cannot meet unrealistic expectation.

People with blindness are often judged either negatively or positively. Most often the judgment is negative when a blind person reads or intends to read mathematics. The resistance or lack of resistance of teachers, parents and school authorities for a person with blindness to read mathematics depends on the attitude of the individual, which in turn depends on the source of their attitude formation.

2.1.9 Personal Attitude of the Visually Impaired Persons towards Visual Impairment

Ozoji (1991) showed concern that much studies on attitude in Nigeria have been towards one direction, the attitude of people towards the persons with disability and its negative effect on them. However, he notes that attitudes of persons with blindness towards the effects of their handicap are of significance. NIVH (1992) gave some main attitudes blind people may have about their blindness. There are those who view blindness as a disaster. They recognise blindness as a severely limiting impairment, which requires reorganisation in all aspect of the individual's functioning. To such person, you cannot talk of teaching them mathematics. This is impossibility in their life.

Visual impairment could be viewed as a nuisance or practical inconvenience. They attribute social prejudice and discrimination as basic to the adjustment process. They believe that it is not for the person with blindness to adjust to his handicap but it is for the society to adjust to the person with blindness. For such person, until you get all the sophisticated equipment or gadget that a person with blindness requires, you should not be thinking of him offering mathematics. Such persons would require that until you take them abroad, there could not be any local effort made to teach them mathematics.

There are those who believe that visual impairment imposes no limitation whatever. They tend to be aggressive and their attitude verges on hostility towards the society. They are often over confident and always on the look out to prove to others that their impairment imposes no limitation. Such people are better in trying to teach them mathematics. They will never give up until they achieve.

2.2 MATHEMATICS AND SPECIAL NEEDS CHILDREN

The researcher on several occasions found out that people are dismayed at the mention of mathematics (geometry) with special needs children. The attitude also is that people wonder as to why a person with visual disability should think of offering mathematics.

2.2.1 Interest of Learners with Visual Impairment in Mathematics

Abraham Nemeth was born blind, and later became a renowned scholar of mathematics. He created the Nemeth code for Braille mathematics in America, and became a Professor of mathematics for 30 years at the University of Detroit. Nemeth retired in 1985 (Nemeth, 2006). He once was told that the field of mathematics was too difficult for people without usable vision. His experience was that after he graduated from high school, he entered Brooklyn College. Nemeth wanted to major in mathematics, but his guidance counsellors insisted that it was too technical a subject for a blind person. His guidance counsellors complained that mathematics notation was too specialized, that volunteer or even paid readers would be difficult to recruit and that he would never get a job in the field of mathematics. According to Nemeth he complied with them and he backed down. After obtaining a degree in psychology and was not satisfied with that, he went on to take a second degree in Mathematics area of his interest. This was a demonstration of the effect of positive attitude towards developing intrinsic interest in mathematics that enabled a learner with visual impairment to be able to read mathematics despite discouragement by other people.

Ramesh (2006) discovered that children with visual impairment could learn mathematics when they were taught in an appropriate manner by making necessary adaptations in the curriculum without altering the learning outcomes. Ramesh further stated that with special efforts, and conviction of the teacher teaching the children with visual impairment mathematics, an effective application of methodology, and useful adaptation techniques enabled children with visual impairment achieved the same learning outcomes. This was why special education was involved in the teaching of mathematics to special needs children.

However, the learning of mathematics especially geometry is always considered to be difficult and is a complex process even for the non-disabled children. Centre for Teaching/ Learning of Mathematics [CTLM], found out that worldwide, mathematics has the highest failure rates, and lowest average grade achievements. The Centre also added that almost all students regardless of the school type or grade could not perform in mathematics on par with their intellectual abilities (as cited by Ramesh, 2006). Ramesh was of the view that if mathematics for the sighted children would be difficult, the same for children with visual impairment would further be compounded due to loss of vision. It would even be worse in the case of geometry. However the teaching of mathematics to children with visual impairment has undergone transition over a period of time, resulting in optimistic views toward learning of mathematics by children with visual impairment. The researchers' experiences with teachers in the primary, post primary and tertiary institutions who thought it was impossible for children with visual impairment to offer mathematics showed that they were beginning to see how feasible it was and were beginning to be optimistic about it. In reality, it is not the difficulty of the child with visual impairment to understand mathematical or geometry concepts, but it is the difficulty of the teacher teaching mathematics or geometry to make suitable adaptations in teaching the concepts (Ramesh, 2006).

O'Connell and Johnson (2006) stated that in 2001, President Bush of the United States of America signed the No Child Left Behind (NCLB) legislation. This was incorporated in the Individual with Disability Education Act (IDEA). O'Connell and Johnson further stated that no child was exempted from offering mathematics instead it was made as a compulsory requirement for graduation at different levels in different states in America. They cited example with California that, all students now need mathematics in order to pass the Californian High School exit examination to graduate with a diploma.

Similarly the Nigerian National Policy on Education has promised the provision of adequate education to persons with disabilities (FGN, 2004). There can never be adequate education without mathematics. The need to pass mathematics at the credit level to qualify for admission into the Nigerian Universities needs not be overemphasized. A research into teaching and learning of mathematics by special needs children should be viewed with great importance in the world in general and in Nigeria in particular.

Ramesh (2006) admonished that the effective application of methodology, and useful adaptation techniques would enable children with visual impairment to achieve the same learning outcomes. Special education is an education that meets the needs and provides the knowledge and skills that are necessary in achieving general educational goals for people with impairment (Sardegna & Paul, 1991). Special education is all about adaptation and modification of general or standard curriculum. It involves changing the educational content, methods of instruction or teaching techniques, instructional materials, environmental factors (O'Connell & Johnson, 2006)

The Department for International Development [DFID] (2006) defined special educational needs in Africa as the extra support provided by schools, colleges, universities, government education and health department for students who may be unable to follow a mainstream curriculum because of a learning disability. The children that benefit from the special education include: children whose general intellect and ability to learn is significantly restricted compared with that of majority of their peers. It covers a considerable range: from children who can communicate readily in words and who can read and write, to children with no ability to use language. DFID further stated that Special Education also includes the provision of special institutions or schools that cater for a specific sensory impairment (eg blindness). These may include schools for the visually impaired and hearing impaired or unit attached to mainstream schools.

Special education therefore is about children or youth who have impairment of different types and severity, which cause learning difficulties. Children with disabilities have peculiar learning difficulties that except the modified instructional methods and materials are used, none of the regular teachers can easily understand them or teach them mathematics and other subjects especially at the lower level where a lot of concentration is on concept development in the subject area. Many friends and colleagues in mathematics and the sciences find it difficult to understand why a person in special education should do a research in mathematics since they cannot see any relevancy between special education and mathematics

Researches in mathematics in the area of special education are on the increase. A lot of efforts are being made in the various areas of special education to see that all categories of children with special needs can offer mathematics. The outcome of these researches was found to be not only useful for children with special needs alone, but have resulted in great improvement in the other children in regular schools (Ramesh, 2006).

2.2.2 Attitude of Learners with Visual Impairment towards Mathematics

Veld (2010) stated that in Netherland, the government encouraged more young people to specialise in mathematics; however the challenge faced was in teaching the subject to persons with visual impairment. It is often said that it is impossible for students with visual impairment to participate in mathematics lessons on equal ground with their sighted peers. Veld observed that students with visual impairment have the same talents as their sighted peers and some have a real talent for mathematics. However veld stated that many teachers and other professionals see mathematics as unsuitable option for learners with visual impairment. They are unaware of the possibilities that even higher level mathematics could be taught to learners with visual impairment. This negative attitude in turn influences the beliefs of the learners and so they admit that mathematics is not a course for them to offer. Often this negative attitude is as a result of ignorance. Some people have wondered as to how a person with visual impairment would tackle mathematics formulae or read and draw diagrams without sight.

Velera (2010) reported that in Peru; Mathematics is a core subject in primary and secondary education. However there was reluctance to accepting children with visual impairment in their classroom for mathematics. Velera in an interaction with many of the teachers documented common questions that came from these teachers who believed that children with visual impairment could not do mathematics and this also in turn made the children to strongly believe that mathematics was not a subject for them to offer. Some of the questions the teachers asked were: How could you introduce mixed numbers and fractions? How would you introduce diagram? How would you introduce calculations with mixed terms? How would you introduce computation to a blind student? How would you teach graphs to a blind student?

There are certain barriers to teaching and learning of mathematics by learners with visual impairment. Most of these barriers are responsible for the learners forming negative attitude towards mathematics. Chander (1992) stated that although lack of vision is a constraint to learning mathematics, but to a certain extent, inappropriate teaching methods and non-availability of learning materials make the problem. Gupta (1999) thought that fear and negative attitude towards mathematics was due to horrifying myths people held about mathematics. Some of these myths are that mathematics is difficult. Recently a student who had credits in all her subjects in senior secondary school certificate except mathematics rewrote mathematics examination three times but did not pass. When she went to write the examination for the fourth time, as she stepped into the SSCE examination hall to write mathematics again, she collapsed and fainted. She was on the hospital bed for two weeks.

Veld (2010) mentioned some of the factors that cause difficulties for persons with visual impairment in learning mathematics as such they develop negative attitude towards the subject. There are very few people with the skills in teaching learners with visual impairment mathematics. Mathematics Braille code is difficult to master so there is lack of Braille mathematics code knowledge.

Vel in mentioning some of the factors that are responsible for children with visual impairment having negative attitude towards mathematics states that the teachers do not have the time and patience to give the amount of individual explanation children need or the time to check that the student has understood the concept. A frustrating aspect of teaching and learning mathematics is in the lack of Braille mathematics text books. They are more difficult to produce and the codes are difficult to interpret. Vel reported a case of a student with visual impairment who in a mathematics class could not see the board but was asked to sit in front. She was passively pretending nothing was wrong and not participating because the teacher did not communicate with her. The student believed if when she was sighted and could barely pass mathematics when she could use paper and pencil how on earth could she do mathematics without those necessities? Her anxieties were reinforced by the discouraging comments by some teachers who informed students with visual impairment that they do not belong to their mathematics classes.

All these have helped in making learners with visual impairment develop negative attitude towards mathematics. Hill and Jurmang (1993) created an acronym that mathematics teachers of learners with visual impairment should always keep in their minds “KISS”. It simply means “KEEP IT SUPER SIMPLE”. It takes a lot of time in presenting the simplest concept in mathematics especially geometry with a learner with visual impairment.

2.2.3 Achievement of Learners with Visual Impairment in Mathematics

In mathematics for the child with visual impairment, he needs the opportunity to learn tactile discrimination, names of shapes, Braille numerals, numeral names and how to make and interpret tactile graphs. The child can explore objects, discuss their properties and learn counting strategies that promote accuracy **(**Petreshene, 1985).

According to Ramesh (2006) one of the major objectives of teaching mathematics is to develop computation skills, to emphasize logical thinking and to enable the child to participate in day-to-day activities of the family and community. To practically support that, Petreshene (1985) stated that children with blindness can participate in early mathematical experiences through encouraging the child to involve in hands on activities including such chores as table setting that promote counting and one to one correspondence. All these concepts are present in both orientation and mobility and in mathematics.

Petreshene further stated that a "number line" made of stairs could be used to teach the concept of signed numbers. The teacher should take the students to a landing between floors, with stairs going up and down. The landing is zero. The stairs going up from the landing are positive numbers, while the stairs going down are negative numbers. Have the student go to "positive seven" (+7), or seven steps up. Then ask the student to add a "negative nine." To do this, ask the student which way is negative? When the student responds "down", asks the student to move down nine steps, and to tell where the student is in relation to the landing [he is at "negative two" (-2)]. The student can relate what he has experienced with the number sentence "+7+-9=-2." This process can be continued with additional addends of both positive and negative value. In orientation and mobility, this is the skill of ascending and descending a staircase.

In order for students to calculate using the four basic operations, they must first have developed basic concepts (including more, less, many, etc.), one to one correspondence, the concept of sets, and basic number sense. According to Smith (2006) as students begin to learn to calculate, the following teaching considerations should help:

Emphasize concept development rather than process or rote memorization. To observe that angles are not affected by the length of their rays, students can place items such as the long cane perpendicular to the floor and use their Braille protractor to measure the right angle formed, noting that one ray (the cane) is much shorter than the other (floor).

To demonstrate the concept of correct movement of the decimal point in metric, the student can use a paper plate as a "dancing decimal point." A group of students can stand in a row, each with an assigned number. The paper plate decimal point is moved between each student, either to the left or to the right, depending on whether there is a change to a larger metric unit or to a smaller metric unit. For example, students could be named with each of the following digits: 2, 5, and 9. To have the number represent 259 meters, the decimal point plate can be placed to the right of the 9. Then, to change to kilometres, the decimal point plate is moved three places to the left, before the 2, representing 2.59 kilometres, and so on. If there are not enough students, lined up chairs could also be used.

A lot of researches have been done in mathematics for primary school children with visual impairment in the area of mathematical computation. It is very important that students see mathematics, and the calculations they perform, as part of their daily life. Providing opportunities to apply basic concepts and operations in daily activities will reinforce students' skills and motivate them to progress in mathematics. (Petreshene1985).

Napier (1974) found that the step-by-step progression in content from grade to grade throughout elementary schools in terms of mathematics for both seeing and children with visual impairment is the same. However, the methods and materials are likely to be different. An important goal of elementary school mathematics is the development of number concepts or numeracy (Hart, 1989). Kamii (1981) stated that the numeration systems have been developed to record numbers and to perform calculations. For example Duncan, Gapps, Dolciani, Quast, Zweng and Gleason (1975) in presenting basic concepts and skills in primary school mathematics show different ways in which numbers are presented. They stated that numbers or sets could be joined like

4 plus 3 equal 7

$4 + 3 = 7$

The 3 and the 4 are addends. When a child with visual impairment is to do this operation on the abacus he needs to clearly identify the addends. First the child needs to set the first addend and then does the operation of the addition by setting the second addend to the first addend.

Numbers or sets could also be separated.

7 minus 4 equal 3

7 - 4 = 3

“7” is the sum.

The child with blindness should understand that in subtraction, he first set the sum or what he first set is the sum and it is from the sum that he deduct the given figure to get the second figure which if added to the given number, it will give exactly the sum he has just first in doing the separation. Similarly, when numerals are presented as follows:

4 + 2 = 6 and 8 - 2 = 6 are equations.

Numbers could be represented as inequalities 5 < 7 or 7 > 5,

They could be families of facts (13 + 5 = 18),

Expanded numerals 50 + 6 or compact numeral (56)

Addition, subtraction or any of the four basic mathematics computations done in equation or vertical form order of numbers etc. Kamii (1981) stated that computations in this system are eminently sensible and easy to perform. This aspect of mathematics is important and crucial in the life of the child with visual impairment. The ability to read and write the Braille mathematical notations for the five mathematical notations and the Braille symbols for inequalities are derived from the literal Braille. Braille numeracy or numbers are identical with the first ten letters of the alphabet and are preceded by a special sign in Braille. This means that a child with blindness has to learn two symbols for each number (Tooze, 1973). The implication of this for a learner with visual impairment is that the same ten letters of the alphabet which make the first ten Arabic numerals are the ones dropped down in position and they make up all the punctuation marks in English Braille and the drop letters are preceded by certain Braille dots to make the basic mathematical symbols. Also these dropped ten letters of the alphabet which when preceded by the numeral sign form the first ten Arabic numbers if dropped and preceded by the numeral sign, will form fractions. When a learner with visual impairment attempts to record arithmetic on the Braille writing frame, it is necessary for him to reverse his paper in order to read what he had written. This makes the recording of figures and computation of mathematics difficult or almost impossible for a learner with visual impairment. Also mathematical computation is difficult for a learner with visual impairment to be done vertically.

For the past several hundred years mathematics has been typically presented on the printed page in two dimensional format with symbols printed not only horizontally left or right across the page but also vertically above and below in superscripts, and subscripts. Admittedly this allows the traditional printed form of mathematical expressions to be quite compact. Tooze (1973) stated that this makes it extremely difficult to record mathematics in Braille. He stated that they felt that their area of inquiry should be into more efficient ways of recording mathematics Braille (p.63).

Sighted children use Hindu - Arabic numbers or figures. According to Hart (1980) the Hindu - Arabic numeration system enables children to deal with types of mathematics, which were utterly impossible. For this when you compare using Roman numeral with the Arabic numeral in terms of difference is like between walking and flying. Hart (1980) stated that by analogy mathematics is fundamentally the same whether written in the German, French, Arabic, Chinese, Spanish, Greek, or English (p.1).

Similarly Kamii (1981) stated that when you compare computation in the past medieval times the modern algorithms make the arithmetic operations (addition, subtraction, multiplication and division) accessible to almost everyone. It is therefore much more convenient computing using the Arabic numeral at the primary level. However, the graphic mark or squiggles in Arabic numbers for sighted are not the same with the shape of embossment in Braille mathematics notation. This creates some differences for a child with visual impairment in recording numerals and in mathematics computation. This situation has set experts in special education for ages in search of the equivalence of paper and pen or pencil for a figure and conveniently computing figures in mathematics.

Common Basic concepts that are found both in mathematics and orientation and mobility skills: (and language to describe them) Size and space relations “bigger than…” “Less than…” Sequencing (ordering) by size, by quantity 1 to 1 correspondence in counting, classification – matching to sorting based on certain characteristics. Others are early awareness of shape and size and awareness of surfaces and faces - pre-area, sorting of three-dimensional shapes and sorting of two-dimensional shapes. Others are capacities sets grouping. seriation, length, pattern – arrangements, coordinate – peg, area, time etc.

Salisbury (1974) warned that emphasis should be laid at the primary level on understanding the properties of the basic operations in mathematics. This comes after basic concepts are developed. Salisbury further stated that the importance of a good foundation in the fundamentals of mathematics cannot be too greatly stressed in the education of learners with visual impairment (p.20).

A simple observation of special schools for children with visual impairment shows that, although there are teaching aids that could be used for practical presentation of mathematical concepts they are not used. Children with visual impairment lack spatial concept due to lack of sight. This calls for predisposing the child with visual impairment to basic mathematics concept before exposing the child to formal mathematical concepts. The basic addition - subtraction facts are those with both addends less than 10 (Duncan, Gapps, Dolciani, Quast, zweng, & Gleason 1973). When one uses these addition and subtraction facts and the place value system of numeration, one can add or subtract numbers of any size. All that is needed there is to memorize them. For example:

2 + 1 = 3

2 + 2 = 4

4 + 3 = 7

7 + 2 = 9

3 - 1 = 2

7 - 4 = 3 etc.

This principle is used when using the abacus for mathematical computation by the learner with visual impairment. In the use of abacus sometimes you add more than what you wanted to add so you must know how much more you have added in excess and then reduce the excess. Similarly you could subtract more than what you had desired to subtract so as to balance your subtraction. Where you have subtracted in excess, you add back the excess number you subtracted. Duncan, Gapps, Dolciani, Quast, zweng and Gleason presented the following basic concepts in mathematics:

Two place addition. Use two steps to add. (a) e.g. 47 and 26

7 + 6 = 13. Write 3 in the one’s place, I in the tens place.

$$\begin{array}{r} 47 \\ \underline{+\ 26} \\ 73 \end{array}$$

1 + 4 + 2 = 7

Write 7 in the tens place.

```
   47
+  26
   73
```

Different method

```
   47
+  26
   13
   60
   73
```

In using the Cranmar abacus for mathematical computation, the different method is used.

Three place addition

```
524
198
 12
110
600
722
```

ii. Properties of addition

(a) The commutative property.

The order of the addends does not affect the sum.

4 + 3 = 7

3 + 4 = 7

These are concepts that learners with visual impairment need to be told because they do not have easy access to these computations as to enable them easily see the patterns involved.

The number line on the learner with visual impairments desk could be used. Also the upstairs climbing could be used to practically show the properties of addition to a learner with visual impairment.

(b) The Associative property.

The grouping of the addends does not affect the sum

(4 + 3) + 2 = 7 + 2 = 9

4 + (3 + 2) = 4 + 5 = 9

(c) The Zero addend property.

The sum of zero and another number is the other number.

iii. The opposite property.

Addition “undoes” subtraction

Subtraction undoes addition

4 + 3 = 7

7 - 3 = 4

7 - 4 = 3

Learner with visual impairment will need help in understanding these concepts in life.

iv. The commutative property and opposite property are used to form families of facts.

4 + 3 = 7

3 + 4 = 7

7 - 3 = 4

7 - 4 = 3

v. Word phrases.

The sum of three and four.

vi. Word sentences,

The sum of three and four is seven.

The sum of three and four is less than eight.

vii. Number sentences

$3 + 4 = 7$

$3 + 4 < 8$

In our special residential schools, the teachers emphasis the computational skills and so they most often avoid word, phrases and sentences when solving mathematical problems. Many authors emphasize the need for basic mathematical concept in the life of both sighted and learners with visual impairment. Adetula (1981) observed that although at the foundation level, the bulk of teaching work is on the basic operations (addition, subtraction, multiplication and division) they are taught with so much drill and practice such that they are mere repetition or procedure thereby ignoring understanding.

Similarly Chander (1992) stated that lack of preliminary experiences at home result in lack of readiness of the learners with visual impairment mathematics in the primary classes. They should be given adequate experiences and skills in processes like classification, serial number, matching, comparing etc which are required for subsequent learning in mathematics. Chander further states that the latter formal work in mathematics will be on insecure foundation if the children with visual impairment are not guided through these preliminary activities.

It is advisable that before the teacher adds a new mathematics concept to the child, the teacher should clarify the child’s present concepts. He should move the child from concrete to abstract level. The children should arrive at an intuitive grasp of the mathematics concepts through experience with concrete and semi concrete material adapted for their use.

Textbooks are also sensitive issues in the learning of mathematics. Adetula (1981) stated that textbooks have a profound influence on a student learning mathematics. Adetula warned that mathematics textbooks can be vehicle for delivering all learning experience. A key to success in teaching and learning of mathematics by the learner with visual impairment is the availability of Braille mathematics textbooks. Therefore the chance for guessing is 25%.

The teacher teaching mathematics to the learner with visual impairment is very important. Ramesh (2006) advised that an effective teacher of mathematics for children with visual impairment needs to be abreast of:

1. Effective teaching methodologies
2. Use of mathematical devices such as abacus
3. Mathematical Braille codes
4. Suitable adaptation techniques without affecting the learning outcomes
5. Preparation and effective use of teaching learning materials
6. Technology aiding mathematics education

2.2.4 Challenges of Learners with Visual Impairment in Mathematics

Jurmang and Hill (1992) found out that the first Nigerian with visual impairment to enter secondary school Bitrust Gani from 1957 – 62 made a division one in West African School Certificate of Education with a credit in Agriculture Science did not sit for mathematics. Other Students with visual impairment who followed his footsteps in teachers colleges and secondary schools shunned mathematics. It was on this background that an expatriate the then head of mathematics department at boys' secondary school Gindiri decided that students with visual impairment in the 1980 intake to the school would attend mathematics classes. The students concerned were shocked and dismayed. One of them was overheard telling learners with visual impairment from the Gindiri teachers college "We have got a mad white woman at Boys Secondary School (BSS), she is trying to teach us mathematics, but blind boys' brains can’t do mathematics – everyone knows that!” This forcefully expressed opinion was the opinion of almost everyone at the time. The expatriate teacher encountered such resistance from learners with visual impairment form one students (aided and abetted by their seniors). At that time she only insisted on the students attending mathematics classes in form one, after which they were allowed to drop it.

A student who was in form two became visually impaired and received rehabilitation in reading Braille, came to BSS and started in form two. He was the first student with visual impairment that agreed to offer mathematics at the Junior Secondary School Certificate and came out with a “P” grade. This incident opened up room for a little of positive attitude change of students with visual impairment, their teachers and the public.

Dinglip Emmanuel Karami got admitted to BSS in 1985/6 academic year. He took mathematics with great enthusiasms. When the time came for choosing options in senior secondary school, staff of the school objected to him offering mathematics and the science. They wanted to push him to the arts traditionally studied by learners with visual impairment. When his continues assessment that was sent to the Ministry of Education was examined his marks in the mathematics and the science revealed that they were not only the best in his class but in the whole of his set. Later his Junior School Certificate Examination results confirmed his class in mathematics and the science. He scored four in mathematics and a VG 2 in integrated science. When he entered Senior Secondary School, his Physics Teacher who was skeptical about the boy’s offering mathematics and sciences displayed the first obvious sign of attitude change when he told of the success of the boy. At the end of his SSCE he got a “P” in mathematics at the second sitting. He got credits at the first sitting in all the other science subjects.

After this success, the researcher with an expatriate teacher took the campaign to so many schools in Plateau State. It took a lot of persuasion. This resulted in students with blindness in many more secondary schools offering and obtaining a pass at the Junior Secondary School Certificate Examination. These schools include: Government Secondary School Barkin Ladi, Girls Secondary School Gindiri, Nakam Memorial Secondary School Panyam, UTFC Jarawan Kogi. Others are Government Secondary School Rim and Government Secondary School Dengi.

Emmanuel entered the University of Jos, he encountered similar resistance from the lecturers. First he was not accepted at the remedial department on ground that they have never seen a blind person offers sciences. The researcher with his former colleague in Gindiri had several meetings with the lecturers. To convince them, they were persuaded that as scientist, it was going to be a research. If Emmanuel succeeds, is a proof that it can work. If he fails, then the research has succeeded in proving that it cannot work. At the end of first semester, many of the lecturers came whispering “your boy is wonderful”. At the end of the year, remedial department posted him to mathematics department. It was another utter rejection by mathematics department. The researcher had several meetings with the department of mathematics. He was allowed to register on the ground that if he experiences hardship, he will quietly withdraw himself. Today Emmanuel is the first learner with visual impairment in Nigeria to have read mathematics at the University level.

2.2.5 How Learners with Visual Impairment Learn Mathematics

Chander (1992) challenged the opinion that mathematics is often said to be a difficult subject even for the sighted. If it is that difficult, there is no need teaching and learning the subject by learners with visual impairment. The reason for its difficulty is that it is a subject involving abstract entities having little resemblance to real objects which could be handled. Chander argues that if mathematics were abstract as people often think, then it should be easier for persons with visual impairment to easily comprehend it. All those perceptual progress in life would not have been there to bother those with visual impairment. Therefore a learner with visual impairment needs successive interactions with basic experiences to arrive at the desired intuitive grasp of the concept.

According to Mani, Plernchaivanich, Ramesh, and Campbell (2005) pace of learning mathematics by learners with visual impairment is quite a problem. Their pace is comparatively slower than that of sighted children. They tend to have limitation in organising ideas, methods and devices used for solving mathematical problems. Learning the concept of the mathematical topic in question and its practical uses is more important than making him do the entire exercise.

Gupta (1992) stated that Learner with visual impairment can learn better if a visual idea is presented in the form of a non-visual experience. Any abstract concept when taught to the child supported by relevant non-visual teaching learning material will certainly arouse the interest of the learner and contribute to the learning of the ideas in a better way. Mani, Plernchaivanich, Ramesh and Campbell pointed six ways visual ideas can be changed into a non-visual experience. They include: clear verbal descriptions, written Braille materials, teaching devices and approaches. Others are modification in terms of content, method of display and situation. Orientation and mobility falls within modification of method of display.

Chander (1992) found that learners with visual impairment lack incidental experiences which his sighted counterpart can make use of. Therefore, they need successive interactions with basic experiences and suggestions to arrive at the desired intuitive grasp of the concept. Learners with visual impairment face the problem of learning mathematics due to inappropriate teaching methods and non – availability of learning materials. The use of conventional materials without adequate adaptation and methods which presume too much from learner with visual impairment can result in inadequate understanding of the mathematical concepts, relation and operations. (Mani & Mittal, 1999).

There are some basic geometrical concepts that can be presented to learners with visual impairment as adapted by Mani, Plernchaivanich, Ramesh, and Campbell (2005). The idea of “Ray” may be explained orally with the help of an embossed ray prepared on a sheet and the arrow indicates infiniteness. A line is straight and extends endlessly in both directions. The idea may be explained with an embossed line prepared on a Braille sheet. Line segment, a portion of a line with two end points, an embossed line segment prepared on a sheet may be given. A plain is a flat surface which extends endlessly in all direction. This can be explained orally. A side is a line forming the boundary of a plane. A circle has no sides because it is a closed curve. Its boundary is term as circumference. The idea of sides may be explained with the provision of different geometrical shapes like square, rectangle, rhombus etc made of hard board for the child to explore and understand horizontal and vertical concepts. Horizontal denotes any object which is parallel to the ground. Vertical denotes an object which is at right angle to the horizontal plane. Provide the child with visual impairment with sheet of paper in which two embossed lines meet at right angle and two others are parallel to each other. The embossed lines show that one line is perpendicular to the ground and the other is parallel to it etc. Ideas in geometry like: space and time should be linked with orientation and mobility training.

According to Gupta (1999) some myth have been generated about the utilisation, about abilities of the learners and generally they have been horrifying young learners.

Some of the myths are that mathematics is difficult, mathematics is a subject for bright children, every child can’t do well in mathematics, girls do poor in mathematics, and learners with visual impairment cannot do mathematics. Gupta adds that naturally a sense of prestige has come to associate with achievement in mathematics. Conversely misery comes to and through those who fail in the study of mathematics. Mani, Plernchaivanich, Ramesh, and Campbell (2005) opined that factors that can contribute to the success of learners with visual impairment learning mathematics include: selection and teaching of suitable mathematical Braille codes; adaptation of the text materials; mastering mathematical devices such as abacus and preparation and use of appropriate teaching aids

2.2.6 Challenges of Spatial Tasks on Geometry of Learners with Visual Impairment

According to Klingenberg (2007) emphasis on the knowledge of children with disabilities (visual impairment) has often been on delays in the development of the children (developmental lag) which causes educational set back in learners with visual impairment. However the understanding now on academic tasks like geometry for learners with visual impairment are on cognitive compensations which depend on spatial senses. Klingenberg (2007) revealed that it has been discovered that in the primary school, the development of the children’s skills and understanding in many topics depend on their spatial sense especially geometry. Similarly Kennedy and Tipps stated that many topics in higher mathematics especially mathematics require spatial thinking and manipulation of objects in space which provide background for understanding all aspects of mathematics (as cited by Klingenberg, 2007). On their part, Berthelot and Salin, (1998), explained that geometry as a subject and field of research is a theory of space. Spatial tasks therefore are demanded of all children, with or without visual impairment; and are found in all aspects of life and subject areas at school. Berthelot and

Salin refer to spatial properties or elements to include shape, size, distance, orientation, and relative location; measurement, estimation, positive and negative integers on a number line, map reading etc. However spatial tasks are said to be visual and this is the main challenge in the life of persons with visual impairment. Never the less, there are spatial concepts in orientation and mobility similar to concepts in geometry which could easily be used in presenting spatial concepts to learners with visual impairment.

Fletcher (1980) has identified theories which have existed for long on the spatial concepts of people with visual impairment base on age at onset of the impairment. There is the 'deficiency theory', which states that spatial concepts are impossible in people with visual impairment from birth. There is also the inefficiency theory which suggests that people who are visually impaired from birth develop concepts and representations of space but that they are functionally inferior to those of the sighted and the late blind. These theories and opinions have dominated the minds of educators of learners with visual impairment and they often simply think that people who are born visually impaired will perform lower than those that are born at later life on any cognitive task. In a study by Wan, Wood, Retunes, and Wilson, who investigated the performance of persons with visual impairment in a fibro tactile discrimination tasks; participants that were congenitally visually impaired did better than those who became visually impaired later in life. Congenitally visually impaired participants were more accurate than the adventitiously visually impaired learners (cited by Kapperman, 2003).

Kitchin, Blades, and Golledge (2014) wanted to find out whether people with visual impairments could understand geographic relationships such as distance, configuration and hierarchy. They reviewed a lot of literatures. Their findings were into three parts. The first was that there were opinions that congenitally visually impaired individuals were incapable of spatial thought because they have never experienced the perceptual processes (e.g., vision) necessary to comprehend spatial arrangements. The second opinion stated that people with visual impairments could understand and mentally manipulate spatial concepts, but because information is based upon auditory and haptic cues this knowledge and comprehension is inferior to that based upon vision. The third view suggested that people that are visually impaired possess the same abilities to process and understand spatial concepts and that any differences, either in quantitative or qualitative terms, can be explained by intervening variables such as access to information, experience or stress. The researcher observed that spatial tasks often given to learners with visual impairment through non visual means are in different forms. There are tactile tasks which are often two dimensional in nature like trailing an embossed line or map with the finger (feeling); these maps or diagrams are made of strings or ropes glued on a piece of cardboard. There are three dimensional tasks which demand for haptic task (grasping) which demands for holding the object in the palm and thereby grasping and observing it with all the fingers. Haptic task demands for identifying the surface or face of the object, the edges and the joints or the apex of the object which is more demanding than touch or feeling a line with the finger. If a research work is only based on tactile task, there is the likelihood that congenitally visually impaired learner will perform creditably well. In using applied orientation and mobility programme (APOMP) as a method, both the process of feeling and drawing lines on polythene sheets on rubber mats and grasping three dimensional objects are involved.

There are views that even though a congenitally visually impaired person may not have visual memory of things around, they have other ways of forming mental imagery of things around. According to Hupp (2003) cognitive theorist stated that visually impaired people develop different cognitive pathways to acquire process, and accommodate sensory information. Therefore persons with visual impairment may "think differently" than sighted individuals. The findings further suggested that congenitally visually impaired individuals have developed alternative methods of cognitively processing nonverbal, abstract, or complex information, especially information involving spatial orientation.

Cohen, Haven, Lanzoni, Meacham, Skaff, and Wissell (2014) using a software system that displays a drawn graph on a Tablet PC and uses auditory cues to help learners with visual impairment navigate graph; ten participants, three of whom were congenitally visually impaired and seven of whom were adventitiously visually impaired were involved. The researchers investigated achievement differences between participants who were congenitally visually impaired and those who were adventitiously visually impaired. The research found a significant difference between the overall time and total error count of those born visually impaired and those who became visually impaired after. However, there was no significant difference between the error and time ratio displayed by the congenitally and adventitiously visually impaired.

On their part, Ungar, Blades, and Spencer (1996) reviewed a number of studies and found that children who lost their sight early in life perform less well on a variety of spatial tasks than sighted children or children who lost their sight later in life. However in a research on the construction of cognitive maps by children with visual impairments, it was found that visually impaired participants in these studies perform very similarly to sighted participants, with the exception that reaction times tend to be rather slower for congenitally visually impaired participants. Therefore there are variations on performances of congenitally visually impaired learners and adventitiously visually impaired learners on different academic tasks base on the nature, type or process of task.

Wikipedia (2014) states that visual memory is a form of memory which keeps some characteristics of our senses pertaining to visual experience. We are able to place in memory visual information which resembles objects, places, animals or people in our mental image. Wikipedia further stated that different parts of the brain have different functions when it comes to geometrical tasks. For example the occipital lobes process colours and shapes. Cognitively people experience object memory. This is the processing of features of an object or materials such as texture, colour, size etc. The logic therefore is that children who have not developed their visual memory skills cannot readily reproduce a sequence of visual stimuli. Therefore the existing controversy is that if much of spatial and geometry tasks depend on visual memory, how can a learner with visual impairment and especially those with congenital visual impairment grasp spatial or geometry concept since they have no visual memory? The researcher is of the view that a learner with visual impairment can through applied orientation and mobility programme experience spatial memory which has to do with the ability to move around the space in a given environment, and have contact with objects in the environment to develop what would have been referred to as "visual memory" or object memory through other remaining senses. However where the task demands for the use of the retina only to determine the characteristics of the object like colour, this is where a learner with visual impairment cannot have direct contact with.

Proulx (2014) in a research at University of Bath found that congenitally visually impaired people mentally visualise their number line from right to left e.g. 5,4,3,2,1 instead of 1,2,3,4,5. This is because persons with congenital visual impairment map the position of objects around in relation to themselves. Replicating the research, an international team from Bath, Sabanci University (Turkey) and Taisho University (Japan) compared responses of congenitally visually impaired people, with the adventitiously visually impaired and sighted, but blindfolded the sighted persons. They found out that congenitally visually impaired people mentally visualise their number line from right to left. Despite visualising numbers oppositely when it comes to mathematical (geometry) algorithm, there is no difference in performance between the congenitally and adventitiously visually impaired (Proulx, 2014).

The researcher is of the view that we all form visual memory of things we have never seen in life the moment the thing is mentioned. A visually impaired student in agriculture class had read, received lectures and written several examinations on the "back of a tree" and pass. All this while nobody had shown him the back of a tree until one day one of his teachers peeled off the back of a tree and showed the student by touch. The student exclaimed oh! is this the back of a tree? The student must have formed visual memory of the back of a tree his own way in the past which helped in his numerous easy writing on the back of a tree.

2.2.7 Mathematics Anxiety

According to Tobias (1993), mathematics anxiety simply refers to feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations. Similarly Ashcraft (2002) define mathematics anxiety as the feeling of tension, nervousness, or fear that disrupts mathematics performance. Tobias mentioned specific areas of mathematics that students usually experience anxiety. Students experience mathematics anxiety during examination or testing period. This is known as mathematics test anxiety. Some students when confronted with any form of computational exercise, they show mathematics anxiety. This is number anxiety. There is the fear of mathematics as a course. The learner gets terrified or fears taking mathematics as a course. This is mathematics course anxiety. While Wells (1994) describes math anxiety to cause one to forget and lose one's self-confidence, Tobias feels that mathematics anxiety can cause one tension that can interfere with manipulation of numbers. Perina (2002) discusses the feelings that mathematics anxious students experience such as, a paralyzed feeling towards numbers or a sense of panic when given a math test or test in general.

Ashcraft (2002) observed that mathematics anxious student who performs disappointingly on a mathematics question, could have done so due to mathematics anxiety or lack of competency in mathematics due to mathematics avoidance. Ashcraft stated that student with mathematics anxiety can perform well on a portion of test that is not difficult. However when they experience performance mathematics test that becomes increasingly more mathematically challenging, they experience inaccuracy due to mathematics anxiety.

Students who experience mathematics anxiety avoid any situation or condition that will make them involved in any mathematical calculations. In giving the implication of having mathematics anxiety, Ashcraft stated that the moment a student avoids mathematics, the student becomes less competent, gets no or less exposure in mathematics and will not practice mathematics as required. Therefore there is a negative correlation between mathematics anxiety and confidence and motivation in mathematics (Ashcraft, 2002, p. 1).

2.2.8 Causes of Mathematics Anxiety

There are a number of factors considered as responsible for causing mathematics anxiety in learners. According to Bluman and McGraw-Hill (2011), there are realities to mathematics anxiety amongst children. The symptoms could physically be seen in children some of which are: nervousness, pounding heart, rapid breathing, sweating, nauseousness, upset stomach; and tenseness. There are also the mentally exhibited mathematics anxieties Bluman and McGraw-Hill listed as: a feeling of panic or fear, cloudy or fuzzy thinking, lack of concentration, a mental block in thinking; and feelings of helplessness, guilt, shame, inferiority, or stupidity.

According to Williams (1988), mathematics anxiety has its roots in teaching and in teachers of mathematics. Williams stated that because people generally are not mathematics anxious before going to school, mathematics anxiety is related to the teaching of mathematics and the notion that mathematics is something to be feared begins in the child's first years in school. Teachers and others often state that mathematics is difficult and should be feared. Tobias (1993) reported that too often teachers play a role in telling people about some nasty myths about mathematics. The teachers emphasis that mathematics ability is only found with gifted children and that not all students are good in mathematics. The first exposure children have with mathematics will be with their primary teachers who are often not trained in mathematics and who are also anxious about mathematics (Harper, 1994; Posamentier, Smith, & Stepelman, 2009).

Supporting the view that teachers are responsible for cause of mathematics anxiety in children, Bluman and McGraw-Hill (2011) stated that teachers are the core reasons for causing mathematics anxiety in children. They stated that mathematics teachers differ. Some are good, some are bad and there are those that are not trained. Some teachers dislike mathematics while others do not understand the subject. When teachers are forced into teaching mathematics especially under these conditions, they will not teach well. There are instances where teachers have caused trauma in children through teaching mathematics. A child that was called to the blackboard to solve a mathematics problem in front of the whole classroom and was unable would experience trauma. Worse is after being unable to solve the problem, the teacher belittles the child for inability to solve the problem. Sometimes it ends up in the child receiving punishment. Children who are punished for not doing their mathematics homework experience trauma. There are instances where teachers, parents or even peers make the children feel stupid on mathematics. Such experiences result in trauma that can cause the children to fear and hate mathematics for the rest of their lives. Many mathematics teachers begin their lessons with insult of the students. They tell the students how stupid they were and that they did not know anything and confirmed their failing the subject. Bluman and McGraw-Hill reported a case where a teacher teaching fraction, picked the child up by his ankles and turned him upside down to illustrate the concept of inverting fractions. This caused great fear of mathematics in the child.

Koca and Sen, (2006), stated that the attitudes of students toward a particular lesson results in their interest and success in the subject. This could be seen in the intrinsic interest Abraham Nemeth developed in mathematics and eventually became a Professor of mathematics despite all discouragements. Koca and Sen confirmed that some students have negative opinion about mathematics (geometry) because of negative behaviours of teachers or wrong experiences. Students who develop mathematical anxiety in schools often learn it from their teachers who are themselves anxious about their mathematical abilities.

According to Bluman and McGraw-Hill (2011) children are not supposed to miss any mathematics class in school. Where this happens especially constantly, the child will fall far behind and will not cope and so ends up failing. The reason for this is that mathematics is a cumulative subject. What you learn today you will use tomorrow. If a child fails a topic because he or she was absent, when the time comes to use the material to learn something new, the child will be unable to do so. For example, to do long division, it involves multiplication and subtraction. The child must know how to multiply and subtract before doing long division. All processes of mathematics are like that.

Hilton and Pedersen (1983) asserted that math avoidance is a serious issue that has many causes, which can be grouped under three headings: societal, familial, and cultural influences; pedagogy; and curriculum. Causes for mathematics anxiety can include socio-economic status, parental background, and the influence of teachers and school system (Hackett, 1985; Kutner, 1992).

Goulding, Rowland, and Barber (2002) are of the view that there is relationship between a teacher's lack of knowledge of the subject and ability to plan teaching materials effectively. Teachers that do not have a sufficient background in mathematics may struggle with the development of comprehensive lesson plans for their students. In a separate research by Laturner (2002) teachers with certification in mathematics are more likely to be passionate and committed about teaching mathematics than those without certification. However those without certification vary in their commitment to the profession. The teacher's attitude is a big factor in mathematics anxiety. When students feel confident at the teacher's handling of mathematics; that encourages even students with difficulties with the subject to take risks. Therefore positive support from the teacher is essential to student with mathematics anxiety.

Posamentier, Smith, and Stepelman (2009) are of the view that most often teachers are compelled to teach mathematics. Such teachers present mathematics in a tensed or strained tone of voice. In such situation, the subject is presented in a tough or difficult manner usually within a short period of time. It is taught as a drill or memorization exercise rather than thinking/problem-solving processes most often as a punishment. This has scared many of the students to participate in mathematics.

2.2.9 Teaching Method can Cause Mathematics Anxiety in Children.

According to Kail and Zolner (2005), the principles of mathematics are generally understood at an early age. Children at those early years do counting in a more sophisticated manner by adding and subtracting numbers using fingers which exposes them and makes them comprehend a lot of principles underlying counting. This becomes a habit in them however they later begin to use a more refined and efficient strategies. The children begin to perform addition and subtraction mentally. As time goes on, they begin to retrieve answers to mathematical equations from memory. Children with visual impairment need to be exposed to methods using their fingers like in Chisanbop method and the use of Cranmar Abacus. What these children need is proper instruction to enable them acquire basic mathematical skills and are able to solve more complex mathematical problem with more sophisticated training.

According to Furner and Gonzalez-DeHass (2011) mathematics is taught as a right or wrong subject. Getting the right answer is vital. Mathematics problems almost always have right answer. The subject is often taught as if there are right way to solve the problem and any other approaches would be wrong, even if students got the right answer. Furner and Gonzalez-DeHass stated that when learning, understanding the concepts should be paramount, but with a right or wrong approach to teaching mathematics, students are encouraged not to try, not to experiment, not to find algorithms that work for them, and not to take risks. They were of the opinion that teachers benefit children most when they encourage them to share their thinking process and justify their answers out loud or in writing as they perform mathematics operations. With less of an emphasis on right or wrong and more of an emphasis on process, teachers can help alleviate students' anxiety about math”.

Oberlin (1982) discussed the following teaching techniques as causes of mathematics anxiety: (a) assigning the same work for everyone, (b) covering the book problem by problem, (c) giving written work every day, (d) insisting on only one correct way to complete a problem, and (e) assigning mathematics problems as punishment for misbehaviour.

On his part, Crawford (1980) enumerated a number of factors responsible for lack of success in mathematics in students. These factors include: poor mathematics instructor, insufficient number of mathematics courses, unintelligible textbooks and lack or misinformation about what mathematics is and what it is not, as well as who should do well in mathematics.

NCTM (1995) lamented that the traditional forms of mathematics assessments, such as paper-and-pencil tests, right and wrong answers, timed tests, and following only one right procedure to solve problems, are an ineffective way of assessing students mathematically. NCTM suggested that teachers should incorporate more qualitative forms of assessment as well as group assessments, portfolios, rubrics, and observations. On their part, Furner and Berman (2002) had as a main focus ways to prevent and reduce mathematics anxiety. A great point that they made is that teachers need to get an understanding of what their students are going through in mathematics by journaling and talking with their students. Furner and Duffy commenting on the role of a teacher in teaching mathematics stated that having a supportive and positive teacher can make a world of difference in terms of learning mathematics.

There are other variables that intervene on the cause of mathematics (geometry) attitude on mathematics achievement. The variables include intelligence quotient (Blair, Gamson, Thorne, & Baker, 2005; Bull & Scerif, 2001; Evans, Floyd, McGrew & LeForgee, 2002; Grissmer, 2000) and motivation for mathematics (Khoush-Bakht &

Kayyer 2005; Yunus & Ali, 2009). This view states that mathematics (geometry) requires a certain degree of intelligence to cope with the subject. However culture is a factor in determining performance in mathematics. In a comparative research by Stevenson and Lee, (1990), they found out students in Canada scoring lower in solving mathematics problem and operations when compared with students from Korea and Singapore. Similarly parents in Taiwan and Japan strongly believe and place more emphasis on effort rather than one's innate intellectual ability or being gifted. The parents therefore set higher expectations and standard for their children. Stevenson and Lee found out that these children in Taiwan and Japan value homework more than children in America. Therefore while people in United State believe that only a few gifted individuals have what it takes to learn mathematics and that hard work cannot compensate for this, Asian parents rather point to hard work than ability. If a learner with visual impairment has in addition intellectual impairment, the teaching of geometry or mathematics will become a little bit challenging. Learners with visual impairment will need a lot of motivation to succeed with geometry.

Many students taking mathematics courses have negative attitudes toward mathematics that can be described as mathematics anxiety or feeling of tension or fear that interferes with mathematics performance. Mathematics anxiety is one of the common attitudinal and emotional factors that have attracted attention in learning the subject. Over the years, studies have shown that mathematics anxiety is a highly prevalent problem for students in learning mathematics (Baloglu & Kocak, 2006; Betz, 1978; Jain & Dowson, 2009; Ma & Xu, 2004; Rodarte-Luna & Sherry, 2008; Alamolhodaei, 2009). As reported in the literature review, a student who has pass in all other subjects at credit level in her senior secondary school examination, for three years kept repeating mathematics and was failing. When she entered the hall for her fourth mathematics examination and on receiving the question paper, she collapsed and fainted and was rushed to the hospital. She was on admission in the hospital for two weeks. This was as a result of the fear she developed for mathematics. Mathematics anxiety has been directly or indirectly, affecting all aspects of mathematics education as one of the most commonly investigated factors in mathematics education (Catlıoglu, Birgin, Costu, & Gurbuz, 2009).

Several people have described the aspect of attitude that has to do with the feeling of the learners towards mathematics (geometry) in different ways. Dreger and Aiken, state that mathematics anxiety is the presence of a syndrome of emotional reactions to arithmetic and mathematics (as cited by Klingenberg, 2007). Fear for mathematics is equated to a disease or illness. Learners under such condition could be seen shivering as if they have fever but it is just fear of mathematics. At the mention of mathematics, you have spoiled the day for the learner.

Tobias and Weissbrod (1980) describe mathematics anxiety as panic, feeling of unassisted, paralyzed and mental disorders when students want or they are made to solve an arithmetical problem. Here mathematics fear is equated to or resulting in mental disorders. This is a very serious issue pertaining teaching and learning of mathematics (geometry). Mathematics or geometry teaching does not end at method of teaching alone, but most importantly the attitude of fear for the subject should be given a serious consideration. On his part Tobias (1993) sees mathematics anxiety as a situation which shows itself with emotional stress and anxiety when the individual is faced with cases such as solving arithmetical problems or doing operations with numbers in either his school or everyday life. This anxiety state can cause amnesia (memory loss) and loss of self confidence. Mathematics (geometry) which is supposed to be an enjoyable subject is often faced with ambiguity, frightening and challenging situations. Bessant (1995) warns that mathematics anxiety is not an isolated phenomenon as it originates and persists within a complex learning process it goes with serious long-term effects. Experts in teaching of mathematics (geometry) should be taught the implication of attitude towards the subject by their students so that they can help them better. A whole curriculum should be developed on attitude in relation to mathematics. Hembree (1990) in reviewing a number of studies on mathematics anxiety done over several years found out that in 151 studies, mathematics anxiety is related to poor performance on mathematics. Chipman (1992) reported that mathematics anxiety is negatively correlated with students' interests in a scientific career regardless of their level of mathematical skills. Therefore mathematics anxiety can spread to other areas or disciplines. Mathematics is said to be the language of all other sciences. Any negative attitude towards it will therefore affect performance in science areas.

Kitchens (1995) described mathematics anxiety as a disease. Kitchen stated that the symptoms of mathematics anxiety could be diverse. It includes nausea and stomach-ache, a 'blank' mind, extreme nervousness, inability to hear the teacher and noise sensitivity, inability to concentrate, and negative self-talk. Individuals with high mathematics anxiety perform worse than their low-mathematics anxious peers in solving difficult mathematical problems (Ashcraft & Kirk, 2001; Ashcraft, & Faust, 1998; Ashcraft, Krause, & Hopko, 2007; Alamolhodaei & Farsad, 2009). All these attitudes components could be observed amongst learners with visual impairment through their remarks and show of hatred for the subject.

Mathematics tasks are often bound to time. In a given short amount of time, the learner is expected to finish solving the problem and to submit the answer to the examiner in the examination hall. Ashcraft and Moore, (2009) stated that students who are used to solving problems without time restrictions might develop anxiety if told they need to solve problems quickly. Ordinarily learners with visual impairment are expected to have extra time during every examination. The extra time for mathematics might be twice what is given in other courses. This can be more with geometry.

There are several factors that can contribute to non participation of learners with visual impairment in offering mathematics especially geometry. The use of paper – pen in arranging mathematical problem for step by step solving or sketching the geometry diagrams is difficult or not possible with a person with visual impairment. The instruments or equipment to use are difficult to come by. Braille mathematics text books are often not available so the learner does not know how to get the information of problems in mathematics. Sometimes the Braille mathematics code is not available. This is because it is a specialized version of Braille code which often not many people especially teachers or transcribers are conversant with.

Considering all the above mentioned issues affecting the attitude of learners with visual impairment towards mathematics or geometry, attitude issues seem to have great influence on learners with visual impairment in learning mathematics or geometry. There is need for attitude change approach to those that have developed negative attitude towards mathematics or geometry. There is also the need to intensify or increase positive attitude in those that have it towards mathematics or geometry.

2.2.10 Materials for Teaching Children with Visual Impairment Mathematics

For decades, persons with visual impairment and their teachers have striven to develop better methods and strategies for the study of mathematics (Chander, 1992). There are two essentials for the student with visual impairment of mathematics. The first is a comprehensive system of notation, capable of expressing all mathematical relationships neatly and concisely. The second is apparatus, primarily to take the place of the pencil and paper, which enables the seeing student of such a subject as geometry to draw the picture of the problem that he seeks to solve, and so to have something, concrete before him (Gupta, 1992).

According to Napier (1974) the step-by-step progression in content from grade to grade throughout elementary school in terms of mathematics for both seeing and pupils with visual impairment is the same. However the methods and materials are likely to be different. When seeing children first come to school, they bring certain learning on them based on prior number experienced, which are acquired incidentally. On the other hand children with blindness lack such incidental experiences and thus fail to develop concepts as their seeing peers. The child with blindness therefore functions at a lower level of readiness.

Nolan and Bruce state that computation processes can be either written or mental (cited in Tooze, 1973, p4). Numerals are used in both instances and written computation is for one or two purposes:

- To arrive at an answer when one cannot accomplish the same via mental approaches.
- To communicate or demonstrate to someone else. The teacher communicates on the chalkboard, while students demonstrate in housework or tests.

2.2.11 Mental Calculation

According to Gupta (1992) for long people with visual impairment rely on their mental capacity for any arithmetical computation. Teachers often dictate figures for their pupils with blindness for computation. A lot of learners with visual impairment have shown great skills in computing mentally. The method can be employed at anytime and anywhere. No paper or instruments are required. However it requires a good memory.

Very often learners with visual impairment, who use their mental skills in computation, are faster than their sighted peers who write down every figure before solving the problem. However mental calculation has a lot of limitation especially when the problems involve many digits. Mental calculation opens up opportunity for only those that are bright or have good memory. A backward child or a child with poor memory will not be comfortable. Also mental work is difficult to check by anyone. This is because none of the steps have been recorded and usually it is only the final answer is shown. The user will have no clue as to at what point he made a mistake for correction sake.

Napier (1974) stated that sometimes the format in mental arithmetic is different from that in written computation. In mental arithmetic procedure, computation generally begins with operation of big numerals, progressing towards digits.

An Example of mental format is shown in fig. 1a and of written format is shown in figure 1 b.

Fig. 1a mental format

  123
x 456

400 x 100=	40,000
400 x 20=	8,000
	48,000
400 x 3 =	1,200
=	49,200
50 x 100 =	5000
	54200
50 x 20 =	1000
	55200
50 x 3 =	150
	55350

6 x 100	=	600
		55950
6 x 20	=	120
		56070
6 x 3	=	18
		56088

Figure 1b. Written format for solving 123 x 456

Example of written format:

```
    123
    456
    738
  615
492
56088
```

This format is very difficult to a child with blindness to present for lack of paper pen equivalent. Although a Braille Writer would have helped in doing the sum, the Perkins Brailler is out of reach of many special schools let alone individuals owning it. When a child with blindness shows different format from his sighted peers is usually because of the difference in the computational device used. The use of abacus results in difference in format.

2.2.12 Braille Writer

Experience has shown that the Braille Writer is useful for writing down mathematical problem step by step. According to Nemeth (2006), although the "blind" have been taught mathematics for over half a century, it was not until the advent of an upward writer that useful progress was made. Before this time, the only machine for writing braille produced dots on the reverse side of the paper.

The machine that is now universally used in schools is the Perkins brailler. The user has to practice shifting of the carriage. Also the most complicated expressions in mathematics notations could be written using the writer. Nemeth stated that the feedback in the process of using writing Braillewriter is immediate. He stated that to operate effectively with a Braillewriter, one must be a skilled and accurate Braille user. Nemeth was congenitally and totally blind and was fortunate to have been taught Braille at an early age. Nemeth (2006) stated that he used the braillewriter as the exclusive device by which he performed mathematical calculations and manipulated mathematics expressions. Nemeth stated that on a braillewriter, the dots appear on the topside of the paper where they can be immediately read. This allows for the rapid alternation between reading and writing which is required when interacting with mathematical expressions, and is the closest thing to the use of a pencil and paper used by the sighted (p.2).

It is not necessary to turn the paper over to check any portion of what has been done. Unlike slate, which you write upside down and you Braille to turn the paper before you are able to read. Mathematical problems can be arranged just as is done with pencil and paper. However, very often the use of numeral or number sign is dropped. According to Chatters (1986) without a number sign which shows that you are using figures and not letter a note is usually indicated somewhere to show that the letters of the alphabet “a” to “j” are number one to nine and Zero.

Doing mathematics at a more advanced level will require the use of two Braille Writers. There is need for Braille writer for rough work and the other for setting out the final work. However the cost of a Perkins Braille writer has put it beyond the price range of many families. The machine is heavy especially for the little children. It will be more inconveniencing where you have to use two. The arrangement of the figures requires constant pushing of the machine forward and backward. It demands for counting the cells. According to Napier (1974) the Perkins Braille writer is more suitable than other Braille writers. This is because rolling the paper up and down does not crush dots or cause the paper to become misaligned.

2.2.13 Talking Calculator

According to Goodrich, Benneth, and Wiley (1977) calculators are machines used in computing figures. They are used as computing or calculating devices and not for the actual teaching of mathematics. They are not for actual teaching of mathematics to the child. They give immediate feedback within a short time. They are easy, fast and accurate. However the user needs to know the appropriate method of operation.

Hill and Jurmang (1993) stated that when using a calculator, it is the machine that works. The child simply sets the numbers and all the answers come out. A student being introduced to a particular operation for the first time will not really understand how to do them if he uses a calculator. A more advanced talking calculator like the scientific ones that have many functions are difficult to obtain. But they are essential for higher-level mathematics.

Hill and Jurmang observed that as computer application became more and more common; small battery - powered calculators for use by sighted individuals were developed. Experience shows that such small calculators were costlier when they were first introduced to the market. However they are cheaper now than before. They further stated that similar small battery - powered calculators, which now have voice synthesizers, are available for "blind" and vision users. The prices are much higher than comparable calculators for sighted users. The scientific calculators with voice synthesizers would definitely be costlier. When Goodrich et al did a research on the desirability of persons with blindness on calculators, they found out that majority of people with blindness expressed the need for them to own a calculator. On the preferred output of calculators, majority of them opted for voice calculator. When the persons with blindness were asked whether they would need more mathematical functions than addition, subtraction, multiplication and division, majority of them said they wanted more mathematical functions. They also express the need for portable calculators than non-portable.

2.2.14 Taylor (Type Slate) Frame

One of the outstanding figures in the history of the early education of persons with blindness was the Rev. William Taylor. He is remembered as the inventor of the Taylor Arithmetic frame, with its star-shaped eight-angled holes, and metal type. About 1918, Mr. Henry Maryn Taylor introduced algebra type for use with the Taylor Arithmetic frame (the invention of his namesake many years before). For many years the Taylor frame was the only piece of apparatus used for the teaching of mathematics. In spite of its use, it is described as cumbersome appliance, comparing very unfavourably with the pencil and paper of the seeing mathematician. It was only rarely that the boy or girl with blindness progressed further than a working knowledge of elementary arithmetic. Even today, most people with blindness of average education will admit that when they leave school days behind them they also discard the Taylor frame, though it is hoped that the recently devised cover for the frame, which enables the board to be carried about without disarranging the type, may make it of more practical service. According to the Taylor frame was in much use. This apparatus, useful though it has proved to be, has definite limitations for higher work.

However the most problem with the Taylor slate today is that the metallic cubes are found to contain lead base. This is dangerous to the health of children with blindness using the frame. Since when this was discovered, schools have ceased to use it and companies have stopped producing it. Many African countries are still using it. Some have made adaptations or modifications by using plastics or wood (Chapman & Stone, 1989).

2.2.15 Cubarithm

Cubarithm is a slate or board holes or depressions apartments that plastic cubes could be inserted into the holes to fit. The cube faces contain dots indicating the Braille letters of the alphabets, which are used as numbers. One of the faces of the cube has an embossed bar which is used in different positions to indicate the five basic mathematics operations (Addition, Subtraction, Multiplication, Division and equal sign). Mathematics problems would be written on the slate by arranging the cubes. Once the problem is set and solved on the slate, it could be recopied into a paper. If a number has not been written correctly, the student can take that particular cube out and put it back correctly. Mathematics algorithm could be done vertically and horizontally; it provides immediate feedback from any part of the problem (CBM, 1991).

It is sometimes difficult to find the right face of the cube that is needed. For example when number "8" is turned in the right direction it becomes a four, when turned in the left direction it becomes six and when turned to face 8 and itself is zero.

Cubarithm is suitable when the child stays at a desk or table to work. But it is not convenient when he must carry it from place to place with complete work on it because cubes turn easily in their holes or may spill out altogether. The cubarithm is now generally recognised as superior to the Taylor frame, mainly because its cubes are in braille notation, so that a new code is not necessary. Tooze (1973) traced the invention of the cubarithm back to 1886. It came to being as a result of efforts to replace Taylor's frame. This is because Taylor's frame does not carry any actual number (Fletcher 1973).

2.2.16 Abacus

According to Gissoni (1977) abacus for centuries was used as a computer of arithmetic and the present day modern digital computers are based on it. The ancient

Roman traders were thought to have spread the use of abacus. It was first used in the sixteenth and seventeenth centuries when writing materials such as pen, ink and paper were in short supply. It was when these materials became plentiful that people stopped using abacus and they started solving arithmetic problems in written form. The part of the world that is found to still use abacus in the 20^{th} Century is China and Japan.

A modified abacus for the use of people with blindness is known as crammer abacus. This is a rectangular frame made of wood, plastic or metal. Anchored to the frame are thirteen rods or columns. Recently a few have been extended to fifteen rods. Each rod has five beads, which travel back and forth. Attached across the frame from one breath to the other dividing the frame into two unequal parts is a bar. This is named “Separation bar”. It divides the five beads on each rod placing one bead at the top part and the other four beads at the bottom. The face of the separation bar contains dots after every three rods counting from the right to the left. The dots are used as decimals.

Cook (1993) advised that in teaching basic skills for the use of abacus to the person with blindness there is need to look at hand and finger position. There should be proper flow of beads. When adding a series of two digit answers, users of pencil and paper or any form of written arithmetic do their addition from right to left hand side. Using the abacus especially by students with visual impairment, it is observed that addition is more conveniently done from left to right and there is no need to carry any number at all.

It is important to outline the equipment available. elementary arithmetic, the cubarithm and the abacus are extremely useful tools, though the cubarithm is perhaps more useful in primary schools and the abacus, being small enough for the pocket, can act as the person with blindness' equivalent of the rough working a sighted person is able to do.

2.2.17 Chisanbop

When using a Chisanbop one starts by using the fingers of right hand. The values assigned the fingers of the right hand are the same as those assigned the beads in the extreme right column on the abacus. The small finger, the second finger and the index finger all on the right hand are assigned the value of one each. The thumb represents a whole “five”. The thumb plus all the other four fingers in the right hand make a total of nine.

On the left hand, the fingers are assigned a higher value. The small finger, second finger, middle finger and the index finger of the left hand are assigned the value of ten each. The thumb on the left hand forms a sum of fifty. The total value of the five fingers on the left hand side is 90. Exchanging fingers of the right hand for those of the left hand follow the same patterns as those defined by the secrets of abacus. E.g. adding one to nine requires the simultaneous raising of one finger on the left meaning 10 and clearing the right hand.

In solving the problem 2 + 4 one raises two fingers on the right hand thereby giving two. In the process of adding four one raises the thumb giving five and brings down one finger thereby clearing one. The answer will be six. In Chisanbop the finger motions are much simpler than the manipulations required setting and clearing the beads on the crammer abacus.

Most calculating systems rely on special equipment, however in Chisanbop the tools are part of the user. Therefore they are constantly present. One does not need to familiarize the student with a new instrument. There is no need for purchase of the equipment. The problem with Chisanbop is that after working out the problem, one just has to memorize the answer before recording since it is the same fingers that solved the problems that will be used to record the answer.

It was a Korean mathematician Sung Jin Pai, an authority on the use of abacus, that designed the system. This was because it was found out that the beads on abacus were difficult for some children with blindness to manipulate. Those who have small or weak hands or limited coordination and control of their hands do not do well with abacus. Although Chisanbop and abacus have many similarities and produce identical results, it appears that Chisanbop would be used with multiply disabled visually impaired children. He also found out that sighted children take interest in it in an integrated situation. They tend to integrate the more when they use their hands together to compute mathematically.

2.2.18 Local Adaptation of Mathematics Equipment

Lack of textbooks and suitable equipment are often cited as reasons for failure to fully involve students with visual impairment in mathematics lessons. The specialist equipment for the "blind" are only found abroad. If our students with visual impairment are to be able to fully participate in mathematics lessons we need to find local alternative to imported equipment and to make them widely available.

According to Hill and Jurmang (1993) much standard measuring equipment can have tactile markings added. Notches can be cut with a razor at 1 cm intervals on a standard wooden ruler. Tape measure can be adapted by punching holes or fixing staples pins at 1 cm (1 inch) intervals. "T – squares" "set squares" and 'protractors' can be made from wood and supplied with tactile markings by hammering cut – off pins at 1 cm or 10 degrees intervals. A flat piece of wood with holes bored at 1 cm intervals makes an adequate compass for drawing arcs and circles. Using a smooth rubber mat certain sorts of polythene sheet and Braille stylus, pencil or "dead" biro raises fellable line.

2.3 CHILDREN WITH VISUAL IMPAIRMENT

2.3.1 Signs of Visual Impairment

Abang (2005) listed series of signs of visual impairment that people, parents and non professionals can easily observe and identify in children. This is often seen through the behaviour of the individual. When you observe and see a child keeps rubbing the eye excessively, it is an indication that something is wrong with the eye. A child will always shut or cover one of his eyes. When he or she does that continuously, you should suspect some sign of impairment in the eye. Some children who have problem with their eyes will often tilt or trust the head forward. Some inability of the child to read is due to problems in the eye and not because the child does not know how to read. Therefore if the child has difficulty in reading, it is good to check the problem from the eye. There are some works that will require close use of eyesight if a child has difficulty with that, it means the eye has problem. When a child blinks more than usual observe for possible problems in the eye. Some become easily irritable when doing close work. When a child bumps or stumbles over objects is an indication of some visual problems (Hyvarinen, 2003).

Werner (1999) listed what he refers to as things that could mean a child has a seeing problem. They include: eyes or eyelids become red, they have pus or they continuously form tears. The eye could be seen to be dull, wrinkled; cloudy or the eye could have sores. When the pupils (black centre of the eye) look gray or white is a sign of eye problem. Other signs of blindness as enumerated by Werner include children who squint their eyes or squeeze their faces in an effort to see. Some of them hold books too close to the eyes. It is an indication of problem in the eye. When a child is unable to see distant things clearly, it is another indication of problem in the eye. There are children that sit close to the television before they see it. Some in a movie theatre, they have to sit close to the big screen so that they will watch the film. Visual problem can manifest through poor eye-hand coordination and clumsiness. Sometimes the appearance of a child can indicate visual problem. Sometimes shabby appearance is due to eye problem. Other signs of visual impairment are crossed eyes, swollen eyelids and inflame or watery eyes.

Kansas Department of Health and Environment [KDHE] (n.d.) listed visual screening guidelines for Infants, toddlers, children and youth in terms of appearance as having reddened eyes, watery eyes, encrusted (covered or coated) eyelids, droopy (tired or worn out eyelids) and difference in size of eyes. In observing behaviour, KDHE mentioned abnormal sensitivity to light, rubbing of eyes frequently, blinks excessively or rarely blinks, turns head so as to use one eye only to look at object in front of child and covers or closes one eye frequently, thrusts head forward or backward while looking at distant objects, squints, frowns or scowls when looking at objects “or reading”. Other areas of observing for possible visual problems as stated by KDHE are: the child’s complains. The child may complain of headache, nausea and/or dizziness. Eyes hurt, experience burning, itching, or tearing of eyes. There is blurring or double vision.

Rahi (1998) stated that the presence or absence of specific symptoms and signs should be determined. When you observe and see eye-poking, recurring sty that is the child keeps seeing rings. Some of signs of visual impairment are itching eye. The eye burns or you feel scratchy. When a child complains that he does not see well it means something is wrong with the eye. Sometimes dizziness, headache or feeling nausea following close eye work are all signs of eye problem. Gilbert (2001) gave a list of signs of visual impairment as: Tropia. This is when the eyes turn inward or outward or one eye is slightly higher than the other eye. When the eye looks crusty or the child has red eyelids, matted eyelashes, is known as Blepharitis. As you observe the eyes of the child, there is constant or rapid motion, this is called Nystagmus. It is an eye problem. There are drooping eyelids which may or may not interfere with vision. This is called Ptosis. Once you see that the child has very small or very big eyes or corneas are a sign of visual impairment. Cornea that looks cloudy is an indication of eye problem. Eyes that are red all the time or have a pitted yellowish surface and those eyes that are constantly watering, they indicate problem. Some people eyes do not close completely in sleep. Is an indication that the eye has problem. Sometimes a child with sign of problem in the vision is not interested in activities that require careful viewing. A child could be sensitive to lights or stares directly at light a lot. Children that poke their eyes frequently, is an indication of eye problem. The child that does not recognise familiar people consistently has eye problem. The child that uses hands to search for dropped objects or ignore dropped objects has sign of eye problem. Other signs of visual impairment include: history of visual impairment in a family. When a child is born with low birth weight or is premature birth, when the child did not cry at birth or trauma, all these are signs of presence of visual impairment.

Many children have been detected to have visual impairment due to these simple observations and most often such children have been attended to. The researcher observed a mother who brought a book to dispatch letters to the department of Special Education University of Jos. Her child was following her and holding her cloth by the side. From the tilting of the head, to squeezing of the face and the gray look of the eye balls, the researcher suspected eye problem in the eyes of the child. When the researcher confronted the mother about the possible eye problem of her child, she revealed more. The child had hearing impairment and a hole in the heart in addition. From that simple eye observation, the researcher ensured that the boy was admitted at Otana School. Today through the support of some workers in Central Bank, the boy was operated in the heart, had cochlear implant to take care of his hearing problem and the child had a heart surgery in the US. The child is back to school and enjoys play more than any child in the school. Simple eye observation could be done any body and that could bring help to the many children that exhibit sign of visual impairment.

2.3.2 Development of Children with Visual Impairment

Experience has shown that one of the problems in teaching learners with visual impairment is the difference in the age at onset of the impairment. Some are born with it, some acquired it during childhood and there are those who acquired it quite later in life. The period of onset of blindness is an important issue concerning adjustment and concept development in the life of a child with blindness (Napier, 1974). Blank stated that when a child loses his sight before he attains the age of five to seven years, the child cannot retain a useful visual imagery (as cited in Lowenfeld, 1974). That however those that were blinded after those years usually have memory of concepts of what they saw in the past. The only difficulty such children have would be on concept of current happening due to lack of current visual observations. This makes for difficulty in planning for school instruction like teaching of orientation and mobility and mathematics to such a heterogeneous group of children. Children with visual impairment who became blind early in life experience the world around them in a different way from the way their sighted peers view it (Napier 1974). The sighted children combine their vision with their other senses. Their “blind” peers rely only on non-visual senses in developing their concept of the world. Lahav and Mioduser (2006) referred to it as using the compensatory sensorial channels as an alternative to gather information. This situation places sighted children at an advantage over their colleagues with blindness. The sighted children are abundantly stimulated by visual signals around the environment and this forms the best source of information, which they need for proper perceptual and cognitive development.

Emerson and Hatlen (1992) stressed this fact by stating that children with visual impairment experience stimulation that is less informative and it lacks the demand value of visual stimulation. There are therefore differences in the perceptual learning of children with blindness as compared with those of sighted children. It is in view of this, that William and Loretta (1992) warned that children with blindness posse deficiencies in the awareness of the environment, and they never become familiar enough with the world in which they live. This creates a big problem in their life in the area of learning, especially academic subjects that demand for early concept development in the related fields.

Early learning experiences set the stage for the development of mathematical skills. Children with normal vision are exposed by direct instruction and through incidental learning to a wide variety of experiences, beginning at birth (Napier, 1974). At least 80% of the information they take in from the world and around them is taken through vision (Hill & Blasch, 1980). For children who are “blind” or visually impaired to have equivalent experiences they must also be exposed to the world around them but in ways that will enable them to learn through senses other than vision (Napier, 1974). Lahav and Mioduser (2006) stated that at least at the perceptual level, the deficiency in the visual channel should be compensated by information perceived via other senses like the haptic, audio, smell and taste channels to a child with blindness.

On his part Kagan (1971) estimated that over 90 percent of learning, which includes mathematical concepts, during infancy, occurs through visual sense. Also Ramesh (2006) stated that, the role of vision is so vital during the early years of life to learn concepts. He suggested that teaching methodologies to children with blindness should include multi-sensory approaches. This means that the remaining senses are utilized to compensate the loss of vision. Ramesh said that this has resulted in success stories in teaching mathematics to children with blindness in spite of visual impairment.

2.3.3 Perception Development

Emerson and Hatlen (1992) described perception as the collection of processes through which we acquire the information contained in the stimulus energy that we experience. They added that perception is a process by which we obtain first hand information about the immediate environment through the use and integration of the functional sensory receptors. To collect this information from the environment one has to be aware of events occurring in the environment and a discriminative selective response to the immediate environment through the functional senses.

Environmental stimulation is so vast and varied that the individual receives more information than he is able to process. According to Gibson (1987) the different perceptual systems specialize in different tasks. Different types of stimulus energy excite them and they have different functions. Different kinds of information are provided by the different sensory stimulus. These differences are important for the understanding of perception. Therefore it will not augur well to lose any of the sensory modalities.

Foulke (1987) opined that it is necessary to compare perceptual systems in terms of the types of information they can provide, and in terms of the quantity and quality of that information made to be sensitive due to different kinds and ranges of stimulus energy supplied by the environment. Very often the sense of sight is being referred to as the queen of the senses indicating its relative importance when compared to other senses (Foulke 1987). The process of perception starts from the process of seeking the relevant stimulus in the environment. The sense organ is brought into proper relationship with the stimulus energy that is being sought for. Also the process of seeking of the stimulus by the sense organ is controlled by the Central Nervous System (Emerson & Hatlen, 1992). The Central Nervous System uses stored information got from past experiences to select the targets of seeking behaviour. It then controls the impulse that controls the muscles involved in seeking (Foulke, 1987). This is why an earlier learned concept can bring to memory or aid understanding a new concept being introduced to a child. Perceptual development is related to objects, imitation, classification, knowledge of time and gender, making analogies and comparison (Gibson, 1987). Perception is a core process in the acquisition of concepts, including basic mathematical and orientation and mobility concepts, skills and processes. Neustadt (2006) suggested that it is widely agreed that orientation and mobility (O&M) professional preparation programs must address the pre-cane foundations of O & M, which include the development of sensory awareness; sound localization; spatial concepts; and independent movement to assure effective navigation and safe travel. Proper handling of perceptual processes with a child with blindness can result in the knowledge of a lot of basic mathematical skills, and orientation and mobility, which are essential foundation for future mastering of the subjects.

2.3.4 Visual Perception

It is maintained that the human being is the most vision oriented of all living creatures, and most learning occurs through vision. Telford and Sawey (1977) stated that a typical classroom experiences are estimated to be 85 percent visual in nature.

According to Emerson and Hatlen (1992) visual perception is in most cases concerned with spatial systems. It involves the analysis of spatial patterns and for acquiring spatially distributed information. It acquires information about the extent of space, the distribution and movement of objects in space, the shapes, textures, colours etc. These are foundations for learning mathematics and orientation and mobility skills.

On his part Gibson (1987) suggested that spatial knowledge is our most basic knowledge. He is of the view that any reduced ability to interpret spatial data from an inadequate conception of space, causes limitation with far reaching ramification. Simpkins (1978) gave an example of how Piaget's friend used the concept of spatial organization in understanding number constancy. At the tender age of five, while playing with pebbles, he put them in a row and counted. He then counted the row backward. He put the pebbles in a circle and counting again and was surprised to find there were still ten pebbles each time he did the counting. Garry and Accarelli stated that children with blindness irrespective of their chronological age and intelligence quotient have difficulties in understanding and applying spatial concepts, which results in poor orientation and possibly mathematics concepts (as cited in William, & Loretta 1992).

According to Emerson and Hatlen (1992), there are a lot of advantages given in having vision. Vision enables an individual to gather direct sensory input at a distance from an object, to comprehend a total image of an object, and to process sensory information rapidly. Luminous energy from visual receptors is a rich source of information children need. Emerson and Hatlen state that due to lack of sight by a child with blindness his sighted peers are being bombarded with luminous energy, which is by far the best source of the spatial information that is vital for proper perceptual and cognitive development. They have no problem in reaching their stimulus energy. Therefore, the child with blindness seems to have a stimulation experience that is not as informative and lacks the demand value of visual stimulation (Gibson, 1987). Vision plays an important role in motivating an infant's environmental exploration. While a sighted child becomes aware of, is attracted to his environment and begins to have direct sensory experience with it, the part of the environment, which is available to the child with blindness, does not have the same stimulus and motivational value (Gibson, 1987).

While a lot of mathematical skills are incidentally acquired and mastered through spatial organisation in the environment by the sighted child, the child with blindness does not have such experiences due to lack of visual perception. The use of orientation and mobility could give the opportunity for such concept formation and the incidental experiences that could form the foundation in learning mathematics by the child with blindness.

Some very important concepts such as colour can only be conceived through vision. Lowenfeld (1974) expressed concern that colour perception, in particular, seems impossible to be performed by any other sensory organ other than sight. This is because it is strictly a function of the retina. The totally blind person can neither have the actual experience of colour nor any real concept of it. In the present day with the use of computer, a lot of mathematical works are more appreciated visually. Three-dimensional graphs and charts are beautifully presented in various colours. This aids understanding and evokes interest in the subject. A person with blindness is completely left out of this innovation.

Knoblock and Pasamanick (1974) warned that seeing cannot be isolated from children's postures, manual skills, coordination, intelligence, or even their personalities. Vision plays a primary role as a source of stimulation and integration of other sensory information in normal development. For example, the gross motor activities such as walking, running and jumping underlie the finer motor skills needed in Braille reading, and Braille mathematics reading (Sykes & Ajuwon, 1984). This is why candidates with blindness have additional subjects such as daily living skills and orientation and mobility taught them due to deficiencies in these areas.

Barraga (1983) insisted that children with visual impairment who have residual sight should be given visual perceptual opportunities through the provision of visual stimulation. No matter how little a visually impaired child can see, it is of great significance in his life. It will make a great difference when encouraged to use it especially in orientation and mobility and mathematics.

2.3.5 Auditory Perception

This is the sensory process that people with blindness are thought to use most. The auditory system makes it possible for the acoustical energy to reach the ears from all directions and over a considerable distance. It makes possible useful estimates of the distances and directions of sound (Hermelin & O'connor, 1975). However auditory perception doesn't go without its disadvantages Fraiberg (1975) explained that when sound sources are directly in front or directly behind a listener, their precise location cannot be detected without the additional cues provided by head movement.

According to Emerson and Hatlen (1992) the spatial information that is so effectively expressed in spatial patterns cannot be conveyed effectively by sound patterns. Sound energy does not make it possible to identify the objects that are responsible for making a particular sound. It is the learned association with the spatial information supplied by other perceptual systems that this can be achieved.

The patterns of sound energy processed by the auditory system do not specify concretely the characteristics of objects that are readily appreciated by vision and touch, such as shape, size, texture and colour. When a child with blindness relies on sounds, unless they are attached to meaningful and understood source, they would result into meaninglessness or nothingness. Despite these short fall, Barraga (1974) opined that the maintenance of human and environmental contact is more easily done and may provide more satisfying interactions in early and later life through the auditory sense. When sound energy reaches the ears of the child with blindness; he must travel to the location of the object in order to discover its characteristics. Thus, this perceptual medium, which seems the most used by the child with blindness, has its lapses. Children with blindness could rely on sound in a mathematics lesson. They could follow the lesson quite well. However most often the mathematics teachers do not read out the figures of the problems they are solving on the chalkboard. Majority of the class are sighted so the teacher points at the figure and refers to them as this and that. Referring to his experience Nemeth (2006) stated that he wished that his instructor would verbalize what he was writing on the blackboard. I tried contacting his professors to ask them to do that; sometimes he was successful and sometimes not (p.1). Children with blindness should have the orientation of listening to figures read to them as early as possible so that they could be used to it. There is the need to educate mathematics teachers to read out figures when teaching children with blindness mathematics.

Hammill and Crandell stated that the auditory discriminative ability developmentally increases at age 7 to 8 (as cited by Lydon & McGraw 1973 p.8). This is particularly important for the acquisition of sophisticated listening skills for learning of academic materials. This shows that children with blindness would do better if given training early in auditory and other sensory skills. Barraga (1974) advised that the stimulation of the auditory sense is important for a child with blindness even before he is able to make use of his tactual - kinesthetic senses. This calls for auditory training in early mathematics skills. They should listen to figures as they are called and follow the operatives as by listening. This could be done through dictating problems and solving together with peers or teacher while they listen and follow tactilely.

Hearing has its main function as a medium of verbal communication. Much knowledge is communicated through language. Therefore, with proper communication, blindness would not put the individual at a disadvantage in this respect (Gibson, 1987). Nevertheless, this has produced the tendency of verbalism (the use of words for which children with blindness do not have the first hand understanding) in children with blindness and sometimes in their teachers as well (Napier, 1974). The child with blindness sometimes learns words by verbal associations and by rote memorization. In dealing with children with blindness, teachers often depend heavily on verbal explanation and description. The value of providing children with blindness with firsthand experience, which gives information through other senses they can use, cannot be overestimated (Napier, 1974). Children with blindness should be taught mathematics practically first before they are presented the concepts abstractly.

2.3.6 Haptic Perception

Haptic perception or the perception of shape by touch depends on excitation of kinesthetic receptors and tactile receptors (Howard, 1973). Touch requires direct contact with the object to be observed. When children with blindness touch or observe objects, they often gain only a partial knowledge of objects, which they hardly have enough time to observe.

Simpkins (1978) presented what the perception of the world by touch may be to people with blindness through a poem titled “Blind Men and the Elephant”. By observing an elephant through touch, six blind men, satisfied their minds. The first man touched the side of the elephant and said the elephant is very like a wall. The second felt the tusk and to him the elephant is like a spear. The third touched the trunk and to him an elephant is like a snake. The fourth felt about the knee and the animal is like a tree. The fifth touched the ear of the elephant and said that an elephant is like a fan. The sixth of them held the swinging tail and said the elephant is like a rope.

Lowenfeld (1974) stated that in order for the visually Handicapped child to feed information to his brain (through his tactile-kinesthetic channels) the range and variety of tactile experiences should be structured and controlled to facilitate a sequential progression of perceptions and to minimize confusion. Children with blindness need variety of experiences for better comprehension of concepts. They should be shown various faces of concepts.

2.3.7 Concept Development of Children with Visual Impairment

Children with little or no usable vision experience the world through their ears, their fingers their skin, their noses, their mouths and their movements (Chander, 1992). Because of this difference in learning children who are blind or visually impaired will not generally develop on their own the same kinds of concepts about the world as their peers with sight do. Therefore their learning experiences and reinforcement of those experiences must be carefully constructed. Otherwise children who are blind and visually impaired are at risk of developing such significantly different concepts about the world that confusion and misunderstanding result leading to later difficulties in all areas of learning, including the formation of mathematical concepts (Schroeder, 2004).

The development of concepts is the foundation of academic, social and psychomotor learning (Copeland, 1979). Mensah (1982) stated that mathematics curriculum has provoked research largely in the area of concept formation. While the sighted individual develops and verifies many concepts informally, the person visual impairment must have a structured presentation of most concepts to ensure accurate development of these fundamentals.

According to Emerson and Hatlen (1992), concept can be thought of as an opinion, an idea, or a mental image formed. It is a mental representation, image or idea of what something should be. Emerson and Hatlen further stated that concepts might range from very concrete or real objects such as dog, table or car, to abstract or more intangible ideas such as beauty, love or justice. It also refers to the attributes a class or group of things have in common. It involves classifying or grouping objects or events with similar properties or form. Most concepts are associated with a general descriptive name or label and are represented by words. Ideas like red, yellow, and blue what is common about them is the fact that they are colours. According to John, Kirby, Louise and Becker (1988) there are different kinds of concepts. Enumerating these concepts, they stated that there is the concept of object permanence. This is the knowledge that objects continue to exist even when they can no longer be seen. The concept of motor meaning is the knowledge that an object is usually used for a particular purpose such as cups for drinking. Other concepts are the concept of range of reaction. This is the span between the highest and lowest average age at which children raised under different conditions achieve a particular milestone. E.g. in children, matching colours is easier than naming colours. A child may match several colours but can name only few. Similarly counting by rote is easier than counting objects. A child may count by rote to ten. It is later that they count for objects and tell how many. Flavell (1977) stated that there are three levels of attainment of concepts. Thus first is concrete. This is the ability to identify specific characteristics of an object. The second is the functional; it is the ability to identify what the object does or what one does with the object. The third is abstract. This is the summarization of all major characteristics of the object. The concrete and functional levels are the steps in developing the completeness of the concept via abstraction. Berdine and Blackhurst (1985) stated that Concepts are useful because they help us bring order to the things in our environment. They reduce the ambiguity in our lives and allow us to function more efficiently, because we do not have to relearn something when we first encounter another member of that class or concept (p. 20)

Orientation and mobility and mathematics are subjects full of such concepts. Children with sight can learn concepts such as more or less and big or little through frequent incidental opportunities to compare and contrast from size, and amount. For example sighted child understands concepts of big as including concept of tall. When the child sees his big sister, she is taller than him. For a child with blindness if he does not have direct hands on instruction he may have no real understanding of “tall” (Smith 2006).

Problems in conceptual development have been reported in almost all children with special needs. They include: children with brain-injure, children with communication disorders (Johnson, 1975), children with deafness (Hicks, 1975), children with Learning Disability (McCarthy, 1975), children with visual impairment and children with mental retardation (Moss & Mayer, 1975).

2.3.8 Cognitive Development

A collection of processes through which information is stored in memory, and is retrieved from the memory is referred to as cognition (Flavell, 1977). The information acquired when filtered by perception organized and stored in memory is further elaborated in any organized collections of remembered information called schemata. Humans refer ongoing experience to the schemata in order to understand it and in order to choose actions that serve present purposes (Hirsch, 1982). According to Advani (1992) cognition is a loosely defined area that embraces the whole complex system of human mental abilities focusing on perception, attention, learning and memory, the comprehension and use of language and reasoning. In a broader definition, Flavell (1977) included more components of the cognitive domain thereby including those that concern intelligence and social psychological processes. His definition includes higher mental process as knowledge, consciousness, intelligence, thinking, imagining, reasoning, inferring, problem solving, conceptualisation, classifying and relating. Others are symbolizing and even fantasizing and dreaming. The less purely intellectual components according to Flavell are organized motor movement, (especially in infants), perception, imagery, memory, attention and learning.

Components of cognition which are social psychological are emotions, personality, aggression, etc. "What you know and think (cognition) interacts in a very substantial and significant way with how you feel (emotion). What you know affects and is affected by how you perceive. How you conceptualise or classify things influences the way you reason about them and the vice versa (Flavell, 1977). Therefore the components of the cognitive domains are complex and inter woven with one another.

Advani (1992) outlined the process of storing information as in cognition into stages that when a stimulus is perceived from the environment, it resides briefly in a pre-processing store called sensory memory. If the stimulus disappears or is not presently there, the memory is still there. Sensory memory is usually relatively unselective in its contents. It has a large capacity and it records most or all of the information. However, this memory goes on for further processing. During this time, attention would be focused on those elements of the impact that are relevant for a given purpose.

2.3.9 Memory

Emerson and Hatlen (1992) stated that persons with blindness must consult their memory to enable them perform many tasks. For them to have results in any given task the information must always be in the memory when consulted. A child with blindness must learn to remember the direction in which he enters a room or else he cannot remember the direction that would lead to his going out. Therefore children with blindness need a lot of training in identifying the information that should be remembered. However Emerson and Hatlen warn that the training should be continued, until remembering has become a habit and they no longer have to remember to remember.

2.3.10 Short Term Memory

Short-term memory has a small capacity. The information maintained in the short-term memory is few. The old items in the short memory quickly give way to new ones. To retain information here, such information has to be organized in a meaningful form and not left in a chunk (Emerson & Hatlen, 1992). According to Advani (1992) short- term memory is the active conscious working component of memory. You use letters to form words, and you need a lot of rehearsal.

2.3.11 Long-Term Memory

This is where information is permanently stored. Its capacity is virtually unlimited. A person may seem to have forgotten information here, however, it is not because the person has lost the information, but it is due to retrieval failure. (Advani, 1992).

According to Emerson and Hatlen (1992) cognitive factors have been suggested as responsible for children's learning problems in simple arithmetic. These are: the encoding of numbers, and the difficulty of operation from the operations. These initial difficulties in the basics arithmetic generate difficulty in more advanced areas of Mathematics as well as in other non-Mathematical areas.

2.3.12 Perceptual and Cognitive Development of Learners with Visual Impairment Compared with Sighted Children

Emerson and Hatlen (1992) suggested that in order to understand the perceptual and cognitive abilities, styles, needs, and desires of an individual, it is necessary to begin by considering those experiences that provided the individuals earliest learning opportunities. They stated that the development of perceptual and cognitive abilities begins at birth and that they develop concurrently and interdependently. Therefore the earlier children are trained to develop abilities the better. Piaget (1972) noted that if concepts have not been introduced and learned at the maturational stage at which they are ready to be learned, they are lost. The formation of the cognitive structures that make possible the interpretation of sense data begins with developing the child's earliest experiences. Inadequate experience at this stage of development will alter the course of future development. This calls for early intervention in the life of a child with blindness. When an infant with blindness is isolated from his peer group and is not provided with, or is prevented from participating in activities he then completely depends on others. This can affect his cognitive development. It can also create psychological problems like tension and anxiety in the child (Flavell, 1977).

Stack, Muir, Shariff and Roman (1989) noted examples of differences between people with sight and blindness due to perceptual and conceptual process. They stated that sighted people are able to perform many tasks satisfactorily. This is because they rely primarily on information supplied by perception while the tasks are in progress. Persons with blindness cannot acquire enough perceptual information to carry on these tasks while they are performing them. They must supplement perceptual information with information acquired on other occasions and stored in memory. They encourage teachers, parents or guardians to always give on the spot description or explanations to the child with blindness. The child should be given the opportunity to take part in any activity that is going on so that he will experience it as it goes on.

A combination of information acquired by all the senses will result in a better association, formation for better conceptualisation and cognitive development. Infants who are learning to perceive must move through space and manipulate the objects in space in order to bring about the behavioural consequence that guides the development of perceptual ability. According to Hanna (1986), Kobberling, Jankowski, and Leger (1992) the consequence of restrictions in mobility by children with blindness makes them develop less motor competence than sighted children. Cutsforth stated that gross motor activities such as walking, running and jumping underlie the finer motor skills needed in Braille touch reading of the “blind” (as cited in Sykes & Ajuwon, 1984). Therefore Sykes and Ajuwon emphasized the importance of developing gross motor ability before teaching the very finer motor skills needed in touch reading. Teachers and parents must find ways to involve children with blindness in activities that will improve strength, flexibility and coordination. They should make the world the children experience as informative as possible.

Lowenfeld (1974) expressed concern over the misconception that persons with blindness are automatically compensated for the loss of their visual sense by a natural increase in their other good senses. That nature increases their other good senses. This belief can lead to neglecting the child with blindness on the assumption that nature will automatically provide for him. Lowenfeld therefore warns that any higher efficiency of the blind in interpreting the sensory data perceived must be the result of attention, practice, adaptation and increased use of the remaining faculties. Many of the authors are of the view that children with blindness will perform better cognitively if teachers and parents deliberately enrich their environment for learning as early as possible in life. They should provide them with variety of experiences leading to a lot of perceptual development. Emerson and Hatlen (1992) stressed the need for people with blindness to consult different sources of information and to acquire different sense data. This suggests the need for the use of methods, procedures and materials that are appropriate to the education of children blindness.

Adelson and Fraiberg (1974) mentioned so many ways in which a sighted child uses his perceptual processes differently from his “blind” peer. According to them, a sighted child uses his visual in-take and learns to perceive objects at greater distance and is able to see them in their wholeness. He sees luminous energy that contains spatial information that reaches his retina from a considerable distance. He learns that object exists, have permanence and differ one from the other. In his exploration and manipulation of objects, he is able to see them in greater perspective. He recognizes the characteristics of the objects and can give an identification of the whole objects. Sighted child abstracts some common elements from several sensory experiences. He uses this abstraction as the defining characteristic of a class. He represents the generalization thus achieved by a symbol thereby forming a concept. The sighted child learns that objects can be significant in terms of their needs and desires, and that in order to realize the utility of objects; they must know where the objects are and how to reach them. Thus he soon grasp that different objects occupy different positions in space. This realization quickly leads to the acquisition of the concept of space as a frame of reference in which objects can be located and identified (Foulke, & Hatlen, 1992). According to Adelson and Fraiberg (1974) sighted children learn how position of objects is related to each other and to themselves, and how their own movement alters this relationship.

A child with blindness is not able to see objects in their wholeness, but must go from the part to the whole. He makes this little achievement by manipulating the objects. Even then the information he receives will not allow him to perceive the depth, intricacy or totality that are there in the object. Once an object is out of the physical grasp of the child with blindness it is gone. For this reason children with blindness acquire the concept of object permanence at a later developmental age than sighted children. Sighted children are able to see objects without having to touch before they are aware of their existence; they begin at a much earlier stage to learn about the characteristics of objects and their relative position in space and about the associations that make sounds meaningful. A child with blindness has no visual stimulation (Fichner, 1979).

Totally blind individuals are, from early childhood on, severely handicapped in their ability to move around by themselves. This restriction is the most severe single effect of blindness. This has affected his opportunities for experiences and his social relations. The lack of movement on one's own and exposure to new experience deprives the child an important avenue of acquiring knowledge and stimulation. He is limited in deciding to engage in or follow up various pursuits of knowledge and happiness. However early intervention of training in mobility and protective techniques are important in helping the child become more confident and self-sufficient (Welsh & Tuttle, 1997).

A person with blindness, besides being restricted in his cognitive activities, is also from early infancy on limited in his ability to expose himself to experience and opportunities. The child with blindness cannot just go out at will on the street for the many reasons which seeing children find attractive. He cannot observe the many displays or the variety of people and objects moving by. He cannot run down to the river or go exploring into fields and to bush. Even if he does, the comparable amount of knowledge, which he gains through tactual and other sensory observations, is far less than that of the sighted children (Spungin, 2002).

Lowenfeld (1974) stated that in the life of a child with visual impairment; he faces the most problem in the area of cognitive functions and mobility. Visual impairment imposes three basic limitations on the person; range and variety of his experience; inability to get about; interaction with the environment. In summary researches show that proper early perceptual and cognitive development training is vital. Attending to their environment must become a matter of habit.

Carla, Mauro, Marco and Cornoldi (2006) did a research to investigate whether the lack of visual experience affects the ability to create spatial inferential representations of the person with visual impairment. They compared the performance of persons with congenital blindness and that of blindfolded sighted persons on four survey representation-based tasks (Experiment 1). They found out that persons with blindness performed better than blindfolded sighted controls. They repeated the same tests introducing a third group of persons with late blindness (Experiment 2). This last group performed better than blindfolded sighted participants, whereas differences between participants with late and congenital blindness were no significant. They concluded that the study reveals that when visual perception is lacking, skill in gathering environmental spatial information provided by non-visual modalities may contribute to a proper spatial encoding. It was also concluded that, although it cannot be asserted that total lack of visual experience incurs no cost, the findings were further evidence that visual experience is not a necessary condition for the development of spatial inferential complex representations.

2.3.13 Children with Visual Impairment in School

People depend on vision or their sight more than all other senses put together. When they smell, feel, or hear something, they rely on their eyes to confirm it. That is why there is a common saying that: “seeing is to believe”. Visual Impairment can affect anyone regardless of age, gender, wealth, physique, or personality. There are persons with visual impairment that are born with it (congenital visual impairment). Some persons acquired it at later life (adventitious visual impairment). The onset of visual impairment may be sudden or gradual. The term visual impairment refers to different groups of visual disorders or impairments. Visual impairment encompasses any deviation from low vision to total blindness (Caton, 1985).

There is no universal definition of the term blindness. The term blind often refers to individuals with no usable sight. It is used to mean absence of light. However majority of people who are considered blind have remaining vision (Sardegna & Paul, 1991). Blindness is defined for legal, economic purposes and for allocation of federal funds to purchase educational materials in America and other advanced countries. There is therefore “legal blindness”. This refers to specified loss of vision that makes individual eligible for benefit and services of government programme or rehabilitation agencies in countries like America. Legal definition of blindness depends on visual acuity test result. It refers to sharpness or clearness of vision. Visual acuity test result ranges from 20/200 for blindness to low vision which is 20/70 or less. This definition does not state how efficient one uses one’s vision. It does not provide enough information to deliver effective educational service to children with visual impairment. It tells little about the child’s ability to read or examine educational materials at close range.

Blindness is also considered in terms of visual field or peripheral (side) vision. When the widest angle at which the stimulus can be seen is 20 degrees or less in the best possible correction, the person is considered to be legally blind. Although the definition of legal blindness emphasises on the measurement of distance visual acuity and visual fields, there is another approach to defining blindness which is known as functional definition of blindness. The American’s Centre for Health Statistics (1975) defined person with severe visual impairment as someone who is unable to read ordinary newspapers print even with the aid of corrective lenses, or a person under six years of age is blind in both eyes or has no useful vision in either eye.

Other visual impairment include: colour blind. This is a defect of vision that affects the ability of the child to identify colours. There are learners with visual impairment that have total colour blindness. There are those with partial colour blindness. They cannot differentiate between the reds and the green or perceive any of them. They also experience confusion on blue and yellow colours. Children with albinism suffer from brightness of light and lack clarity of sight. There are children who suffer from night blindness, decreased contrast sensitivity, sensitivity to glare. Others suffer from refractive errors, astigmatism (blurred vision) (Berdine & Blackhurst, 1985).

There are important limitations of visual impairment on learners with visual impairment. Lowenfeld pointed out that blindness imposes three general restrictions. It causes restriction in the area of range and variety of experience, ability to get about, control of environment and self in relation to environment. A visually impaired person lacks information through vision which provides more continuous information than sound. Although he or she uses touch which may be continuous, its range is extremely limited. The capacity to organise a wide range of experiences through vision is much greater than through touch or sound. Vision gives much more detailed information than any other sense modality. The totally blind child depends to a large extent on verbally mediated information. The mediation of words may leave gaps in experience and the filling of these gaps may require a very special effort on the part of the teacher. Some of the functional problem resulting from visual impairment include: diminished ability to read, recognise faces, and facial expressions, and perform visually guided motor tasks.

2.4 ORIENTATION AND MOBILITY

2.4.1 Meaning/Basic Concepts

According to Hill and Ponder (1978) Orientation is the process of using the remaining senses to establish one’s position in the environment. Mobility is the capacity, facility, and readiness to move. Yasarapudi (1999) defined orientation and mobility is the term used for teaching people with visual impairment to move independently, safely and purposefully through the environment.

Orientation is establishing one's position in the immediate environment. Skills of orientation refer to the gathering and processing of information from the environment with the remaining senses, through which one establishes his position.

Mobility is the movement of a person from the present position to a desired position.

Best (1992) stated that orientation is the ability to understand surroundings through an awareness of space and spatial relationships between objects and people in the environment. Mobility is the ability to travel through the surroundings. It can be in form of walking or even crawling. Kephart stated that a child will need a certain level of cognitive skill to remember the route and understand what is happening as (as cited in Hart, 1980, p.15). Motivation and confidence will be needed. In orientation and mobility, there is need for language skills this will help in understanding directions. The coordinated use of several senses –touch vision, hearing, kinaesthetic-will enable the child to monitor direction and space. Orientation and mobility is all about development. Yasarapudi (1999) stated that mobility is a basic aspect of psychomotor development. It is essential for education, occupation and social needs. When you lack visual input, movement through the environment may not occur naturally. Yasarapudi (1999) opined that blindness affects the basic skills of mobility; the control of environment and self in relation to it; getting about and experiential deprivation. Similarly, Mittal (2006) stated that blindness clearly poses several restrictions on the individual's ability to orient himself in the spatial environment and to locate its physical features and form reliable mental images of routes through it. This in turn may result in severe restrictions in physical locomotion.

Sight is a motivator for movement, and through movement children learn about the world. Through the process of orientation and mobility, young visually impaired children are able to interact with the environment and develop conceptual understanding that leads to growth in all other areas of development. Welch and Blasch (1983) stated that the ability to move independently safely and purposefully through the environment is a skill of primary importance in the development of each individual. Orientation is the cognitive component of purposeful movement. The goal is for the child to travel, in whatever mode possible for his or her development and physical ability.

Orientation and Mobility as a process begins at birth. The earliest part of orientation include: understanding one's body and how it moves, differentiating one's body from the immediate environment, understanding the world beyond one's body. Yasarapudi (1999) mention certain aspects of human mobility before mobility training can be given. They include: motor skills in preparation for sitting; walking, developing protective reactions and segmental rotation leading to normal gait. Others are: balance and posture: balance is prerequisite for movement, and posture becomes the basic pattern from which movement must originate. Vision plays an important role in learning posture, even though basically it is learnt kinesthetically.

Body image: this is the proper knowledge of parts o the body and their relative movements. Absence of vision creates postural deviations, which in turn affect body image. Appropriate body image leads to good posture, which has to be flexible in order to meet the demands of all body positions.

Posture and gait deviation:

2.4.2 The Goal of Orientation and Mobility: the ultimate goal of orientation and mobility for a blind person is to move safely, independently, efficiently and gracefully by utilising a combination of orientation and mobility skills (Hill and Ponder 1976).

There are four most common ways for people with visual impairment to move around: human guide or sighted guide, trained guide dogs, sticks or walking canes, electronic, travel aids.

Human guide or sighted guide: Person with visual impairment travels with the help of a human sighted guide. This is necessary when travelling in new places, busy streets and buildings not familiar to the visually impaired person.

Trained guide dogs: certain species of dogs are trained to guide people with visual impairment. Once the dog is trained, the blind person and the guide dog need to be trained together. The training programme includes walking down all the routes usually covered by the blind person. Guide dogs can only help in overcoming obstacles in a route, but the blind person should know the route.

Walking canes: the blind person walks with the help of a long folding cane.

Electronic travel aids: electronic gadgets have been developed to aid visually impaired people in travel. For example, sonic guides, laser canes. They help the user to detect obstacles before he comes into contact with them.

2.4.3 Spatial Concept in Orientation and Mobility

As defined by Hill and Ponder (1978) orientation is the process of using the remaining senses to establish one's position in the environment. APOMP involves the use of the remaining senses to be aware of the environment and movement from one point to the other involving, identification of shapes, polygons and quadrilaterals in relation to their bodies and engaging into geometry construction and algorithm. Therefore it is worthwhile giving a learner with congenital visual impairment the opportunity to use substitute means of acquiring spatial concepts through the use of other remaining senses.

Chander (1992) emphasised on linking concept of geometry with mobility training. It is based on the discovery of similarity in spatial concepts in geometry and orientation and mobility and other aspects of the school curriculum that led to investigation into the concepts and the skills in orientation and mobility and geometry and the eventual investigation towards the development of APOMP which could be used also as a method for teaching geometry for learners with visual impairment. Concepts in geometry are embedded in concepts and practical skills in orientation and mobility.

Lydon and McGraw (1982) noticed that students who experience difficulty in an orientation programme have difficulty with courses like geometry or subjects that have spatial concepts. Knowledge of spatial concepts has a wide importance in other areas of studies. According Kennedy and Tipps, (1994), manipulation of objects in space provides background for understanding other mathematical concepts like algebra, calculus, and many topics in higher mathematics that require spatial thinking. Studies of human problem solving and language understanding have pointed out the importance of spatial representation and reasoning (Hobbs and Narayanan, 2002). This shows that geometry is not an isolated part of the curriculum it touches on other subject areas of learning.

2.4.4 Training in Orientation and Mobility

Several centuries back, people with visual impairment used different devices to aid their movements. They used sticks or bamboos etc. Today, there are different kinds of canes or sticks which are used for mobility. Some are made of aluminium or other metals. There are those made of wood, bamboo or “cane”. The canes that are used today have varied tops. Some have crook tops. There are those with rubber grip and those with bent neck. Cane can be rigid or can fold up (Jaekle, 1993).

The earliest process of teaching orientation and mobility began in hospitals. An “Orientor” supported the client in interpreting the landmarks, layout, echo and changes of surface in the environment (Neutadt, 2006). Orientation and mobility has been described as a skill of primary importance in the development of persons with visual impairment. Children will only be able to achieve their class based learning activities through orientation and mobility. They have to move from lesson to lesson independently. They would be able to participate in physical educational activities and sports, informal recreational activities (Pavey, 2006). Luxton, Bradfield, Maxson, and Starkson (1997) described orientation and mobility as consisted of collection of skills and abilities that people use when they traverse (pass through) an environment and maintain their awareness of relationship of themselves and of places within that environment.

Best (1992) defined orientation as the ability to understand surroundings through an awareness of space and spatial relationship between objects and people in the environment. Mobility on the other hand means the ability to travel through the surroundings. It is about movement or motor skills needed in order to reach, crawl, walk or run etc. The child or person with visual impairment walks round a classroom or in the room at work place or at home or in an open space such as playground, around the village, compound, town, market place etc.

There are certain prerequisite that the child needs to have before the commencement of teaching of orientation and mobility. Best (1992) stated that the child needs a certain level of perceptive and cognitive skills to remember the route and understand what is happening. Hill and Ponder (1976) clarified that apart from the prerequisites that are needed; there are basic readiness levels both physically and mentally. The child's mental level should be such that he can utilize the cognitive process. If the child has mental retardation, brain damage, mental illness or any impairment affecting cognition, the child may not be able to develop good orientation. Others are: the student's frustration level, tolerant level, attention span, concentration level and ability to use abstracts. The child needs motivation, confidence, language skill to understand directions and the coordination of several senses like touch, vision, hearing, and kinesthetic (Luxton, Bradfield, Maxson & Starkson, 1997).

Hill and Ponder (1976) saw as prerequisite before the client orient himself within the environment should have concept of self. This concept is referred to as body image. This is an awareness and knowledge of body parts, their movements and functions. There is the need for the knowledge of the environment. The child should be able to relate environment to environment, in a functional manner. The logical progression of cognitive awareness would be from the concrete to the abstract. There is the need for independent movement skills. The child walks and maintains a straight line or makes a turn and maintains a vibrant posture.

The teaching and learning of orientation and mobility in Nigeria has been controversial. Dala (2012) reported that she found the teaching of orientation and mobility on the schools' timetable. The literature Dala reviewed from Dyelmang (1994) showed that orientation and mobility was not taught in Gindiri. Ejikeme (1994) on the other hand like Dala's report contradicts Delmang's report. The researcher's experience of teaching orientation and mobility in Gindiri has been that orientation and mobility teaching had been fluctuating in the school. At one time, teachers were selected by foreign partners and sent to countries like Togo, Ghana, Malawi etc to train in orientation and mobility. When the teachers returned, they were still in the spirit. The subject was mounted on the timetable and was intensively taught. After sometimes, the teachers became tired and they abandoned the teaching of the subject. There were instances where those trained came back and got transferred or left the school. The result therefore is that at one time, the subject reflects on the timetable and at other time, it disappears.

The controversy of teaching orientation and mobility is now in different dimensions. Neutadt (2006) reported that the teaching and training of O&M has been rejected by some countries due to its cost and lack of awareness of the capabilities of people who were blind and also due to ignorance. People are not aware of the opportunities that independent travel could open up for blind individuals within their communities. Unfortunately many countries do not have curriculum for their children in O&M. For quite some times in the developing world, international organisations tend to provide short term courses. Neutadt reported that participants in O&M training workshops from developing regions are usually already employed by an agency for the blind, most frequently in school settings. Their newly acquired expertise in O&M becomes part of their repertoire of work skills but not their major activity. It is common for a teacher of mathematics, computer science or geography to be designated by the school to teach O&M too. There were instances where care givers were made to give lessons in O&M. Some feel that O&M skills should be taught in the children's free or recreation time.

Due to lack of proper attention in teaching O&M, Neutadt reported how parents took over the teaching of orientation and mobility. He stated that due to increased exposure to the media it enabled parents in developing countries to find out more about what is available to blind children in other parts of the world. As a result they voice out their opinions and demand that their governments should supply O&M training. Some have registered as parent's organisation. This enables them to contact international organisations that support them and they get trained in O&M. Many of them have taken over the responsibility of training other parents who train their children.

Another new dimension of training in orientation and mobility is through communities. People are trained within communities such that they become trainers of others in the community. The researcher has found out that medical personnel are now actively engaged in O&M training. Nurses have become trainers in orientation and mobility. Neutadt states that the concept of O&M as a paramedical discipline aligned to health care professionals (which is how the profession initially started) should be reconsidered, after its journey through a full circle encompassing community, educational and social services. Its training outside school may have implication on APOMP. Training by parents, care givers, community members and nurses may not harness the basic concepts in O&M that would have been used to achieve concepts and skills in geometry in school.

2.4.5 Relationship between Orientation and Mobility and Geometry

Chander (1992) explained that the basic concepts of any branch of mathematics have to be general. The concepts become relevant to a very wide class of objects. For example the concept of natural numbers can refer to pebbles, apples, coins, houses etc or any entities. Similarly there are sets of basic concepts of geometry that are found in orientation and mobility; for example point, line, plane etc. Chander further stated that if you teach a sighted child the concept of line, you may draw up a line on the chalk board and say that represents a line. For the learner with visual impairment, the concept has to be put through learning activities that will result in the desired learning the concept effectively. The teacher has to present to the child concrete objects for manipulation to explore the edges with his finger tips. The child may be made to explore threat, wire etc and subsequently will be presented with embossed diagrams.

Spatial concepts in orientation and mobility and concepts in geometry are similar especially with the ideas of space, time, speed etc. Experience shows that these concepts are areas that appear to be the major problem areas of learners with visual impairment. Chander encouraged the linking of the concept of geometry with mobility training which is crucial for their daily living.

Hill and Ponder (1976) listed five components of orientation to include: landmarks, measurement, compass direction, indoor numbering system and clues. A close observation of these orientation components shows how close they are related to geometry. Similarly there are series of mobility skills that are also linked to geometry which are embedded in to mobility skills. Some of the skills include: reversing directions, transferring sides, and stairways. Others are seating, self protection, trailing, dropped objects, sighted guide, use of long cane etc.

Welch and Blasch (1983) gave an exhaustive number of spatial concepts in O&M that link with geometry to include: Clock wise, counter-clockwise, parallel, perpendicular, around, middle, between, in between, centre, anterior, posterior, superior, inferior, interior, adjacent, medial, median, northeast, northwest, southeast, north, south, east, west, westward, diagonal, horizontal, vertical, upper most etc. Welch and Blasch state that concepts of shape become extremely important when the visually impaired individual begins to identify objects and work with mobility concepts such as street configurations, building and layouts. They enumerated the followings list of important shapes used in orientation and mobility.

Primary shapes: They include round, triangle, circle, rectangle, square, oval, loop etc.

The secondary shapes are: sphere, octagon, hexagon, pentagon, cylinder, figure 8, eclipse, cube, (cubical), cone, rectangular solid, pyramid, rhombus, trapezoid, parabola, and parallelogram.

Shapes of particular objects: pear shaped, rain drop, tear drop, heart shaped, ring shaped, box shaped, diamond shaped.

Letters used to describe shapes: T – intersection. H, L, O, T, V, U, X, Y.

According to Welch and Blasch (1983) concepts of measurement are extremely important in daily living and for orientation and independent mobility. Some of the concepts they gave are:

Distance -, millimetre, centimetre, meter, kilometer, inch, foot, mile, yard, block, degrees,

Time – second, minute, hour, day, week, month, year, today, tomorrow, yesterday, quarter – hour, half – hour, time/distance, per second, per minute, per hour, morning, afternoon, evening, night

Weight: ounce, pound

Spatial concepts dealing with action in orientation and mobility are: Turns – 45^0 turn, ¼ - turn, 90^0 turn, right – angle turn, 180^0 turn, half turn, whole turn, about face, 360^0 turn, full turn pivot, U – turn.

Hill and Ponder (1976) stated that landmarks are used for perpendicular or parallel alignment for straight line travel. The learner with visual impairment while establishing landmarks would experience distance awareness, use of compass directions and identify distinguishable characteristics of objects that may be utilised as landmarks. When learner with visual impairment experiences landmark activities, the learner would have been exposed to the following concepts in geometry: Perpendicular lines (right angles) (lines which meet to form a right angle or cross each other at right angles). Others are horizontal and vertical lines. Some of the objects identified and walked to from the landmark and using tactile skills their features are identified. For example the learner identifies a table. The characteristics are that it has a flat top this is horizontal. The legs of the table are vertical. All the edges of the top of the table are parallel to the ground. If a Pole of a flag in school is used as landmark or an object in the environment, the Pole is vertical, and it makes an angle of 90^0 with the ground. There are a number of objects in the environment that have parallel lines. For example the edges of the Braille books they use, railway tracks, edges of the veranda, doors etc.

Measurement in orientation and mobility is the act or process of measuring, ascertaining the exact or approximate dimensions of an object or space using a unit. Everything in the environment is measurable. Linear measurements are constant. There are standard units or measurement. Measurements may be divided into three broad classes: measurements using standard units; comparative measurement (compares the length or distance of two lengths or distance of two things, eg longer than, wider than, less than) and non-standardized (paces, knee high). Linear measurement is applied to the three basic dimensions: length, height and width. The non standard units may be used for approximate measurement. The learner is required to be able to count, have concept of relative value of numbers, ability to add, subtract, multiply and divide. The child will have skills and knowledge of standardized measurement units. He or she will have the understanding of concepts of less than, greater than, and equal to. Measurement in orientation and mobility can be used to determine or approximate the dimensions of an area whose size will affect the students' functioning. It is used to determine what mobility techniques are appropriate in a particular area. Measurement in orientation and mobility makes the learner to gain an accurate concept of particular objects and positional relationships between them. It helps the learner to obtain a class concept of the size or an area or object in relation to body size.

Measurement in geometry like in orientation and mobility starts with the body unit. Osuagwu (u.d.) reported that many years ago people used parts of the body as units of length. The units were the most popular for measuring length. There was the measurement of the Span. The measurement of the span was done by spreading the fingers and measuring across from thumb to the small finger. There was the use of the thumb to measure which was referred to as digit. This involves measuring across thumb from left to right or from the tip of the thumb down to the root of the thumb. Cubit measurement was the stretch of the arm at 45^0 measuring from the tip of the middle finger to the elbow. The palm is used as a means of measurement, measuring from index finger to small fingers placed closed without the thumb. The foot measurement was done from the toe to the heel. For learners with visual impairment, during their orientation and mobility activities, they come across objects in the environment and take rough measurement of the objects using these parts of their body. Both in orientation and mobility and in geometry, learners with visual impairment use standard units of measurement. They include meter unit. The learners can use adapted meter ruler, measuring tapes etc to measure things in the environment.

In a graphical description of the following geometrical terminologies: linear, planes, rectangles etc, Clarke (1977) stated that in a typical room, the shape of the room is exactly that of a box or cuboid. The walls, ceiling, floor and blackboard are planes. The shape of the floor is a rectangle. Two planes such as a wall and the floor meet in a line. A wall and the ceiling meet in a horizontal line. Clarke describes plane in relation to a flat surface such as the blackboard or a wall and a horizontal plane is a flat, level surface such as the top of a table. A horizontal line is any line in a horizontal plane. A vertical plane is a plane such as a wall or a room. All lines perpendicular to it are horizontal. Learners with visual impairment can measure length. They measure distance all round different shapes (perimeter). The learners can explore an area by measuring in square units. They count the squares to find the areas of rectangles etc.

Compass directions are specialised directions which are dictated by the magnetic fields of the earth. The four main compass directions are cardinal points, and are spaced with 90^0 intervals around the circle of the compass; they are north east, south, and west.

In orientation and mobility, compass directions are transferable from one environment to another. It allows the learner to relate to the distant environment. The learner will be able to relate environment to environment concepts in a more positive and definite manner. There are four main compass directions. Principles of opposites: East and West are opposites; North and South are opposites. An East – West line of direction is perpendicular and at right angles to a North – South lines are parallel. Travel may be either east or west on an east – west line, and north or south on a north – south line (Hill & Ponder1976).

In compass direction in orientation and mobility the learner is expected to execute 90^0 and 180^0 turns; should understand parallel, perpendicular, and right angle; knowledge of existence of the four cardinal directions; understanding the directions of turns in relation to directionality. In Basic sighted guide technique the learner's upper and lower arm form an angle of approximately 90 degrees with the forearm pointing forward. The purpose is to enable the learner and guide to execute an 180^0 turn in a limited amount of space. At Upper hand and forearm technique. The arm is positioned parallel to the floor at shoulder level. The forearm is flexed at the elbow, forming an obtuse angle of approximately $120^{0.}$ In trailing, the learner facing the desired line of travel is positioned parallel and near the object to be trailed. The arm nearest the object is extended downward and forward at an approximate angle of 45 degree in the anterior-posterior plane. In reversing directions the learner releases his grip hand and turns 90^0 degree towards the guide's opposite arm. In transferring sides the learner releases his grip hand and turns 90^0 degree towards the guide's opposite arm (Hill & Ponder, 1976).

The human mobility is the movement of a person from the present position to a desired position. It is concerned with the ability to move from one point in space to another. It is also the ability to walk along both familiar and unfamiliar routes efficiently with safety, comfortably, independently and with minimum stress (Hart, 1980; Caton, 1985; Yasarapudi 1999). The ability to walk briskly and independently constitutes a form of aerobic exercise that helps improves health, muscles tone, posture and coordination through the lifetime (McCall, 2006).

This gross movement is a prerequisite for many activities that the child will need to perform throughout his life including mathematics. A child with blindness can only see the world mathematically through orientation and mobility. Narrating his experiences with his father on how practically his father used a lot of orientation and mobility skills on him when he was a child that eventually gave him the foundation of mathematics. Nemeth (2006) stated that his father would take him by the hand as a little boy and would keep up a constant conversation to keep him in touch with his environment. “Right now we are walking west,” his father would say “and as soon as they made a left turn, they would be walking south. His father would apprise him of the names of the entire cross streets along their route to travel. He would lead him from home to their usual destinations always by a different route so that he would develop a mind’s – eye map of the neighbourhood in which they live (p.1).

Welsh (1983) stated that the ability to move independently safely; and purposefully through the environment is a skill of primary importance in the development of each individual. They further stated that when one is able to move independently, safely and purposefully through the environment, the individual’s status is increased in the eyes of others and will have a positive impact on the individual.

In discussing concept formation, it is vital to see how important the effect of mobility is as a determinant of the process of conception. Kephart states that the neurological system matures first in the motor area and that the area becomes functional before the perceptual systems is ready. Also that the areas of motor activity and perception are then both operating before cognitive association develops (as cited in Hart 1980). Harts states that the motor system thus becomes the initial system in the hierarchy of development. Piaget and Inhelder agreed that the motor skills are developed first and future learning is based upon the first motor learning. However in considering perception in orientation and mobility, most often perception is viewed as the first step in performing a motor act. Perception is seen as the awareness of objects, qualities or relations and is basic to motor activity. This includes the use of one or two sensory organs to meet up sensory stimulation around (as cited in Harts, 1980). Logically the process of finding an object in the space by the sense organ e.g. the eye would involve the movement of the muscles that control the eye balls first before the process of perception happens. This makes motor movement happens before perception.

Harts (1980) in analyzing perception in relation to orientation and mobility listed the following: Kinesthetic discrimination in relation to having the accurate concepts of the body. This includes body awareness. This is the ability to recognize and control the body. It can be in the area of bilateralism, which involves movement performed by both sides of the body; laterality movement perform by one side of the body, body image, an awareness of the body, body relationship to surrounding objects in space (directional concepts) etc.

Visual discrimination: This involves visual acuity, the capacity to distinguish form and fine details, visual tracking, and the ability to follow symbols or objects with coordinated eye movement and visual memory, the ability to recall from memory past visual experiences.

Auditory discrimination involves auditory memory, the ability to recognize and reproduce past auditory experience, auditory acuity, auditory tracking, and ability to distinguish direction of sound and follow it. Tactile discrimination is the ability to differentiate between varying textures. There are coordinated abilities that involve two or more perceptual abilities and movements.

Actual visual apparatus and functioning are affected by factors like age, sex, maturity, metabolism, experience and education (Harts, 1980). Harts (1980) stated that in looking at the spatial concepts, the main tasks of the human visual systems as far as orientation is concern is to provide information so as to know where a seen object is in relation to the body stimulating other senses so that they can determine whether or not the object is moving. It is to also maintain accurate functioning and position in space in spite of changes in the position of the eyes, head and the body. It is also to judge relative direction and distance.

In the motor aspect, Cratty and Sans see a mark relationship between movement and body perception and states that unless a child can perceive his body parts, it would be unlikely that he could move them very effectively (as cited in Harts, 1980).

The exploration that a child carries out, aids in obtaining and storing information regarding the surrounding environment. This eventually leads to body image and laterality, which is the directional differentiation that forms the lateral dimension of space (Lydon & McGraw, 1982).

Body Awareness: Basic Orientation relates to the knowledge of space and the relationship of objects to each other and to the person. According to Lydon and McGraw (1982) body image is the knowledge of one's body parts, the function of each, and their relationship to one's spatial environment. It is the body image that is the point of origin of all spatial relationships to objects outside of the body and the motor activities of the child are what teach human awareness of his body in space. Cratty and Sam divided body image into five:

Body planes: This is in relation to location of self in relation to body planes. i.e. Sides, front and back.

Body parts: This is the ability to name and locate various parts of the body

Body movement: This involves the gross motor movement and various limb movements.

Laterality: This is the identification of left and right sidedness in addition to knowing left and right body parts.

Directionality: This involves so many things. It refers to projection out, away from the self, in terms of left – right, etc are nearest to object's movement in relation to left - right etc. It also refers to knowledge of objects in terms of left – right, etc. Relating objects to self in terms of left – right (as cited in Lydon & McGraw, 1982, p.12)

All these concepts include: the identification of the different body parts eg. Head, eyes, ears, nose mouth, teeth, tongue, shoulder, neck, chest, knee etc. Basic concepts that relate to body parts are: top – bottom or up – down, front – back, side etc. other concepts that have to do with the function of the various part of the body are: open – close, apart – together, across, rotate, circular, straight, like – difference, diagonally, over etc.

Bryant (1995) showed some sample of screening tests for body image of children with blindness by asking body planes, the child touches his head or the bottom of his foot. Considering body plane in relation to external horizontal and vertical surfaces, the child lies down so that the side of the body is touching the mat. The back could be touching the mat or the wall. Objects in relation to body planes, the child places a box so that it touches his side or stomach or above his head etc. In terms of body movement, the child could be asked to bend body backwards or forward or sideways etc.

This body awareness becomes a critical factor in helping a child relate to his environment. Lydon and McGraw (1982) stated that for a person with blindness to achieve effective motor movement; he must have accurate concepts of body image and spatial orientation. That the child with blindness must first learn about himself before he can accurately relate to others and to his surrounding environment.

Lydon and McGraw (1982) noticed that students who experience difficulty in an orientation programme have difficulty with courses like geometry or subjects that have spatial concepts. The children are unable to understand concepts of distance and measurement and or meaning of certain words like “center” in industrial education and social studies. The children could not do any map work with any degree of success. Both orientation and mobility and mathematics are very important subjects in the life of children with blindness. As children grow their ability to get about independently determines to a great extent what the range and variety of their experiences will be and what opportunities they will have (Best, 1992).

Spatial awareness in orientation and mobility refers to formation of concepts related to position, location, direction, and distance (Lydon & McGraw, 1982). Stone and Church recognized five major areas in learning spatial concepts in orientation and mobility.

Action space: These are the locations to which the child anchors his movements.

Body space: This is the child’s awareness of directions and distances in relation to his own body.

Object space: This is the situation where objects can be located relatively to each other in terms of directions and distances transferred from body space.

Map space: This is the process of elaborating and unifying of concrete spatial experiences into more or less extensive “mental maps”

Abstract space: This involves visualizing or the ability to deal with abstract spatial concepts necessary to mapping or navigational problems, geographical ideas, or problems of solid geometry (as cited in Lydon & McGraw, 1982).

According to McCall (2006) children with visual impairment cannot go round their environment except where they are taught to do so. Failing to do that will result in missing experiences that would have aided in their understanding their many school subjects especially mathematics. Napier (1994) compared the life experience of sighted children with those of the children with blindness states that when sighted children come to school during the first grade, they bring certain learning with them based on prior number experiences. These experiences are acquired incidentally; it is essentially, a foundation for formal teaching of mathematics. Observing the early experiences of children with blindness Napier states that children with blindness at the same level before entering school have not had enough of the same kinds of incidental experiences and concept so they function at a lower level in mathematics. Unless they are given experiences that will enable them develop similar concepts as seeing children but in a different way, they would encounter problems with mathematics. This experience is achieved through giving the child with blindness orientation and mobility skills. This will remove some limitations in interacting with the environment by the child.

Berdine and Blackhurst (1985) explained that the sighted child learns that objects exist because he sees them, they have permanence and they differ one from the other. He identifies and names the objects. He defines the characteristics of the object (in addition to identification of the whole object). The child abstracts some common elements from several sensory experiences and uses this abstraction as the defining characteristics of a class; he represents the generalisation by a symbol. This he forms the concept. From this experience the sighted child has gone through concrete level. For example identifying specific characteristics of an object, functional level what the object does abstract level. This is the summarisation of all major characteristics of the objects. As for a child with blindness, he lacks perceptual means of organisation. He is unable to see objects in their wholeness but must go from the parts to the whole. The child with blindness does it through the manipulation of objects. His limitation in learning through this tactual manipulation of objects is that the information he receives will not be seen wholly but in bits and parts (Fraiberg, 1975).

Smith (2006) found the areas of mathematics concepts that can be developed through orientation and mobility. According to Smith, orientation and mobility use several geometric words like: parallel, perpendicular, point, line, rectangle, curve etc. in indoor and outdoor travels. The child realizes the concept of parallel through the idea that the street with cars runs parallel or beside them as they travel down a sidewalk. “Point” refers to fixed position in space so that child will understand his or her position in the environment. Line could refer to a connection that ties points together. Lines are points arranged in a row and when points are arranged in an arc shape, it creates a curve. Other explanations by Smith that are related between orientation and mobility and mathematics are that: concepts of angles, parallel, perpendicular shapes etc through squaring off, or making 90^0 turns when engaged in street crossing activities or travelling around a shaped area. The procedure to become familiar with a room or travels around covers the concept of perimeter, area, angles, shapes etc. There is connection to measurement, consumer mathematics skills, etc.

2.4.6 Tactile Discrimination

The teaching and learning of mathematics in a tactile mode is as essential for a child with blindness as the teaching and learning of print mathematics (O’connell & Johnson, 2006). Hart (1980), in orientation and mobility, the sense of touch serves to organize perception of the shape, size and position of objects in his spatial world. The child relies upon the sense of touch in conjunction with his other remaining senses for informational intake. Through it he identifies textures, Sizes, shapes, length and width. Others are relationships between objects (similarities and differences) and object identification (comparative identification). These concepts are taught the child with blindness to aid his skills in orientation and mobility, which incidentally are mathematics concepts themselves. Pick (1980) listed activities involved in tactile concepts as:

Texture: The child becomes familiar with the differences between rough and smooth, soft and hard, hot and cold.

Size: The child compares and contrast differences in weights. (Heavy and light)

Shapes: The child becomes familiar with different shapes (round, square, rectangle, triangle etc).

Shapes of common everyday objects: (Compare and contrast lengths and widths of objects.)

Concepts that have to do with relationships: Recognizing similarities between objects (same weight, or length, same shape but one is heavier than the other) etc.

Other tactile skills are:

Touching varieties of materials including lines of Braille on a page; sorting materials into two or more categories by touch (all these shapes are big, all these shapes are small); matching objects from a given set of concrete objects based on one attribute (e.g. match circle with circle, square with square, triangle to triangle regardless of size or texture) and sorting by one attribute and to state or demonstrate what that attribute is (e.g. All these are circles all these are other shapes) (Pick, 1980). Others are identifying like shapes in various positions (e.g. recognize two triangles as the same even through one has apex pointing up and the other has the apex pointing down (Hart, 1980). In mathematics for learners with visual impairment, concept development can best be achieved through activities that promote independence and interaction with their peers. Ramesh (2006) revealed that children learn primarily by manipulation till the formal operational stage. If children are not taught mathematics with hands on methods up to the age of 12, their ability to acquire mathematics knowledge is disturbed at the point when hands on explorations were abandoned in favour of abstractions. (CTLM, 1986) Hence learning by doing, wherever feasible, is the right approach in teaching mathematics to children with visual impairment. There is the need to provide meaningful experiences that promote early acquisition of mathematical concepts and readiness for reading and writing Braille numerals and mathematical symbols. There should be a lot of activities that will expose the child with blindness to a Braille rich world as sighted children are in a print rich world with Braille numerals on objects where incidental print numeral are found. The child is exposed to many kinds of objects to count and compare shapes to explore and items such as rulers, clocks, measuring cups and spoons and thermometers designed for “blind” users (Linda, 1989). Similar concepts can be developed in mathematics for the child with visual impairment through repeated giving of opportunities to count, develop one to one correspondence and many activities to vocabulary of mathematics: more, less, equal, full, shorter, longer, taller, same, different, some, all, none, before after, bigger, smaller, middle, size, heavier, lighter, holds more, less etc

2.5 READING AND WRITING SYTEMS FOR LEARNERS WITH VISUAL IMPAIRMENT

2.5.1 Early Systems Developed for Reading and Writing for Learners with Visual Impairment

Historically, people with disabilities were perceived best on the beliefs the people had on them. Blindness was believed to be a curse; therefore people with blindness were treated unkindly and maltreated because they were seen as outcasts (Abang, 2005). Because of the biblical prohibition in Leviticus which states that “thou shall not put a stumbling block before the blind” France had to enact Laws which punished severely those who maltreated blind persons. Despite these laws, people including some Kings were still maltreating people with blindness. They made blind persons to become Jesters. They were made to dress up in funny ways and were made to sing or act in funny ways that people would be entertained (D’Andrea, 2009). At one of such occasions were blind persons were dressed in rags, they were made to act funnily and people watched and laughed and even threw objects at them. One Valentin Hauy watched the scene with displeasure. He was a teacher by profession and when he left, he vowed to start educating children with blindness.

Valentin Hauy came across a blind beggar boy of six year old by name François Lesueur and he picked him, gave him a home and started educating him. He taught him reading using moveable wooden letters which he arranged to form single words and phrases (D’Andrea, 2009). This eventually became the first school for blind children in the whole world. This was also the background from where the concept of special residential school was brought. It was with the aim of securing a safe place for them in order to provide them with the best education and care. One of the earliest methods of teaching reading and writing for persons with blindness the use of moveable wooden letters was also used.

2.5.2 Earliest Methods of Teaching Children with Blindness Reading and Writing

According to D'Andrea (2009) from the beginning, human beings were an oral species and not literate. It was later that writing was developed. Despite that, most people would not like to read and write. This was because renowned Philosophers as Socrates and Plato discouraged people by saying that books would only cause people to become more forgetful because they would no longer have to rely on their memories to recall important information (McCann, 2009). If that was the school of thought about reading and writing at that time, it was more difficult to dream developing a means of reading and writing for people with blindness with such an ideology at the time.

When people started reading and writing, there were no books. They were scarce. Books were written by hand and so they were few and difficult to get. Those who got books were people that were wealthy and could purchase and the priests since most of the books in those days were religious books. It was when Gutenberg developed movable type and printing press that mass production of books came to being and many more people had access to books and learned to read and write. When people started getting books, the situation of people who were blind remained the same as it had been for centuries. D'Andrea (2009) stated that it would be many years until a similar Gutenberg movement occurred so that affordable books were available for people with blindness.

Up to today, no much attention is given to books production for learners with visual impairment especially in countries like Nigeria. The worse books to produce are the sciences and mathematics textbooks in Braille. Braille is made of six dots cell which can produce only 64 unique combinations. The same Braille system equally expresses text in mathematics, music and science notations. Therefore each of the character of Braille has to be redefined to carry a different meaning in different subject areas depending on the type of information to be written. The ability to change comprehension of the type of Braille code being read is called code-switching (McCann, 2009). In literal Braille, the code used to express –ING as in present continuous tense (going, eating, sitting), in mathematics, you have to switch the same code to read "superscript" or "raised" to a given power (4^2, O^2, X^3). The researcher had to liaise with organisations in Britain to get mathematics textbooks transcribed to the blind student who read mathematics at the University of Jos, the first of its kind in Nigeria. Even then, the production of the text books and the transportation took long such that some of the textbooks came at the time the student had left the level he needed books most.

Before Braille was invented, there were many tactile systems that were developed to enable persons with blindness to read and write. Alphabets were produced with wood, tin, wax, and strings (Dixon 2009). According to D'Andrea (2009) there were no uniform methods of teaching blind children to read. It was Italian Jesuit Priest in the 1500s that pointed out that blind people could learn by touch. However Nijhawan (1999 p.201) did a rundown of the chronological description of reading method of persons with blindness as: the earliest systems were primitive and crude. Didymus of Alaxandria (308-395) carved letters out of wood and joined them to form words and sentences. Other inventions that followed are carving on thin tablets of wood, engraving letters on wood instead of carving, movable lead type were invented, and letters of tins were made. There were string alphabets, letters cut out of papers, sticking pins into cushions, letters pierced on cardboard. There were Line Types, which include the Hauy's Type, Gall's Type, Fry and Alston Type, Boston Line Letter/Type. There was Philadelphia Type including Lucas Type, and Frere Type. There was the Moon Type and eventual the Braille code and today Unified Braille Code for English.

According to Nobel (2009) Cranmer and Nemeth sent a memo to the Braille Authority of North America (BANA) on the need for a uniform Braille code for English. The concern was that the use of Braille was losing prominence amongst people with visual impairment due to emergence of technology, the difficulty of learning several codes and the lack of comparability between the Braille and the print text. They showed concern on transcribers who often have to switch from one meaning of a code to the other due to the fact that more codes may be used in one text.

The modern way of writing makes it difficult in Braille. There are several fond and fond sizes in a particular write up, different styles. For example, to transcribe the name **2Face**, it will be difficult in Braille. Letters ‘A’ – “I’ if preceded by number sign, they become numbers eg A becomes 1, B becomes 2, C becomes 3... I is 9. Letter “J” stands for 0. **2Face** must begin with number sign because it starts with 2 so the F is 6, a is 1 c is 3 and e is 5. Instead of reading 2Face, it will read twenty six thousand, one hundred and thirty five (26,135). Computer will not be able to switch from one meaning of a code in a particular subject area to a different meaning in another. There can never be two meanings in a code that has been fed into the computer. The principles of Unified English Braille is that: music Braille would not be part of it. Mathematical codes, computer and scientific notation would be included in the unified English Braille.

2.5.3 Braille Code

According to Chapman and Stone (1989) the most universal tactile code in use up to today is Braille. It is based on the configuration of six embossed dots and formed such that there are two rows of three vertical dots (Abang, 1995). The six dots make up a Braille cell. The dots are numbered for ease of learning and reference. There are also Braille signs that stand for groups of letters or short complete word or syllables.

Sykes and Ajuwon (1984) stated that learning to read is a complex task for children with visual impairment since they do that tactilely. Those of them who are of below average intelligence find it almost impossible to master Braille. Sykes and Ajuwon (1984) stated that their research "showed that the process of reading by means of Braille is much more complex than reading print". Sykes and Ajuwon gave reasons for the difficulty as Braille code involves the memorization not only of letters of the alphabet (Grade I Braille) but of contracted Grade II Braille. The various grades of Braille are governed by complicated and sometimes arbitrary rules.

Abang (1995) explained that the first ten letters of the alphabet were formed from the four upper dots. This gives letters "A –J". The next ten letters of alphabet are made of letters "A - J" but with a constant addition of dot 3 on each letter thereby giving the next letters "K-T". The first five letters in the second group with dot three are repeated to give the last five letters of the alphabet without letter "W" This is because Braille is of French origin and there is no letter "W".

Sykes and Ajuwon (1984) stated that Braille contractions cause problem in reading. They are not always logical; they do not consider phonetic and structural elements. They prevent auditory analysis and cause problem in syllabication and spelling. A summary of analysis of Braille by The British National Uniform Type Committee (1970) is as follows: Single letters could be used to represent words. They are known as SIMPLE UPPER WORD SIGNS. They are simple because they have dot in the top of the cell. Word signs because they represent words.

Rule: They are used for exactly the word they are representing. No other letters are added. Of the 26 letters of the alphabet only three letters "A. O. I." do not represent word signs.

E.g. B. = But, C = can, D = do, E = Every, F = from, G = go (Anumonye, 1998).

According to RNIB (1995) in Braille, there are special signs that express five very Common words. “AND, FOR, OF, THE, WITH”

Rule: Where two or more of these five word signs come in succession, they are written adjoining one another as if they were one word.

For example: ANDFORTHE...

The article “a” is similarly to be written un-spaced from any of these special signs.

There are SIMPLE UPPER GROUP SIGNS.

Group signs are signs expressing two part of a word.

The special signs that express the five common words AND FOR OF THE WITH are also used as group signs. This is because they could be used to form part of a longer word. In this case, they are priority contractions where there is a choice of contraction in a word. For example: BAND FORCE WITHDRAW

There are five upper group signs (With H) CH GH SH TH WH These signs may be used in any part of a word for the letter they represent For example: Chap High She Who However in a case where (i) and (ii) come together e.g. as in the words Then, clothes, etc. The rule of priority contraction applies here. For example: THEN, CLOTHES Out of the five upper group signs (with H) four of them could stand for word signs.

e.g. CH = child

SH = shall

TH = this

WH = which

The rule of word signs applies here.

They may only be used to express the exact word they represent and when no other letters are added to them e.g. Childish.

iii. Four upper group signs (two with “E” and two with “O”)

ED ER OU OW

Rule: They may be used in any part of a word

E. G. Bed deed Weeded

One out of these four group signs is used as a word sign

OU = out

Good Braille readers are slower than print readers (Best, 1992). Spungin, (2002) stated that there are an increased numbers of illiterate people with blindness. This is due to certain reasons. Some of them are: Positive attitudes towards the use of Braille have diminished, and potential Braille users are given second – class status and attention. University training programmes for teachers of students with visual Impairment have given lip service to teaching Braille and have over the years graduated less – proficient Braille instructors as teachers all over the world. The complexity of the Braille code makes it difficult when learning it. The dependence on audiotapes and speech output devices has helped to minimize the perceived necessity for Braille (p. 2-3). This will have a great implication on the child with blindness when it comes to teaching him or her Mathematics. This is because the mastering of Braille Mathematics codes depends on a sound knowledge of the literal Braille notation.

2.5.4 Braille Mathematics Notation

Nigeria officially adopts the British Braille System. Chatters (1986) pointed out that if the print text contains symbols which are not listed or otherwise covered in the code provided by the authority, special Braille signs may be devised to represent them or else the meaning of existing signs may be changed for the purpose (p.6). Should any of such non-standard notations be stated, it should be stated before hand at the beginning of the work or at the point of use.

The first ten letters of the Braille alphabet are of great significance. In Braille Mathematics notation, there is a sign indicating numeral or number sign. The number sign immediately following letters "a – j" represent numbers 1 - 9 and 0.

a = 1 b = 2 c = 3 d = 4 e = 5 f = 6 g = 7 h = 8 I =9 j = 0

Sighted children use different symbols for Latin letters of the alphabet from the Arabic numerals or figures. Children with blindness use the same letters of alphabet for numerals or figures. They have to show the number sign before writing the letter so that it will not show letter for number. Despite the use of numeral or number sign Chatters (1986) stated that Numeral signs may be omitted altogether from table or worked calculations to save space or to allow an uncluttered presentation. In such cases advance notice should be given (p.7).

For example to set out the mathematical expression 96 + 54 vertically, it will read exactly.

if 96

ed 54

According to Bonham (1973) an outstanding rule that teachers and pupils need to know is that sets out mathematical expressions are generally brailled in cell 5 with run over in cell 7, whatever the setting in print.

In Braille, small Latin letters and their capitals are shown with a special letter font for them. Dots 5 and 6 produced in a Braille cell following immediately a letter, the letter is a small letter.

Dot 6 alone in a Braille cell following a letter, such a letter is in a capital form. The small Latin letter sign dots 5 and 6 is generally omitted, all letters being assumed to be small Latin unless shown otherwise must, however be stated when the letter stands alone or begins a mathematical expression in ordinary text.

Is "a – j" immediately following a number (but not a lower number, e.g. the denominator of a simple fraction) even at the beginning of a line.

Immediately follows vertical bar 1

Is an O within brace brackets { }.

Is an "a" immediately after an opening square brackets [ ] in ordinary text.

Is the first letter of a small Roman numeral, or a capital Roman numeral...

The small Latin letter sign must be stated for letters a - j. This is because mathematical expressions like 2a, 6b, 5c, can cause confusion.

2a will read 21

6b will read 62

5c will read 53 etc.

Chatters (1986) stated that simple numerical fractions are coded by stating the denominator as a lower number following the numerator in the upper position (p.7).

The first ten letters of Braille alphabet (a - j) could be produced at upper case. In showing a fraction, the numeral or number sign is showed first. A letter could follow from A to J depending on the value of the numerator. A lower case of the same letters A - J is shown depending on the value of the denominator to show the denominator. In mixed numbers the numeral sign is repeated for the fractional part.

Punctuations are indicted in Braille by the same first ten letters of the alphabet as they are indicated in denominator of a fraction. To understand that you are referring to a punctuation and not a denominator of a fraction where a punctuation occur immediately after a figure, dot 6 precedes any punctuation sign except a hyphen or dash, used within or immediately following a mathematical expression (Chatters, 1986).

The punctuation marks are:

Lower a comma (,)

Lower b is Semicolon (;)

Middle c is colon (:)

Lower d is full stop (.)

Lower f is exclamation mark (!)

Lower g is round bracket in literal Braille ( )

Lower h is opening quote (“)

Lower j is closing quote (”)

If the fraction 3/4 period is to be written the ‘d’ sign or 4 sign for period and the denominator are both the same lower D. The fraction will read 3/44 (c/dd).

However it is written and a full stop indicated the second lower d is preceded by a dot 6 meaning it is punctuation and the punctuation is a full stop.

A child with blindness faces a lot of difficulty in mastering all these complex mathematical notations and their rules before he starts learning the subject. However a child with blindness can only be successful in mathematics if he or she has a sound knowledge of the mathematics Braille code. Nemeth (2006) stated that he believed that he could not have reached his potential in mathematics without the Nemeth Code. With it, he was able to read and write mathematics, as well as other sciences, at all levels, limited only by his talent and his ambition (p2).

Despite that need in the Braille mathematics codes, researches have shown lack of learning the code by both teachers and the students. Researches support the contention that teachers of children with visual impairment are not prepared in the mathematics code. According to Semwal and Evans-Kemp (2000) the teachers of students with visual impairment are woefully lacking in skill and knowledge for providing high quality instruction in mathematics for their students. He stated that the teachers lack the ability to read and write the symbols which represent mathematical concepts, and so the field of mathematics is closed to persons with blindness.

In a similar study, Wittenstein (1993) surveyed 1,663 teachers of students with visual impairment to determine the extent to which they received training in the mathematics code. He found out that 50.2% of them reported having no proficiency in the code for mathematics in their teacher preparation programs; only 35.8% reported that their knowledge of the mathematics code was satisfactory. The remaining 14% remained neutral.

Kapperman (1994) conducted a survey of 34 certified teachers of students with visual impairment, randomly selected from a list of members of the Association for Education and Rehabilitation of the Blind and Visually Impaired (AERBVI). The respondents were asked for the dot configurations of the five basic symbols from the mathematics code, which is a small portion of the total content of the code. The results demonstrated that knowledge of the mathematics code among teachers is lacking; the percentage of correct answers was exceedingly low. The most distressing statistics is that 76% (26 persons) had no knowledge of the mathematics code whatsoever; these individuals were unable to provide even a single correct answer.

DeMario, Lang, and Lian, (1998); DeMario and Lian, (2000) queried teachers of children with visual impairment to determine their perceived level of competence with regard to the literary Braille code as compared to the mathematics code. In their study DeMario, Lang, and Lian (1998), found that Teachers indicated that they felt much better prepared using the literary Braille code than using the mathematics code, and their attitude towards mathematics code was not as positive as was their attitude towards literary Braille (p.356)

In their second study, DeMario and Lian (2000), found out that the mean anxiety ratings of teachers of children with blindness increased as the level of math materials to transcribe became more advanced. As the mathematics becomes more sophisticated, teachers experience more and more difficulty. Amato (2002) studied the training in Braille for teachers of students with visual impairment, in universities where teachers of visually impaired youngsters are trained. Among her findings, the most significant with regard to training in Braille mathematics is that 20% of the programs offer no training in the mathematics code. While 22% reported that their students achieve competence in the Braille mathematics code, 24% rate their students as incompetent in this area.

2.6 EMPIRICAL STUDIES ON ATTITUDE AND ACHIEVEMENT OF CHILDREN WITH VISUAL IMPAIRMENT

2.6.1 Empirical Studies

There are more efforts in applying O&M to achieve knowledge and skills in other fields of studies of learners with visual impairment. According to Pavey (2006) independent living skills and social and emotional development have not traditionally been associated with "travel" aspects of mobility. The belief is that independent living skills and orientation and mobility are two different areas of the curriculum that could be treated separately. Pavey reported that the Visual Impairment Centre for Teaching and Research (VICTAR) of the University of Birmingham undertook a research for one year which was funded by a consortium of organisations in U.K. The research team sought for information through a combination of literature reviews, information collection and consultation through documentation analysis and semi structured interviews and focus groups with variety of professionals and people involved in the provision of mobility and independence education within the U.K.

The main data collection consisted of focus group sessions and interview with more than 70 people involved in mobility and independence policy and curriculum documents held by services around the U.K. which were obtained in response to a letter sent to 156 Local Education Authority (LEA) services and 19 special schools for the visually impaired across the U.K. Based on the findings of the research, there was common agreement that many of the foundation skills required for both independent living skills and orientation and mobility are similar. Therefore, orientation and mobility could be used to achieve skills in Independent Daily Living Skills (IDLS).

In a study titled development and validation of orientation and mobility training programme for primary schools children with visual impairment in North Central Nigeria; Dala (2012) investigated the significant difference between the effectiveness of Dala Orientation and Mobility Training Performance (DOMTP) in the knowledge level of children with visual impairment who received training and those who did not. The data collected and analysed showed the t calculated of 4.006 and the table value of 2.009 with a df of 57 at a significance level of 0.05. The Null hypothesis was rejected. The result therefore showed that Dala orientation and mobility training programme achieved and performed better in the orientation and mobility test than their peers in the control group. When learners with visual impairment train in orientation and mobility using the Dala Orientation and Mobility training programme, and at the same time are exposed to APOMP, there is the likelihood that they perform better in orientation and mobility and geometry. In a research by Rungren and Stengern (2000) they found out that concept in orientation and mobility practically helped students with blindness in understanding topics related to measurement in mathematics.

2.6.2 Challenges of Researches in Visual Impairment

There is a growing concern on the ineffectiveness and quality of research in the field of education in the world. This led to the emergence of movements to oversee issues of educational researches. Some of these movements include: the Cochran Collaboration, (http://www.cochrane.org/); established in 1993, the Campbell Collaboration (http://www.campbell collaboration.org/); established in 1999, the Norwegian Center for the health sciences established in 2004. These organizations work with the “what works clearinghouse” (WWC) (http://www.kunnskappssenteret.no) established by the Institute for Education Sciences in the US Department of Education specifically to examine research in education. Only Cochran Collaboration has investigated topics related to blindness and visual impairment. WWC has produced no reviews in visual impairment and blindness (Ferrell 2011).

Similarly researches that are in the area of visual impairment are hardly directed towards the children with visual impairment or blindness. Ferrell (2011) found that researches that employ systematic, empirical methods that draw on observation or experiment; involving rigorous data analyses that are adequate to test the stated hypotheses and justify the general conclusions drawn is often difficult to meet when it comes to children with visual impairment. Most researches in this area seem to build on case studies, anecdotal reports, individual philosophies, common sense, intuition, clinical practice.etc which are more descriptive than empirical.

According to Ferrell (2011) the National Centre on Low – Incidence Disability (NCLID) at the University of Northern Colorado examined the literature in visual impairments to determine which practices are based on the hard evidence of scientifically based research. They identified articles in mathematics and literacy that were published in English in peer reviewed journals from 1955 – 2005. One hundred and twenty eight (128) articles were identified, but only ten (10) studies (7.8%) had evidence of scientifically based research. The seven (7) of the qualifying studies in literacy and two (2) of the qualifying studies in mathematics utilised single subject research designs.

Using the American Speech Language Hearing Association (ASHA) method which has identified four levels of evidence for examining research:

a. Meta – Analysis including well – designed randomized controlled studies.

b. Controlled Studies without randomization and quasi – experimental design

c. Well designed non experimental studies (i.e. correlation and case studies)

d. Expert committee report, consensus conference and experience of respected professionals

NCLID applied these levels to the research in visual impairment and found out that most studies have been conducted at levels of “well designed non experimental studies (correlation and case studies) and expert committee report, consensus conference and experience or respected professionals. Studies that have led to the promising practices have reached the level of controlled studies without randomization and quasi – experimental design.

Gall, Borg, and Gall (2006) sought for research studies that included participants who were blind and visually impaired between the ages of 3 and 21 years; that investigated an intervention; and that included a control or comparison group of some type (participants could be their own controls) they found out that sample sizes are often too small. Often the studies are between children with and those without visual impairment. Most of the studies are qualitative studies and single subject design. Backing this opinion, Tobin (2011) in what he refers to as research commonalities, stated that even if most of the research design requirements are met for persons with visual impairment, it still remains a single sample that is often used. This makes generalization to a larger population difficult. It is difficult to have an intervention and a comparison group. Tobin is of the opinion that although Longitudinal study where the same group of participants is seen over a prolong period of time, would have reduced the possible defects of single studies, some of the changing influential factors may be lost over the years and that leads to lack of reliability, validity and generalization of the findings. Tobin finally reveals that a more research design that has potential value in a research with children with visual impairment is the single in-depth case-study which is becoming popular in the field of special education.

Bak (2011) stated that in the field of visual impairment, much of the research reflects a qualitative methodology. That much of research that happens in the field of visual impairment is case studies or surveys. Bak states that the reliance on qualitative methods occurs because of the difficulties in conducting quantitative research due to low prevalence of population of visually impaired persons. Bak gave a third research method that is in used today with children with visual impairment. This is mixed methods research. This method relies on both qualitative and quantitative studies.

Utilizing a statistical procedure used to identify trends in the statistical results of a set of existing studies examining the same research problem in mathematics, Ferrell, Buettel, Sebald, and Pearson (2006) reported that American Printing House for the Blind located 125 articles, only 10 employed systematic, empirical methods that draw empirical and involved rigorous data analyses. Wild and Allen (2009) revealed that there is a dearth of research in the field of visual impairment from which to draw the best practices.

In a review of PhD theses in the Department of Special Education and Rehabilitation Sciences University of Jos Nigeria; Osuorji (2006) in a study of an empirical validation of beginning reading skills for Nigerian primary schools using three structured methodologies, he used an experimental design for the study. The study initially aimed at addressing the beginning reading skills of junior primary school pupils (class one to two). However primary four was chosen.

The children were found to still be in the process of learning to read. They were considered as “at risk” for reading as there was the need to develop their beginning reading skills. The specific experimental design used in the study is the pre-experimental research. All samples took pre-experimental test, then the treatment and finally the post-experimental test. The tests were individually administered to the subjects. In the data analysis, the t-Test for correlated sample was used for data analysis. The sample population for the study was two hundred and seventy pupils. Despite the huge sample population of two hundred and seventy, due to the presence of disability or learning difficulty, specifically needing beginning reading skills (children at risk for reading), the treatment was administered on the pupils individually hence pre-experimental design was used.

In another study by Okwudire (2007) on the use of exchange communication system as an intervention strategy for developing non verbal language in children with autism, the researcher used a sample of four autistic children. The study therefore adopted single subject experimental design. The type of single subject experimental design chosen is the A-B-A-B design. The reason for using this design is that the number of participants was small. The design involves analysing the effect of an intervention on one or more learning outcome on an individual. The design allows the researcher to establish what had occurred with each participant in respect of his own unique performance before and after intervention. With this type of sample population, it is not possible having two groups to have control and experimental groups for experimental research. Autistic children are currently one group of children the world is battling with in terms of learning at school. A group of Americans visited Otana School in Jos seeking for the best practice in handling autistic children in school. They were ready to carry any staff with the best methods of teaching the children to America for possible further research. This is in view of the difficulty in handling autistic children.

2.7 SUMMARY OF REVIEW OF RELEVANT LITERATURE

The review of literature was done on the teaching and learning of geometry by learners with visual impairment in Nigeria. Literature review on the investigation in special schools and West African Examination Council (WAEC) results showed that learners with visual impairment in special schools do not offer mathematics (geometry) and learners with visual impairment also do not sit for Senior Secondary Certificate Examination (SSCE) mathematics (geometry) examination (RDII, 2013). This situation was earlier observed by the Federal Government of Nigeria and the government gave a directive for the enforcement of the teaching and learning of mathematics (geometry) by learners with visual impairment in schools (Personal communication by Federal Ministry of Education1987). Despite the order given by Federal Government, schools still find it difficult to teach the subject to learners with visual impairment.

The outcome of the literature review showed that non inclusion of learners with visual impairment (LWVI) in mathematics and geometry is found in many countries of the world. There are many reasons for the non achievement of learners with visual impairment in geometry. There are no provisions for special teaching materials and skills on how to operate them. There is no mastery of the mathematical Braille notation code due to lack of training.

Literature review showed that mathematics especially geometry is a field which has often been considered beyond the capacity of learners with visual impairment to master. Traditionally it has been inaccessible to them because the content is perceived to be rich with visually presented concepts and information; and the concepts of geometry do not come readily to a learner with visual impairment, because of its spatial content (Kapperman & Sticken 2003). However spatial tasks are said to be visual and this is the main challenge in the life of persons with visual impairment. Never the less, there are spatial concepts in orientation and mobility similar to concepts in geometry which could easily be used in presenting spatial concepts to learners with visual impairment. There is the need to link concept of geometry with orientation and mobility training (Chander, 1992). This is why applied orientation and mobility programme (APOMP) needs to be tested in this study.

Despite the policies and directives given by Federal Government of Nigeria on teaching and learning of geometry to learners with visual impairment (LWVI), despite theories and beliefs on the difficulties LWVI have in offering the subject, there are no suggestions on new methodologies or new programmes developed with the aim of enhancing participation and achievement in geometry of LWVI. This is why research on applied orientation and mobility (APOMP) at this time is important.

The results from the literature review revealed that people discourage learners with visual impairment from attempting to offer mathematics (geometry). This in turn has caused fear and anxiety in learners towards offering the subject. Parents, teachers, friends, guardians etc because of the perceived difficulty of geometry to LWVI exempt the learners from offering geometry and make it a norm. This has in turned made LWVI to form attitude that has made it impossible for them to learn the subject. Attitude is an important concept to learn mathematics (geometry) (Hassan & Farazed, 2011). The literature review showed that LWVI confessed that they do not like mathematics (geometry). This affects their interest, self confidence and achievement in geometry. They develop anxiety, fear and tension which interfere with their mathematics or geometry achievement. The anxiety in some cases has led to different diseases or illnesses such as syndrome of emotional reaction to mathematics (geometry) (Dreger and Aiken as cited by Klingenberg 2007); has led to paralysis and mental disorders (Tobias & Weissbrod, 1980); emotional stress, amnesia (memory loss), nausea, stomach-ache, nervousness etc (Tobias, 1993; Kitchen, 1995).

There cannot be any effort in investigating the achievement of learners with visual impairment in mathematics (geometry) without looking at factors like attitude of the learners towards mathematics (geometry). There is need for working on the attitude of learners with visual impairment (LWVI) towards geometry in particular and mathematics in general. There is the need for developing programmes and methodologies that can result in participation, success and achievement in geometry and mathematics hence the need for the present research study.

The review of literature showed that visual impairment can be classified based on age at onset. There are learners with congenital and adventitious visual impairment. There are theories based on the age at onset of visual impairment that existed for long. There is the deficiency theory which states that spatial concepts are impossible in people with visual impairment from birth (congenital). There is also the inefficiency theory which suggests that people who are visually impaired from birth develop concepts and representations of space but that they are functionally inferior to those of the sighted and the late (adventitious) visually impaired (Fletcher, 1980). A research on achievement in and attitude to geometry needs to compare these two factors on learners with visual impairment.

Much of the literature review linked on impossibility of teaching geometry to learners with visual impairment resulting in non participation or involvement in learning of mathematics or geometry by learners with visual impairment but with the use of applied orientation and mobility programme (APOMP) is possible and the result showed high achievement in geometry. The use of concepts and skills in orientation and mobility to teach mathematics specifically geometry is a new idea. There is therefore dearth of literature on the use of orientation and mobility to teach mathematics or geometry.

CHAPTER THREE
METHOD AND PROCEDURE

Chapter three of this study discusses the research method and procedure namely: research design, population and sample, sampling technique and sample size. Others are instruments for data collection, description of instruments, and procedure for instrument development, validity and reliability of the instruments. There is procedure for data collection, training research assistants and method of data analysis.

3.1 RESEARCH DESIGN

The research design used in this study was experimental design. Specifically the pre-test post test design was used. The subjects were randomly assigned to experimental group and the control group. Both groups were given pre-test; No treatment was given to control group. Treatment was given only to experimental group. Both experimental and control groups were given post-test.

Table 1: Experimental Design.

S/N.	Design	Group(s)	Pre-test	Treatment	Post-test
1	Pre-test-Post-test design	RE	O_1	X	O_2
		RC	O_3	_	O_4

RE = Randomly Assigned Experimental Group

RC = Randomly Assigned Control Group

X = Treatment

O_1 = Pre-test for Experimental Group

O_2 = Post-test for Experimental Group

O_3 = Pre-test for Control Group

O_4 = Post-test for Control Group

3.2 POPULATION AND SAMPLE

3.2.1. Population: The population of the research was all the learners with visual impairment in all the residential special schools solely for learners with visual impairment in the Federal Capital Territory Abuja and Plateau state, Nigeria. The residential special schools in the Federal Capital Territory Abuja and Plateau state had a total population of one hundred and fifty seven (157) learners with visual impairment.

3.2.2. Sample: Ten samples were randomly selected from each of the two schools (Abuja and Gindiri) making a total of twenty sample size.

Table 2: Population of Learners with Visual Impairment in Residential Special Schools in Abuja Federal Capital Territory and Gindiri Plateau State of Nigeria.

S/N	States/FCT	Residential Special School	Number of Learners with Visual Impairment
1	FCT Abuja:	FCT School for the Blind Children Abuja (Solely for blind children)	94
2	Plateau State:	School for blind children Gindiri (Solely for blind children)	63
Total			157

Source: field data (2013)

3.3 SAMPLING TECHNIQUE

This section discusses the sample size and the sampling technique that were used in selecting the samples.

3.3.1 Sample Size

The sample size was ten learners with visual impairment in classes four and five of each of the schools for blind children in Gindiri, Plateau state and Abuja, Federal Capital Territory (FCT) in Nigeria. This made a total sample population of twenty learners with visual impairment in all.

The sampling method used was the stratified sampling technique. The choice of stratified sampling technique was because the learners with visual impairment were grouped in two strata based on age at onset of their impairment. Those that were congenitally (acquired impairment before, during or at birth) visually impaired and those that were adventitiously (acquired impairment at later life) visually impaired. The age at onset of visual impairment was determined from the records of the learners as documented by the school when they first came to the school and they filled the school forms.

Proportional stratified random sampling method was used in drawing the samples. The population for classes four and five in the two schools were 19 in Abuja and 16 in Gindiri making a total of thirty five (35). The ratio of congenital to adventitious learners with visual impairment = 0.5: 0.5 Sample size needed for each school was 10. Therefore there were five (5) congenital learners with visual impairment in each school and five (5) adventitious learners with visual impairment in each school, making a total of ten (10) learners with visual impairment in each school.

Table 3: The Population of Gindiri and Abuja Schools for Blind Children in Classes Four and Five

Institution	Congenitally Visually Impaired	Adventitiously Visually Impaired	Total Population
Abuja	10	9	19
Gindiri	7	9	16
Total	17	18	35

Source: Field Study 2013

Table 4: Determining Sample Size

	Age at Onset		
	Congenital	Adventitious	Total
Population of subgroups	17	18	35
Proportion	17 ÷ 35 = 0.48 (0.5)	18 ÷ 35 = 0.51(0.5)	0.99 (1)
Sample size of sub groups	0.48 x 20 = 9.6 (10)	0.51 x 20 = 10.2 (10)	19.8 (20)

Sample size needed was 10 for both congenital and adventitious groups in each of the two schools (Abuja and Gindiri) making a Total of 20

Source for determining sample size: Nwankwo (2011, p.104 – 105)

Table 5: Distribution of Sample Size for the Two Residential Schools in Percentage

Population	Stratified by Age at Onset of Visual Impairment	Selected Sample for each school
Learners With Visual Impairment (LWVI)	Congenitally VI (0 – 7) Adventitious VI (8+)	Abuja Congenital = 5 (25%) Adventitious = 5(25%) Gindiri Congenital = 5 (25%) Adventitious = 5 (25%) TOTAL = 20 (100%)

Table 6: Distribution of Sample to Experimental and Control Groups

School	Experimental Group	Control Group
Abuja	5 (25%)	5 (25%)
Gindiri	5 (25%)	5 (25%)
Total	10 (50%)	10 (50%)

Sample size for experimental group in Abuja is 5 (25%). Sample size for experimental group in Gindiri is 5 (25%). Sample size for control group for Abuja is 5 (25%). Sample size for control group for Gindiri is 5 (25%).

The congenitally visually impaired were grouped from ages 0 to 7 because it is believed that children who become visually impaired at those ages will not have enough memory of the past. Some authors indicate ages 0 – 5. However, there is usually a lag in all round development of children with visual impairment in developing countries hence the researcher extended the age at onset of congenitally visually impaired to 7 years.

3.4 INSTRUMENTS FOR DATA COLLECTION

There were a total of two instruments used in the study. They include:

1. Attitude to Geometry Scale (AGS).
2. Adapted Geometry Task Performance Test (AGTPT).

3.4.1 Description of the Instruments

Two instruments were used for this study. They were:

Attitude to Geometry Scale (AGS).

The instrument is a non cognitive and researcher design instrument. It was developed to assess the attitude condition or nature and direction of learners with visual impairment towards geometry. The Attitude to geometry scale (AGS) has two sections: A and B. Section A has items on the learner's background information while section B has items that measure the learner's attitude to geometry. The questionnaire was based on Likert's five point scale on attitude of: Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D), and Strongly Disagree (SD). The scale has a total of 30 items that measure the nature and direction of learners' attitude to geometry.

Adapted Geometry Task Performance Test (AGTPT)

This is a geometry task performance test developed by the researcher. It contains ten (10) items with concepts and skills in orientation and mobility connected or linked to geometry tasks. The items covered spatial concepts, concepts of measurement, directional bearing, identifying and drawing straight, curve, horizontal and vertical routes and lines, polygons and quadrilaterals. All the topics and content in the task performance test designed were from geometry taught in classes four and five in the primary school in Nigeria. The questions were drawn in line with the evaluation guide of applied orientation and mobility programme (APOMP).

3.4.2 Procedure for Instrument Development

Development of Attitude to Geometry Scale (AGS)

This is a non cognitive scale or questionnaire on the nature and direction of the attitude of the samples towards descriptive geometry. The construction of the questionnaire was based on alignment with the research process. The questionnaire items were aligned with the purpose of the study and the research questions. The construct of content of attitudinal issues were based on three components. They were belief, affect and behaviour. The items or statements in attitude to geometry scale (AGS) were all on opinions on descriptive geometry and were based on the three components of attitude (belief, affect and behaviour). Each of the components contained ten (10) statements making a total of thirty (30) statements in the questionnaire to cover a wider content area or dimension of the variables. None of the questionnaire items was written in a question form. The items were written in both positive and negative form. These were the principles that guided the development of attitude to geometry scale (AGS).

Development of Adapted Geometry Task Performance Test (AGTPT)

The Adapted geometry task performance test (AGTPT) was a cognitive instrument developed from geometry task contents that were related to basic concepts and skills in orientation and mobility. The tests were aligned to the hypotheses stated in the work. The questions were derived from measurement of objects in space to measurement of embossed lines. The use of centimetre as a standard unit of measurement of length was considered. The learners therefore were engaged with adapted measuring devices, e.g. embossed rulers. The questions involved measurement of embossed lines and drawing lines to a given specification using instruments from the drawing kits. The questions touched on shapes. They include finding perimeter and drawing of given types of shape to a given dimension both of objects and two dimensionally embossed shapes and lines. There was the consideration of the different lines in geometry. The test covered topics on bearing or angles. Primary school mathematics text books were used. The particular text books were those of classes four and five. The questions were formed from topics within geometry.

3.5 VALIDITY AND RELIABILITY OF THE INSTRUMENTS

3.5.1 Validity

Face validity: The two instruments and one programme were given to experts in the field of mathematics and orientation and mobility to check the content of the instruments for scrutiny. Applied orientation and mobility programme (APOMP) has a total of four themes that cover four main topics in geometry. Questions were set to cover the four themes and the four main topics so that representatives of what had been taught or skills trained on were set.

3.5.2 Reliability

The researcher determined the extent to which the scores of measurement have stability. A stability estimate of reliability or test – retest reliability was used. This was done by administering the task performance test and the attitude questionnaire on a group of respondents and after three (3) weeks the test was re-administered to the same group. The resultant scores were correlated. This was to measure the consistency of the respondents' performance over time. The results of the tests were correlated and the correlation coefficient obtained for the attitude to geometry was 0.70 and task performance in geometry test was 0.72.

3.6 PROCEDURE OF DATA COLLECTION

The researcher established a good rapport with the subject. This was because learners with visual impairment are often sceptical of a stranger. They often rally round a person making first contact with them and even fill the person with their hands to give them more idea as to how the person looks. They would wish to discover the attitude of the person towards them immediately. The respondents being with visual impairment were given instruction on how to respond to the questionnaire. They were supplied the questionnaire in Braille and since they could not tick as sighted persons, they were given a Braille sheet of paper to indicate their opinion against the number of every questionnaire item using Braille machine or slate and stylus. Research assistants helped in reading for those that acquired the impairment at later life and were still struggling with Braille skills and those that were poor at reading. In such cases tape recorders were used to record the responses of some and research assistants ticked for some. The research assistants were told on the need for honesty when dealing with learners with visual impairment. They read and tick the choice of opinions from print copy of the questionnaire for the learners with visual impairment.

On the use of applied orientation and mobility programme (APOMP) as treatment (intervention), the research assistants with the support of the researcher were exposed to the experimental groups to the treatment four times a week for a total of eight weeks. This involved demonstrating the geometry skills first as per the topic through orientation and mobility skills and concepts since it is embedded in the skills. When learners had identified the geometrical skills in the orientation and mobility skills, the second stage was to transfer the skill to tactile embossed form then finally they presented the concept abstractly as was always done in the classroom. The control group was not exposed to the treatment.

3.6.1 Training of Research Assistants

Three research assistants were trained in each school. One was a mathematics teacher at the primary school level teaching learners with visual impairment, one a special education expert with specialty in the education of the visual impairment, with competency in orientation and mobility skills. The third was an aid or assistant who had to oversee the equipment/materials used and their distribution and supported the other two research assistants. There was collaboration work among the research assistants.

3.6.2 Administration of Pre-test

The research design used was pre-test, post-test design. Pre-test was given to both experimental and control groups. The learners responded to the questionnaires before and after treatment.

3.6.3 Description and Administration of Applied Orientation and Mobility Programme (APOMP) (Treatment)

The treatment period lasted for two hours forty minutes lessons per week for a total period of eight weeks. The experimental group was exposed to practical demonstration of geometrical skills as embedded in orientation and mobility for a total period of one hour twenty minutes a week and they were further exposed to geometry skills for another one hour twenty minutes within the same week. With the support of the research assistants, the experimental group practically demonstrated the tasks using other remaining senses by identifying three ‘Dimensional’ objects as in shapes and polygons, walked through given directions and made turns to given angles as in compass bearing and angles and took measurement of their body parts as in body parts and measurement and transferred the measurement to objects in the environment etc as stated in the applied orientation and mobility programme.

With the use of improvised rubber mats, polythene sheets, the three “D” shapes or objects identified and measured were translated to two ‘D’ shapes and measured etc. The teaching and learning materials include: drawing kits which include – embossed rulers, protractors, pair of compass, T – Square, clock faces, embossed special angles etc. Practical activities as embedded in orientation and mobility were translated into geometry algorithm. This gave the experimental group the opportunity to practically experience the teaching and learning of geometry and to translate it to classroom situation using rubber mat, polythene sheet and stylus just like their sighted peers will use paper and pencil. The researcher frequently visited the sessions during the treatment to ensure that the research assistants were giving the right instructions.

3.6.4 Administration of Post-test

At the end of eight weeks of administration of treatment (APOMP) on the experimental group, Post-test on attitude to geometry scale (AGS) and adapted geometry task performance test (AGTPT) were administered on the experimental and control groups.

3.7 METHOD OF DATA ANALYSIS

Three research questions and five hypotheses were used for this study. The three research questions were analysed by the use of simple percentage and mean. An independent t-Test was employed in testing all the five hypotheses.

3.7.1 Research Questions

Research Question One

This research question seeks to find out the nature of task performance of learners with visual impairment in geometry. Mean scores and mean were used in the analysis to determine the task performance and were presented in bar charts.

Research Question Two

This research question seeks to find out the utility value of applied orientation and mobility to learners with visual impairment in geometry. Simple percentage and mean were used and the results presented in the form of bar charts.

Research Question Three

This research question seeks to find out the nature and direction of attitude of the respondents towards geometry. Simple percentage and mean were used and the results presented in the form of bar charts.

3.7.2 Hypotheses

Hypothesis One

The hypothesis compared the mean task performance scores of the experimental group and control group in geometry. An independent-sample t-Test was conducted to test the significant difference in the task performance in geometry. On the bases of making decision 0.05 was used as the level of significance.

Hypothesis Two

The hypothesis compared the mean task performance scores of the congenital group and adventitious group in geometry. An independent-sample t-Test was conducted to test the significant difference in the achievement in geometry. On the bases of making decision 0.05 was used as the level of significance.

Hypothesis Three

The hypothesis compared the mean applied orientation and mobility programme utility value scores of the experimental group and control group in geometry. An independent-sample t-Test was conducted to test the significant difference in the utility value of the two groups in geometry. On the bases of making decision 0.05 was used as the level of significance.

Hypothesis Four

The difference between the mean scores of attitude of experimental and control groups was tested. An independent sample t-Test was used to test the significant difference in the attitude towards geometry of the experimental group compared with the control group at 0.05 significant level.

Hypothesis Five

The mean scores difference in attitude of congenital group compared with the adventitious group towards geometry was tested; using independent sample t-Test at 0.05 level of significance.

CHAPTER FOUR
RESULTS AND DISCUSSION

The results of the data collected for the research questions and hypotheses were presented, analysed and discussed.

4.1 RESULTS

4.1.1 Research Questions:

Research Question One:

What is the nature of geometry task performance of learners with visual impairment?

The data for analysing this research question were obtained from adapted geometry task performance test (AGTPT). The statistical tool used in analysing the scores was simple percentage and presented in bar chart.

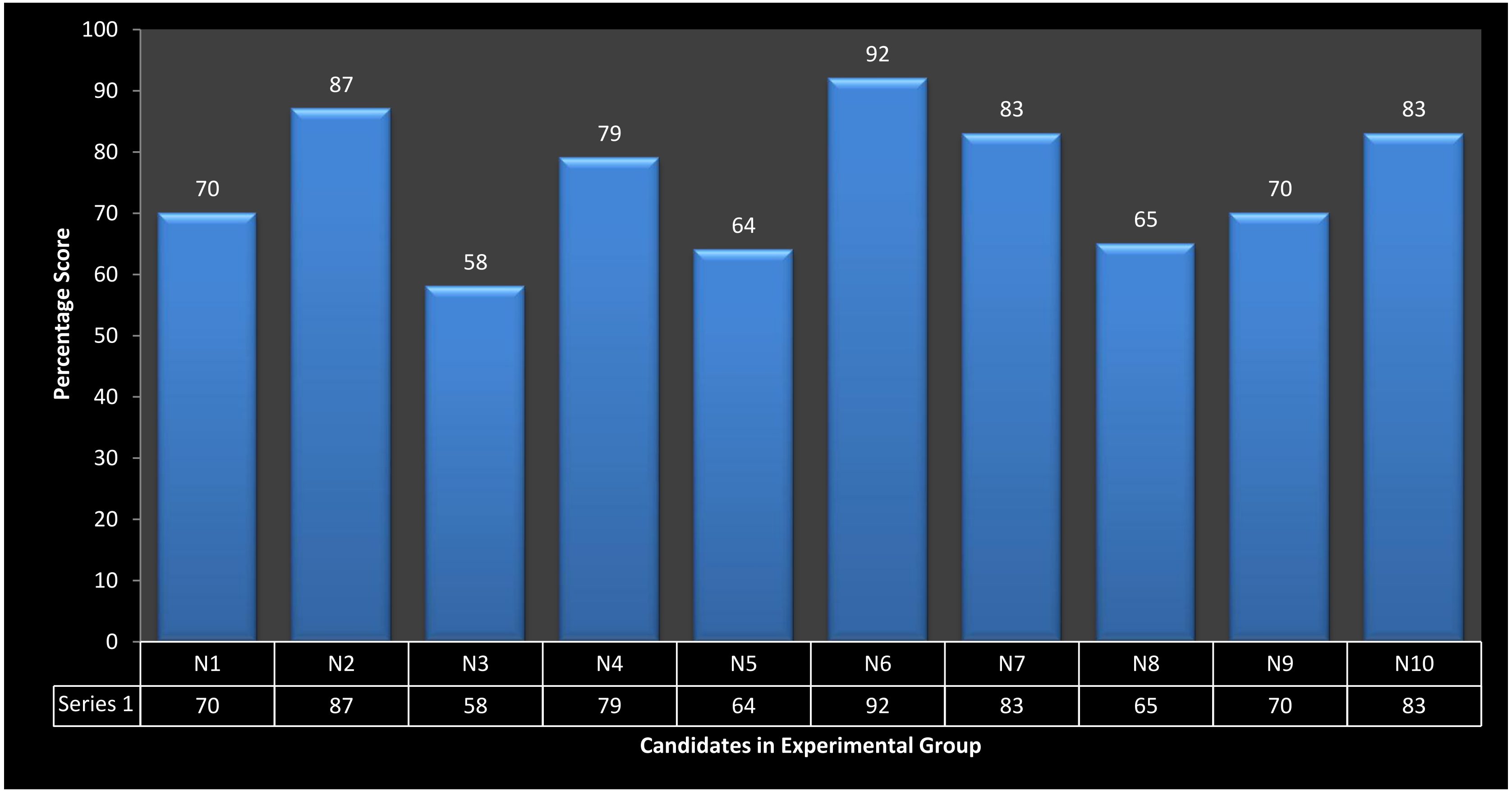


Figure 1 Individual Performance in Adapted Geometry Task Performance Test (AGTPT) for Experimental Group

Figure 1 shows individual performance in adapted geometry task performance test of experimental group on the bar chart

N_1 = 70% N_2 = 87% N_3 = 58% N_4 = 79% N_5 = 64% N_6 = 92% N_7 = 83%

N_8 = 65% N_9 = 70% N_{10} = 83%

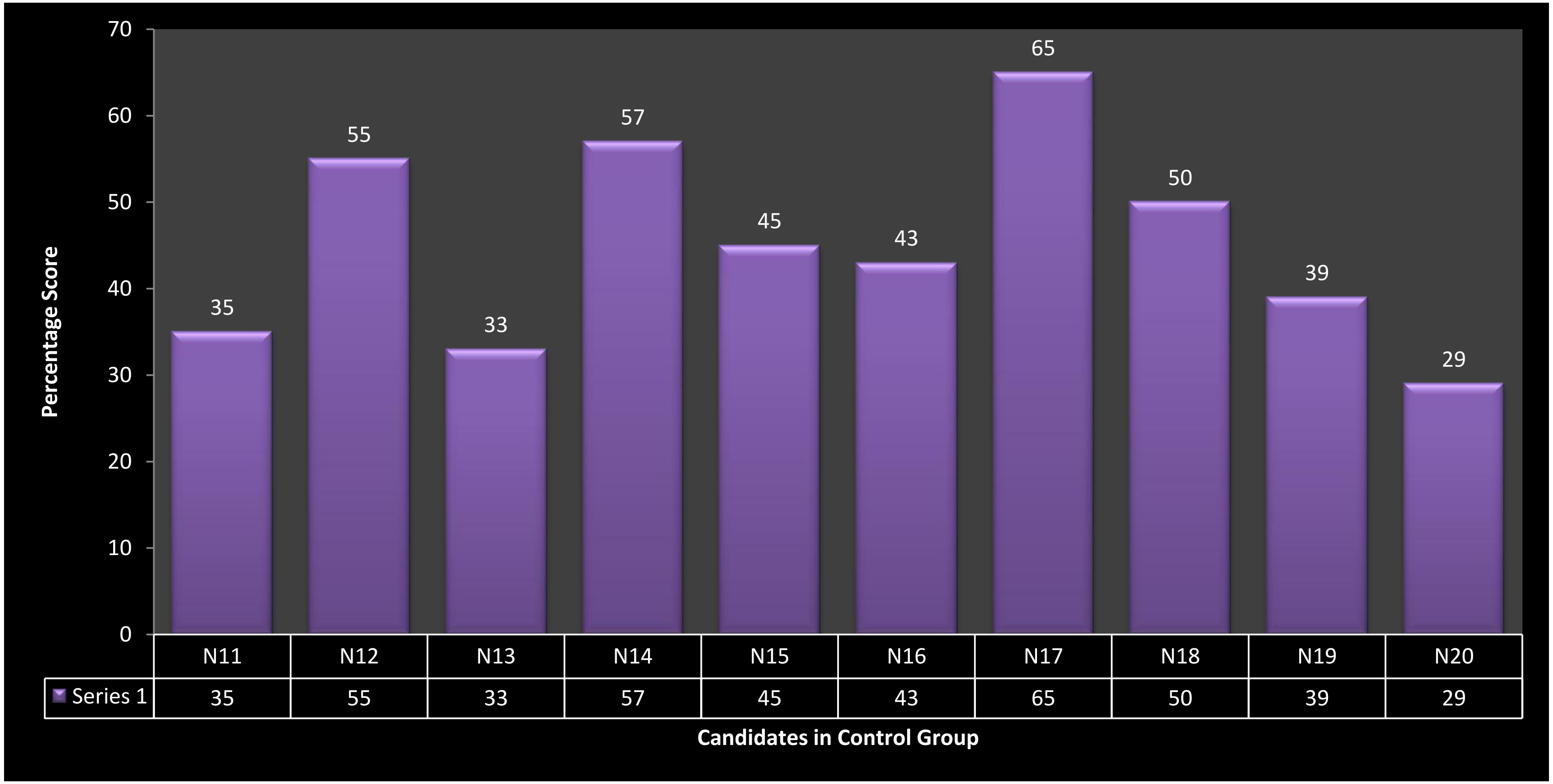
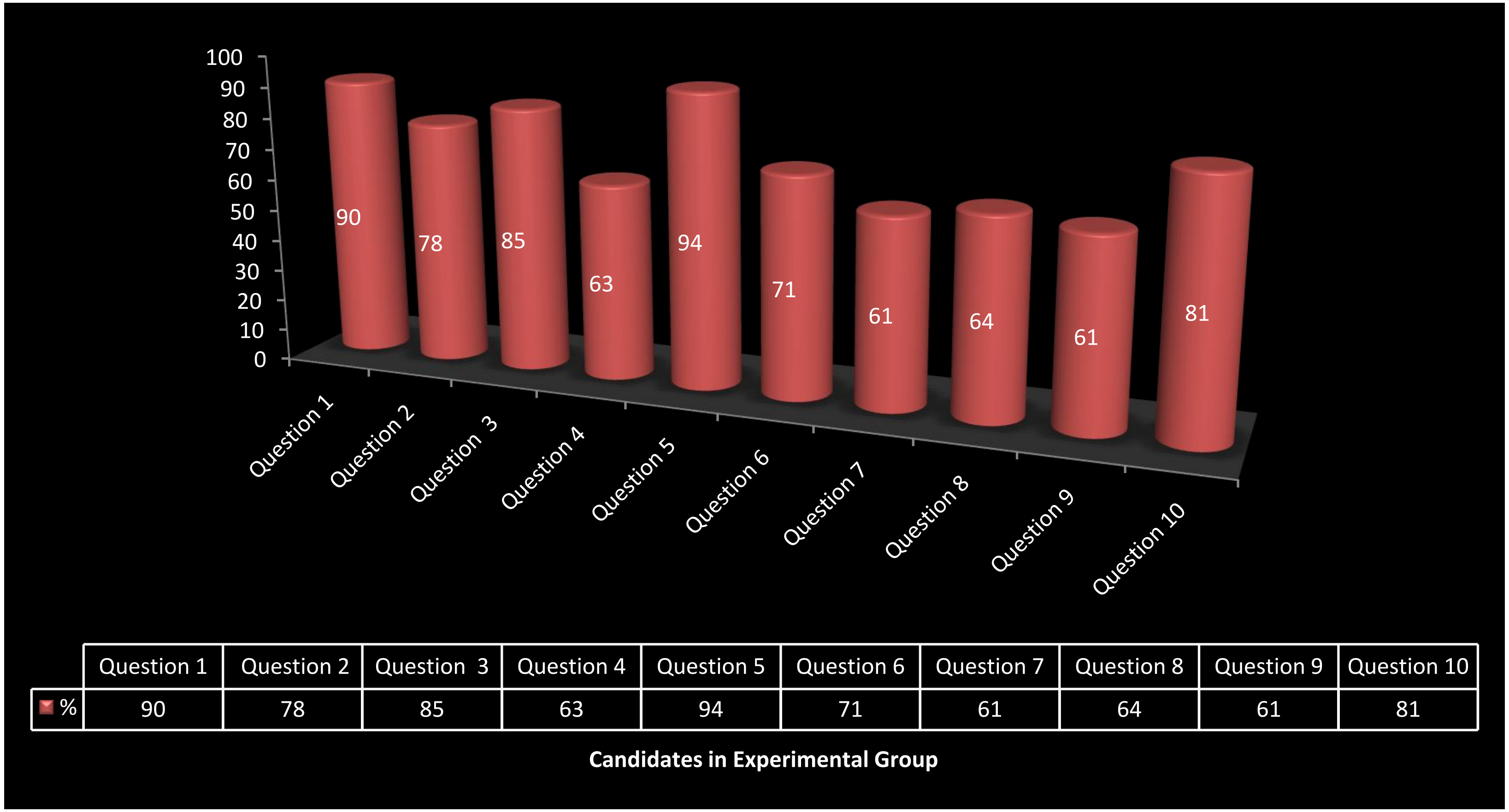


Figure 2: Individual Performance in Adapted Geometry Task Performance Test (AGTPT) for Control Group

Figure 2 shows the individual performance in adapted geometry task performance test of control group on the bar chart.

N_{11} = 35% N_{12} = 55% N_{13} = 33% N_{14} = 57% N_{15} = 45% N_{16} = 43% N_{17} = 65%

N_{18} = 50% N_{19} = 39% N_{20} = 29%



	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6	Question 7	Question 8	Question 9	Question 10
%	90	78	85	63	94	71	61	64	61	81

Figure 3: Adapted Geometry Task Performance Test (AGTPT) Result in Percentage for Each Question for Experimental Group

Figure 3: Question one stated that learners with visual impairment should identify two objects in the environment and take measurement between the objects. This question aimed at achieving identification of land marks in the environment; and spatial tasks to process and identify spatial properties which include: shapes, size, distance, and measurement. The result showed 90% task performance by learners with visual impairment in experimental group on question number one of adapted geometry task performance test (AGTPT) as seen on the bar chart.

Question two was an instruction asking the respondents to walk through routes that were: i. Straight ii. Curved iii Horizontal iv Vertical. This question aimed at making the learners walk through paths, roads, and routes to establish straight lines, curved lines, horizontal lines and vertical lines. It gives the learners the concept of straight, curve, horizontal, vertical and distance. From figure 3, learners with visual impairment in experimental group achieved 78% in the tasks in question two of adapted geometry task performance test (AGTPT).

Question three: From the given polygons, identify their shapes and put Braille name tags on each. i. Triangle ii. Rectangle iii Parallelogram iv. Trapezium: The aim of this question was to give the learners the opportunity to observe various shapes both with haptic (grasping) and tactile (feeling) processes to identify the number of sides, shapes and names of the given polygons. Task performance as seen on the chart in question three by experimental group was 85%.

Question four: With the use of the face of a clock learners with visual impairment show the following: i. 90^0 ii. 180^0 iii. 45^0 iv. 190^0 between the two hands of the clock. This question aimed at testing the learners on cardinal points, relating it to rotation and setting given degree of rotation. The task performance of learners with visual impairment on the adapted geometry task performance test (AGTPT) on question four on the chart for experimental group was 63%.

Question five states: Given objects in the environment, learners with visual impairment identify the following shapes: (i) Circle or round (ii) Rectangular shapes, (iii) Triangular shapes and (iv) Square. This question aimed at giving a practical experience involving spatial tasks given to learners with visual impairment through non visual means. It required processing and understanding spatial properties which include shapes, size, distance, measurement etc. The graph showed the total score in the adapted geometry task performance test (AGTPT) question five (5) for experimental group to be 94%.

Question six of the items in adapted geometry task performance test (AGTPT) of research question two was: Given the following embossed lines and using adapted measuring rulers, measure their lengths

i. (2cm) ____________________________ ii. (4cm) _________________________

iii. (6cm)_____________________________

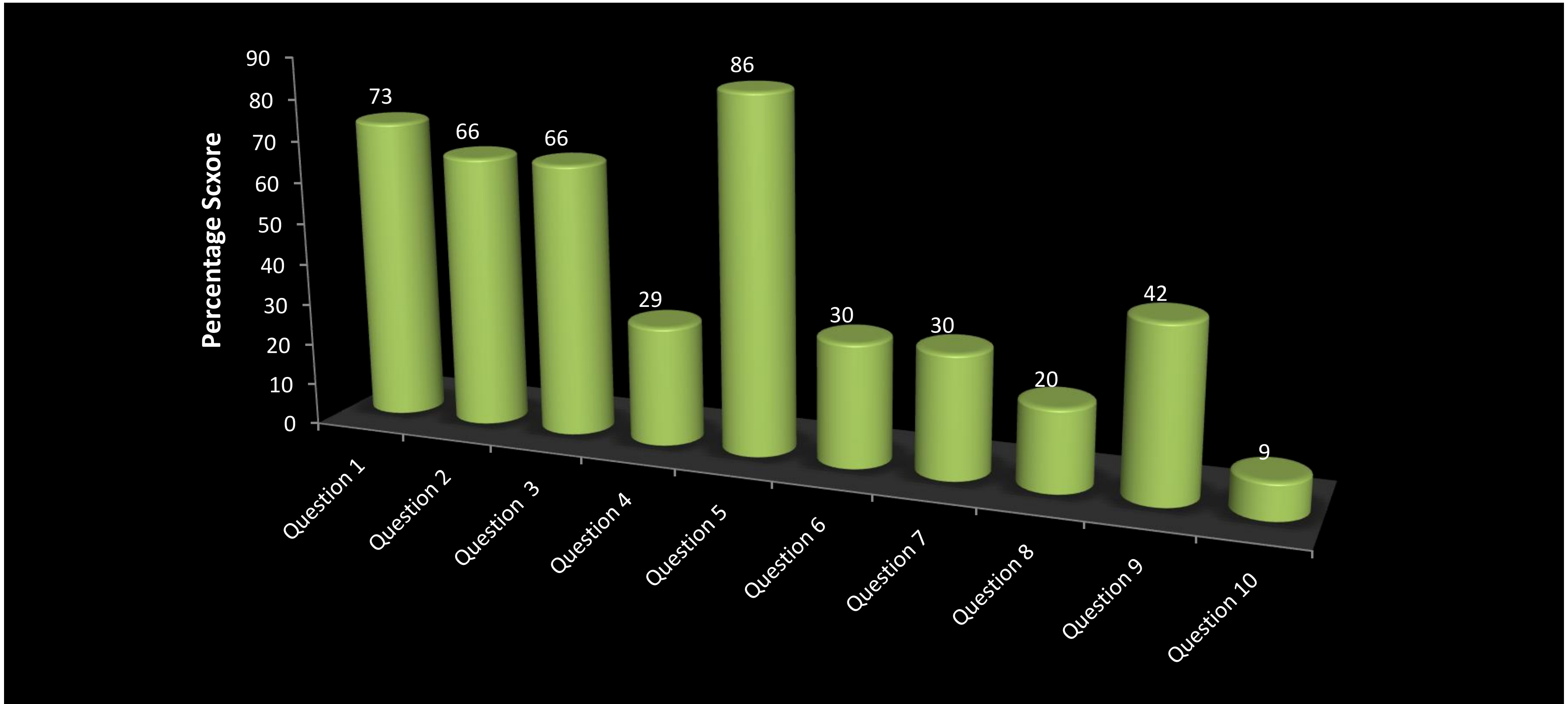
This question aimed at tactile identification of embossed lines, practical measurement of lines, and practical use of standard measurements. LWVI scored 71% on the task performance chart of adapted geometry task performance test (AGTPT) of the experimental group.

Item question seven of the adapted geometry task performance test (AGTPT) stated that: Using drawing Kits draw by embossment: i. Horizontal line of 4cm; ii. Vertical line of 2cm; iii. Two parallel lines of 6cm each. This question aimed at making the learner use adapted materials in the drawing kits e.g. adapted drawing mat, plastic sheet, embossed ruler, pair of compass, T-square to draw different types of lines to given distances or measurements. The result on the chart showed 61% achievement for experimental group.

Question eight: With the use of adapted protractors, measure and name the following special angles: (right angle), (straight angle), (obtuse angle), (reflex angle). The question aimed at making the learners identify, name, and measure angles. The task performance of learners with visual impairment on the adapted geometry task performance test (AGTPT) on question eight on the chart was 64% for experimental group.

Question nine: Tactilely identify and name the following embossed shapes: (Triangle [3 sides]), (Pentagon [5 sides]), (Hexagon [6 sides]), (Rectangle [4 sides]), (Octagon [8 sides]). The question aimed at making the learners to identify flat embossed polygons by shapes, number of sides, names and angles. The task performance score for this question on the chart showed 64% for experimental group.

Question ten: using adapted drawing instrument, draw by embossment the following shapes: i. Rectangle, ii. Triangle, iii. Square. Question ten aimed at making the learners to identify shapes, shape sides and use instruments in the adapted drawing kits to draw given quadrilaterals. The result of the task performance on the adapted geometry task performance test (AGTPT) as seen on the chart was 81% for experimental group.



	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6	Question 7	Question 8	Question 9	Question 10
%	73	66	66	29	86	30	30	20	42	9

Candidates in the Control Group

Figure 4: Adapted Geometry Task Performance Test (AGTPT) Result in Percentage for Each Question for Control Group.

Figure 4: Showed the bar chart of scores obtained in adapted geometry task performance test in percentage. Question one stated that learners with visual impairment should identify two objects in the environment and take measurement between the objects. This question aimed at achieving identification of land marks in the environment; and spatial tasks to process and identify spatial properties which include: shapes, size, distance, and measurement. The result showed 73% task performance by learners with visual impairment on question number one of adapted geometry task performance test (AGTPT) as seen on the chart for control group.

Question two was an instruction asking the respondents to walk through routes that were: i. Straight ii. Curved iii Horizontal iv Vertical. This question aimed at making the learners walk through paths, roads, and routes to establish straight lines, curved lines, horizontal lines and vertical lines. It gives the learners the concept of straight, curve, horizontal, vertical and distance. From question two, learners with visual impairment in control group achieved 66% in the tasks in question two of adapted geometry task performance test (AGTPT).

Question three: From the given Polygons, identify their shapes and put Braille name tags on each. i. Triangle ii. Rectangle iii. Parallelogram iv. Trapezium. The aim of this question was to give the learners the opportunity to observe various shapes both with haptic (grasping) and tactile (feeling) processes to identify the number of sides, shapes and names of the given polygons. Task performance as seen on the bar chart of the control group in question three was 66%.

Question four: With the use of the face of clock learners with visual impairment show the following: i. 90^0 ii. 180^0 iii. 45^0 iv. 190^0 between the two hands of the clock. This question aimed at testing the learners on cardinal points, relating it to rotation and setting given degree of rotation. The task performance of learners with visual impairment in control group on the adapted geometry task performance test (AGTPT) on question four on the chart was 29%.

Question five stated that: Given objects in the environment, learners with visual impairment identify the following shapes: (i) Circle or round (ii) Rectangular shapes, (iii) Triangular shapes and (iv) Square. This question aimed at giving a practical experience involving spatial tasks given to learners with visual impairment through non visual means. It required processing and understanding spatial properties which include shapes, size, distance, measurement etc. The graph showed the total score for control group in the adapted geometry task performance test (AGTPT) question five (5) as 86%.

Question six of the items in adapted geometry task performance test (AGTPT) of research question two was: Given the following embossed lines and using adapted measuring rulers, measure their lengths

i. (2cm) ________________________ ii. (4cm) ________________________________

iii. (6cm)______________________________

This question aimed at tactile identification of embossed lines, practical measurement of lines, and practical use of standard measurements. Learners with visual impairment scored 30% on the adapted geometry task performance test (AGTPT) of the control group.

Item question seven of the adapted geometry task performance test (AGTPT) states that: Using drawing kits draw by embossment: i. Horizontal line of 4cm; ii. Vertical line of 2cm; iii. Two parallel lines of 6cm each. This question aimed at making the learner use adapted materials in the drawing kits eg adapted drawing mat, plastic sheet, embossed ruler, pair of compass, T-square to draw different types of lines to given distances or measurements. The result on the chart showed 30% task performance for control group.

Question eight: With the use of adapted protractors, measure and name the following special angles: (right angle), (straight angle), (obtuse angle), (reflex angle). The question aimed at making the learners identify, name, and measure angles. The task performance of learners with visual impairment in the control group on the adapted geometry task performance test (AGTPT) on question eight on the chart was 20%.

Question nine: Tactilely identify and name the following embossed shapes: (Triangle [3 sides]), (Pentagon [5 sides]), (Hexagon [6 sides]), (Rectangle [4 sides]), (Octagon [8 sides]). The question aimed at making the learners to identify flat embossed polygons by shapes, number of sides, names and angles. The task performance score for this question on the chart for control group showed 42%.

Question ten: using adapted drawing instruments draw by embossment the following shapes: i. Rectangle, ii. Triangle iii. Square. Question ten aimed at making the learners to identify shapes, sides and use instruments in the adapted drawing kits to draw given quadrilaterals. The result of the task performance of control group on the adapted geometry task performance test (AGTPT) as seen on the chart was 9%.

Table 7: Result of the Mean Score of Adapted Geometry Task Performance Test (AGTPT) of Experimental and Control Groups

	Group	N	$\bar{X}$
Achievement score	Experimental	10	75.1
	Control	10	45.1

Table 7 above shows that the mean score for experimental group is 75.1. The mean score for control group is 45.1. There is significant difference in the mean score in the task performance in adapted geometry task performance test (AGTPT) of the experimental group and the control group.

Research Question (Two):

To what extent can applied orientation and mobility programme be of utility value to learners with visual impairment in geometry?

Table 8: Result of the Mean Score in five geometry task performance for Utility Value of Applied Orientation and Mobility of Experimental and Control Groups

	Group	N	$\bar{X}$
Achievement score	Experimental	5	67.6
	Control	5	26.2

Table 8 shows that the mean score in five geometry questions in applied orientation and mobility programme for experimental group is 67.6. The mean for control group is 26.2. There is significant difference in the mean score in five geometry questions of experimental group and the control group.

Research Question Three:

What is the nature and direction of attitude of learners with visual impairment to descriptive geometry aspect of mathematics?

The data for this question were derived from the opinion of the experimental and control groups by responses to the items of the three attitude constructs (belief, affect and behaviour) of attitude to geometry scale (AGS). The data were presented in charts in figures and tables.

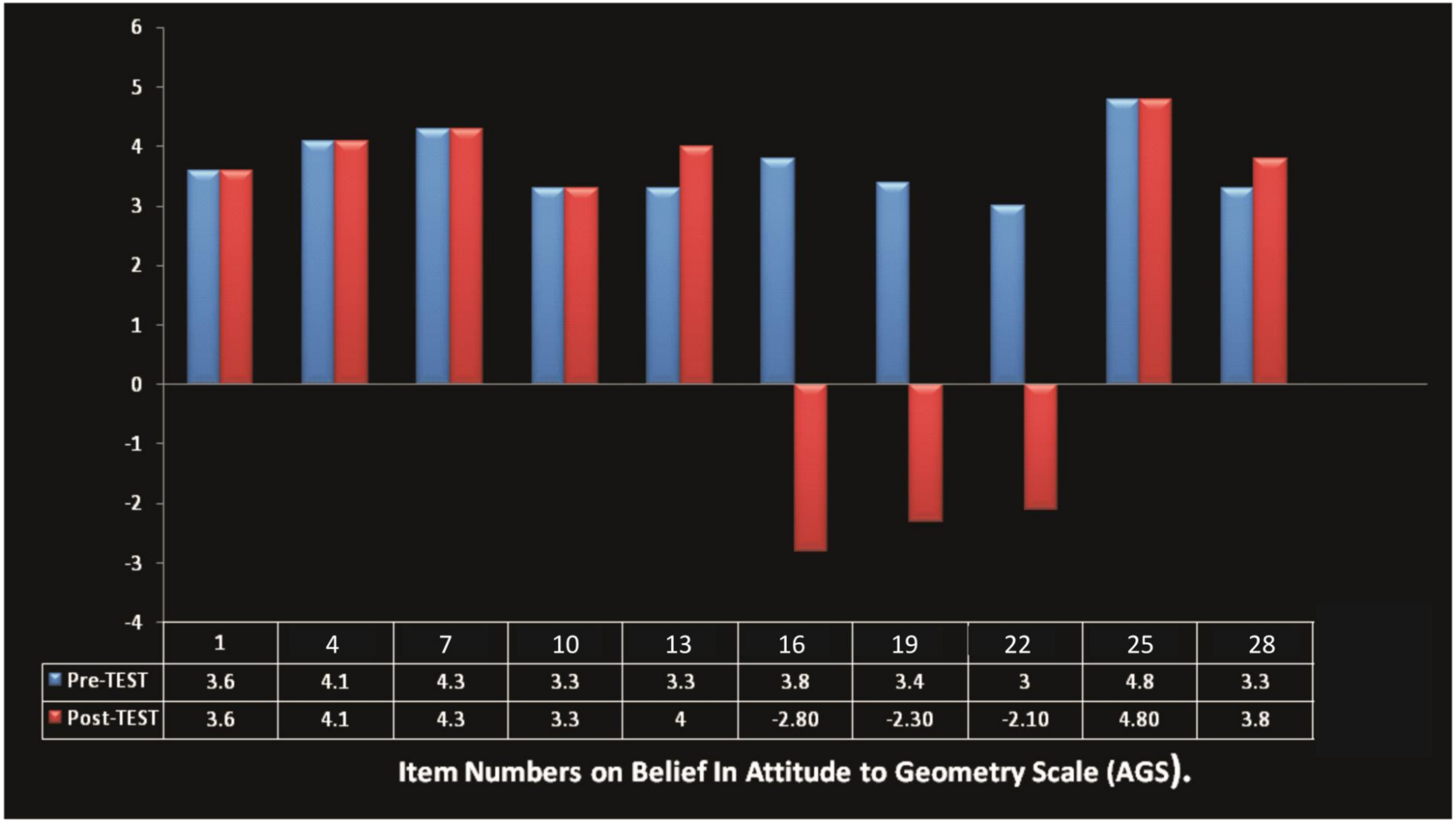


Figure 5: Pre-test and Post-test Mean Score for Experimental Group (Belief)

Figure 5: shows the chart of the mean ($\overline{X}$) of the respondents containing the nature and direction of attitude to attitude to geometry scale (AGS) based on beliefs for the experimental group for pre-test and post test. Figure 5 shows statements that were made on belief in attitude to geometry scale numbered as items. The items are: item 1, item 4, item 7, and item. Others are; item 10, item 13, item 16, item 19, item 22, item 25 and 28. The mean criterion for acceptability or being positive is 3. Any mean score less than 3; the statement is negative and so rejected. Any mean score that is from 3 and above, the statement is positive and so the statement is accepted.

Item number 1 stated that: Geometry is easy. From the bar chart for experimental group, the mean scored for pre-test was 3.6. The bar chart similarly showed a total mean score of 3.6 at the post-test. The responses of the experimental group therefore both at the pre-test and the post-test of item 1 showed their belief that geometry was easy were positive.

Item number 4 stated that: With the right support, learners with visual impairment can offer geometry. The bar chart at pre-test level showed that the mean score for statement in item 4 was 4.1. Similarly the total mean score on the bar chart at the post-test level showed 4.1. The responses therefore both at the pre-test and post-test of the experimental group accepted the statement that with the right support, learners with visual impairment can offer geometry.

Item number 7 stated that: Learners with visual impairment should be given the opportunity to offer geometry. The mean score at pre-test level on the bar chart for experimental group showed 4.3. In the same manner, the total mean score on the bar chart for experimental group at the post-test level showed 4.3. The respondents at pre-test and post-test therefore were of the belief that learners with visual impairment should be given the opportunity to offer geometry.

Item number 10 figure 5 stated that: People, who offer geometry, have better thinking ability. The mean score for this item at the pre-test level was 3.3. Similarly the mean score at the post-test level was 3.3. The respondents both at the pre-test and post-test levels believed that people, who offer geometry, have better thinking ability.

Item number 13 stated that: The knowledge of geometry helps in solving our daily activities. The mean score at pre-test level on the bar chart was 3.3. The mean score at post-test level was 4. Both at pre-test and post-test levels the respondents believed that the knowledge of geometry helped in solving their daily activities.

Item number 16 figure 5 stated that: Learners with visual impairment should be exempted from offering geometry. The mean score on the bar chart was 3.8. The mean score at post-test level was 2.8. At the pre-test level, the experimental group agreed that learners with visual impairment should be exempted from offering geometry. However at the post-test level, they did not believe that learners with visual impairment should be exempted from offering geometry.

Figure 5 item number 19 stated that: It is not normal for learners with visual impairment to offer geometry. The mean score at pre-test level showed 3.4. The mean score at post-test level on the bar chart showed 2.3. While at the pre-test level the statement was accepted, at the post-test level the respondents did not believe that it was not normal for learners with visual impairment to offer geometry hence their rejection of the statement.

Figure 5, item number 22 stated that: Geometry cannot be taught to learners with visual impairment in Nigeria. The mean score on the chart at pre-test level showed 3. The mean score for post-test on the bar chart showed 2.1. Therefore the respondents while at pre-test level accepted the statement that geometry cannot be taught to learners with visual impairment in Nigeria; at the post test level they rejected the statement.

Item number 25 stated that: There are no equipment for teaching geometry in our schools. The total mean score at the pre-test level on the chart showed 4.8. The total mean score on the chart for post-test also showed 4.8. Both pre-test and post-test accepted the statement that there were no equipment for teaching geometry in schools.

Figure 5 item number 28 stated that: Geometry brings bad luck. The mean score at pre-test level was 3.3. The mean score for post-test was 3.8. At both the pre-test and post-test levels; the respondents accepted the statement that geometry brings bad luck.

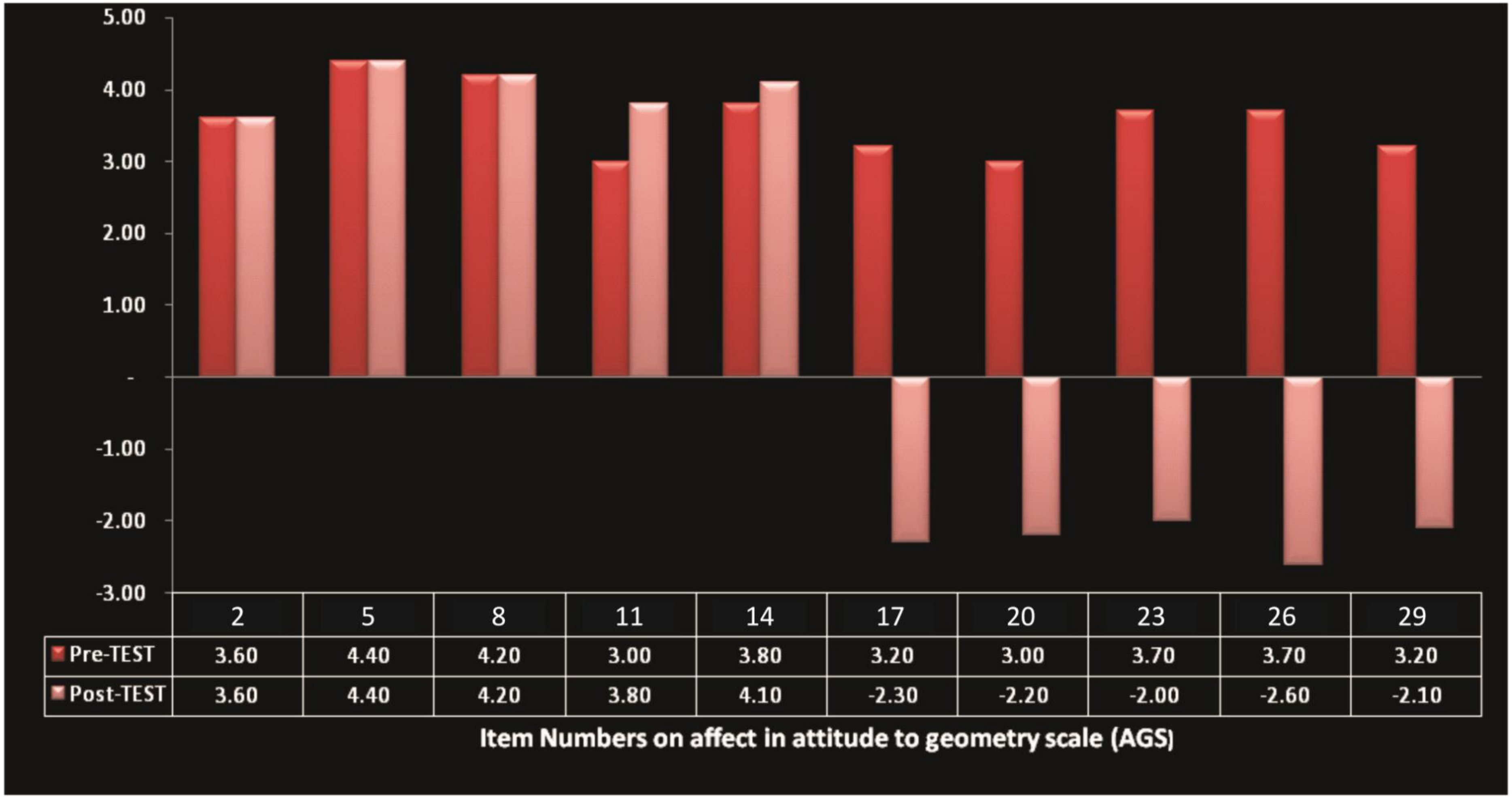


Figure 6: Pre test and Post test for Experimental Group (Affect)

Figure 6: showed the bar chart of the mean ($\bar{X}$) of the respondents containing the nature and direction of the attitude of learners with visual impairment on attitude to geometry scale (AGS) based on affects for the experimental group for pre-test and post test. Figure 6 contains item numbers 2, 5, 8, 11, 14, 17, 20, 23, 26 and 29. The mean criterion for acceptability or being positive is 3. Any mean score less than 3; the statement is negative and so rejected.

Item number 2 stated that: Geometry is my favourite area in mathematics. From the bar chart in figure two, the mean scored for pre-test for experimental group was 3.6. The mean scored at the post-test level by the experimental group was 3.6. Therefore both at pre-test and post-test levels on the attitude construct of affect accepted the statement that: Geometry is their favourite area in mathematics.

Figure 12 item number 5 on the bar chart stated that: I feel satisfied whenever learners with visual impairment make progress in geometry. The mean score for statement number 5 for pre-test affect on the chart was 4.4. The mean score at pre-test level was also 4.4. Therefore learners with visual impairment in experimental group both at the pre-test and post-test levels in number five accepted the statement that they felt satisfied whenever learners with visual impairment make progress in geometry.

Figure 12 item number 8 stated that: I admire learners with visual impairment that offer geometry. The mean score for pre-test on the chart showed 4.2. Similarly the mean score for post-test showed 4.2. Therefore the respondents both at pre-test and post-test levels admired learners with visual impairment that offer geometry.

Item number 11 for pre-test for experimental group on affect stated that: I will love to be a qualified mathematician with geometry skills. The mean score for this item was 3. The mean score for post-test for this item was 3.8. Therefore the respondents at both pre-test and post-test would love to be qualified mathematicians with geometry skills.

Item number 14 under affect stated that: I feel happy when ever somebody helps me with geometry. The mean score for pre-test for experimental group as shown on the bar chart was 3.8. The mean score for the post-test was 4.1. The learners with visual impairment in the experimental group both at the pre-test and post-test levels on item 14 believed that they would feel happy when ever somebody helps them with geometry.

Item number 17 for affect stated that: I don't like studying geometry. The mean score for item 17 for pre-test was 3.2. The mean score at post-test was 2.3. Therefore while the respondents accepted the statement that they do not like studying geometry at pre-test level, at the post-test level they rejected the statement that they do not like studying mathematics.

Item number 20 of affect stated that: I feel bad when learners with visual impairment offer geometry. The mean score for pre-test showed 3. The mean score for post-test showed 2.2. While the learner with visual impairment at the pre-test period accepted the statement that they felt bad when learners with visual impairment offered geometry, at post tests period they rejected the statement.

Item number 23 on affect stated that: I hate geometry. The mean score on the chart for pre-tests showed 3.7. The mean score on the chart for post-test showed 2. Therefore while the respondents accepted the statement that they hated geometry at the pre-test level, at the post-test level, they rejected the statement.

Item number 26 under affect stated that: Geometry is a subject that makes me sick. The total mean score on the chart for pre-test showed 3.7. The total mean score on the chart for post-test showed 2.6. The respondents accepted the statement that geometry made them sick while at the pre-test level, they rejected the statement that geometry made them sick at post-test level.

Item number 29 on affect for experimental group stated that: I dislike geometry teachers. The total mean score on the chart for pre-test showed 3.2. The total mean score for the post-test on the chart showed 2.1. The respondents at pre-test level accepted the statement that they disliked geometry teachers. At the post-test level they rejected the statement that they dislike geometry teachers.

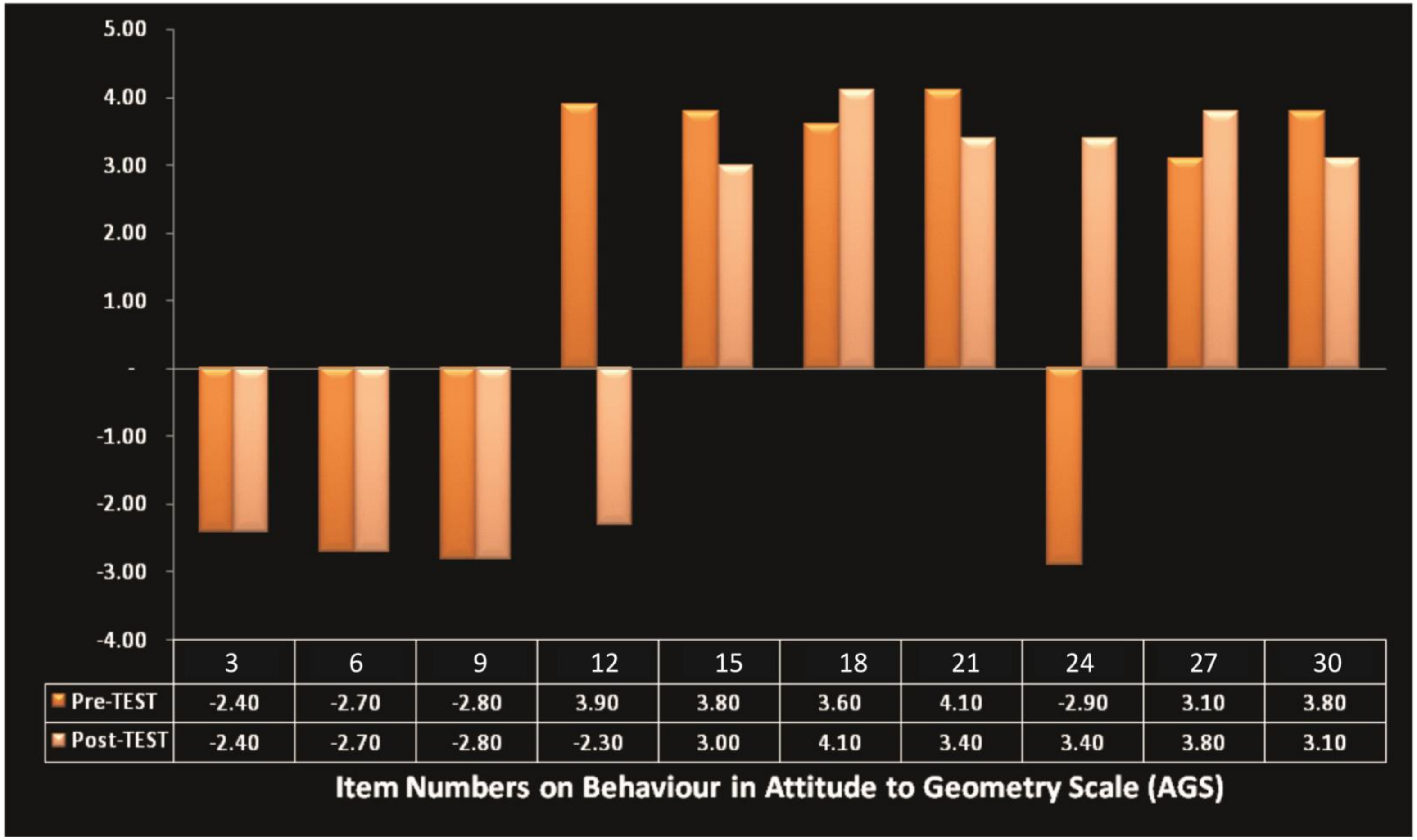


Figure 7: Pre test and Post test for Experimental Group (Behaviour)

Figure 7: Shows bar chart with the mean ($\overline{X}$) direction of the pre-test and post-test of the attitude of learners with visual impairment on attitude to geometry scale (AGS) based on behaviour for the experimental group. Item numbers on the bar chart include: 3, 6, 9, 12, 15, 18, 21, 24, 27 and 30. The mean criterion for acceptability or being positive is 3.

Item number 3 stated that: If any learner with visual impairment wishes to offer geometry I will stop him or her. The mean scored at pre-test was 2.4. The mean scored for experimental group at post-test level was 2.4. Therefore both at the pre-test and post-test levels, the respondents rejected the statement that if any learner wishes to offer geometry they would stop him or her.

Item number 6 stated that: I feel I may not work where geometry skill is required. The mean score for statement number six at the pre-test level was 2.7. The mean score for statement number six at post-test level was 2.7. The statement in item six both at the pre-test and post-test levels was rejected.

Item number 9 stated that: I cheat in geometry exams to pass. The mean score on the chart for pre-test showed 2.8. The mean score for post-test on the chart showed 2.8. Therefore both at the pre-test and post-test levels, the statement have been rejected.

Item number 12 stated that: I run away where studying geometry is required. The mean score for this item at pre-test level was 3.9. The mean score for this item at the post-test level was 2.3. Therefore at pre-test the statement was accepted and at the post-test level the statement was rejected.

Item number 15 stated that: I will fight who ever forces me to offer geometry. The mean score as shown on the chart at pre-test level was 3.8. The mean score as shown on the chart at post-test level was 3. Both at the pre-test and post-test the statement was rejected.

Item number 18 stated that: One should work hard even when one fails geometry exam. The mean score at pre-test level was 3.6. The mean score at post-test level was 4.1. Therefore both at the pre-test and post-test levels the statement was accepted.

Item number 21 stated that: It is normal being angry when asked to offer geometry. The mean score at pre-test level showed 4.1. The mean score at post-test showed 3.4. Therefore both at pre-test and post-test levels the statement was accepted.

Item number 24 stated that: I am not tired during geometry lessons. The mean score on the chart for pre-test showed 2.9. The mean score on the chart for post-test showed 3.4. While the statement was rejected at the pre-test level, it was accepted at the post-test level.

Item number 27 stated that: I study geometry on my own. The total mean score on the chart for pre-test showed 3.1. The total mean score on the chart for post-test showed 3.8. Therefore both at pre-test and post-test levels the statement was accepted.

Item number 30 stated that: I practice geometry. The total mean score on the chart for pre-test showed 3.8. The total mean score on the chart for post test showed 3.1. Both at pre-test and post-test the respondents accepted the statement.

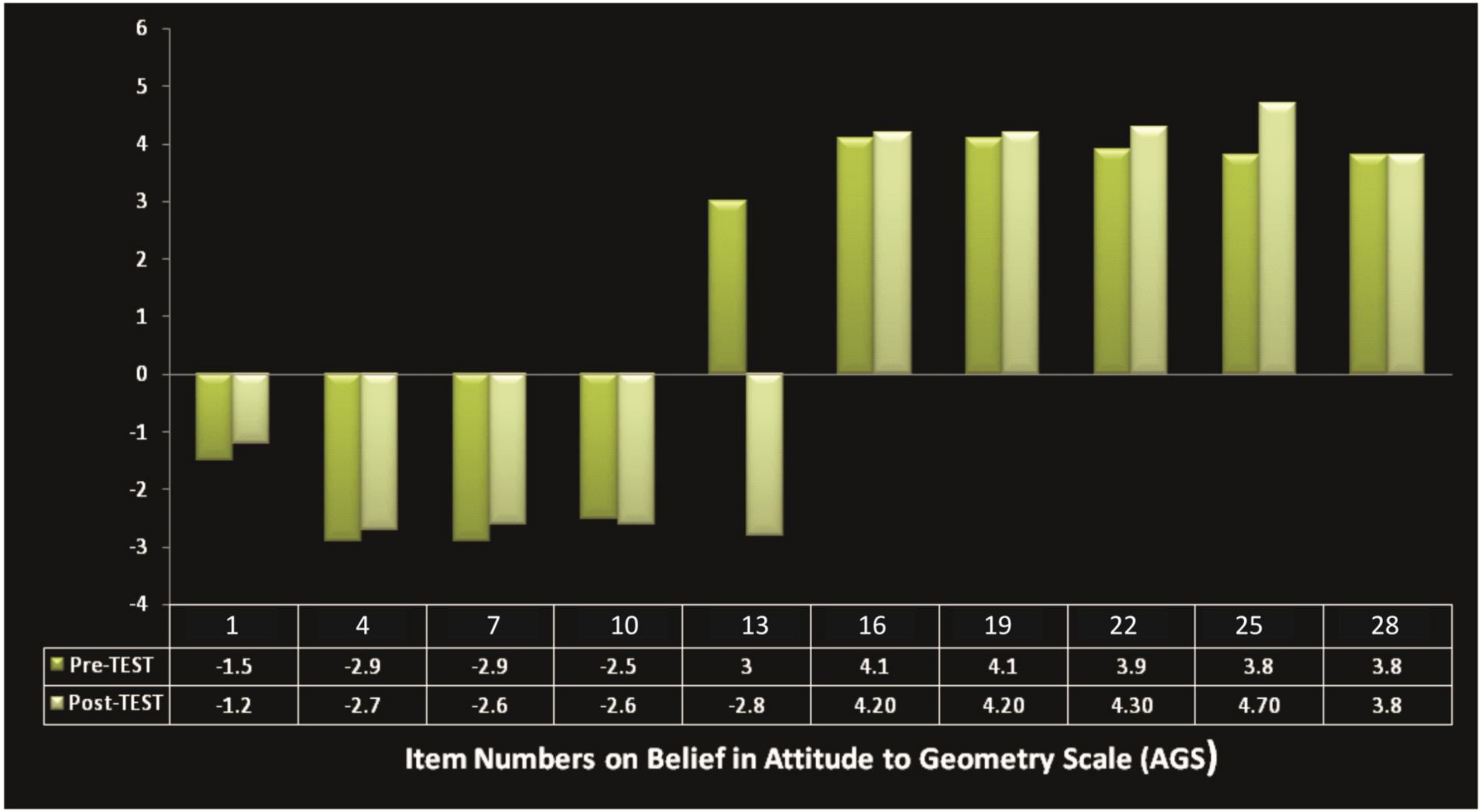


Figure 8: Pre test and Post test for Control Group (Belief)

Figure 8: Bar chart showing the Mean ($\overline{X}$) direction of the Pre-test of the attitude to geometry scale (AGS) based on beliefs for the control group. The figure contains the following item numbers: 1, 4, 7, 10, 13, 16, 19, 22, 25, and 28.

Item number 1 stated that: Geometry is easy. The mean scored for pre-test of control group on belief was 1.5. The total mean score on the chart for post-test for control group on belief showed 1.2. The respondents therefore rejected the statement that geometry was easy both at the pre-test and post-test levels.

Item number 4 stated that: With the right support, learners with visual impairment can offer geometry. The chart showed that the mean score for statement number 4 for pre-test was 2.9. The total mean score on the chart for post-test showed 2.7. Therefore both at pre-test and post-test levels the respondents at the control group on belief rejected the statement.

Item number 7 stated that: Learners with visual impairment should be given the opportunity to offer geometry. The mean score on the chart for pre-test showed 2.9. The total mean score on the chart for post-test showed 2.6. Therefore both at the pre-test and the post-test the respondents in the control group for belief rejected the statement.

Item number 10 stated that: People, who offer geometry, have better thinking ability. The mean score for this item for pre-test for control group under belief was 2.5. The mean score for this item for post-test was 2.6. Therefore for both the pre-test and post-test the respondents rejected the statement.

Item number 13 under belief stated that: The knowledge of geometry helps in solving our daily activities. The mean score as shown on the chart for pre-test was 3. The mean score as shown on the chart for post-test was 2.8. Therefore at pre-test the statement was accepted while at the post-test the statement was rejected.

Item number 16 stated that: Learners with visual impairment should be exempted from offering geometry. The mean score for item 16 for pre-test was 4.1. The mean score for item 16 for post-test was 4.2. Therefore both at the pre-test and post-test levels the respondents accepted the statement.

Item number 19 on the chart stated that: It is not normal for learners with visual impairment to offer geometry. The mean score for item 19 on the chart for pre-test showed 4.1. The mean score for item 19 on the chart for post-test showed 4.2. The statement is accepted both at the pre-test and post-test levels.

Item on belief number 22 stated that: Geometry cannot be taught to learners with visual impairment in Nigeria. The mean score on the chart for pre-test showed 3.9. The mean score on the chart for post-test showed 4.3.Therefore both at the pre-test and post-test levels the respondents accepted the statement.

Item number 25 stated that: There are no equipments for teaching geometry in our schools. The total mean score on the chart for pre-test showed 3.8. The total mean score on the chart for post-test showed 4.7. Therefore both at the pre-test and post-test levels the statement was accepted.

Item number 28 stated that: Geometry brings bad luck. The mean score for pre-test was 3.8. The mean score for post-test was 3.8. The respondents therefore both at the pre-test and post-test levels accepted the statement.

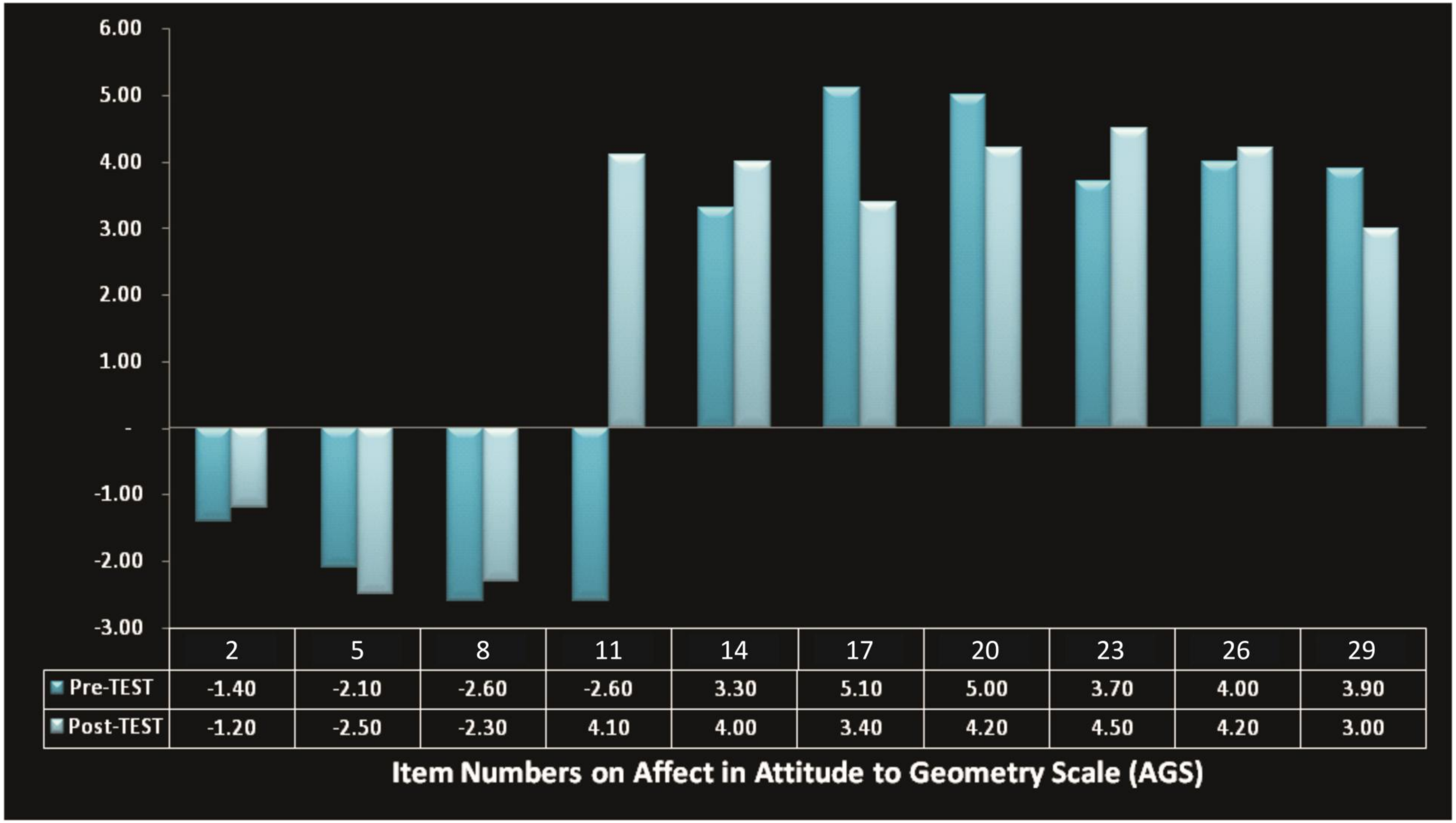


Figure 9: Pre test and Post test for Control Group (Affect)

Figure 9: Bar chart showing the Mean ($\overline{X}$) direction of the Pre-test of the attitude of learners with visual impairment on attitude to geometry scale (AGS) based on Affect for the control group. The figure contains the following item numbers: 2, 5, 8, 11, 14, 17, 20, 23, 26 and 29. The mean criterion for acceptability or being positive is 3.

Item number 2 stated that: Geometry is my favourite area in mathematics. From the bar chart in figure two, the mean scored for pre-test was 1.4. The mean score for post-test was 1.2. Both at the pre-test and post-test levels, the respondents rejected the statement.

Item number 5 stated that: I feel satisfied whenever learners with visual impairment make progress in Geometry. The chart showed that the mean score for statement number 5 for pre-test was 2.1. The chart showed that the mean score for statement number 5 for post-test was 2.5. The statement was rejected both at the pre-test and post-test levels.

Item number 8 stated that: I admire learners with visual impairment that offer geometry. The mean score on the bar chart for pre-test showed 2.6. The mean score on the bar chart for post-test showed 2.3. Both at the pre-test and post-test the statement was rejected.

Item number 11 stated that: I will love to be a qualified mathematician with geometry skills. The mean score for this item for pre-test was 2.6. The mean score for this item for post-test was 4.1. Therefore at the pre-test the statement was rejected but at the post-test the statement was accepted.

Item number 14 under affect stated that: I feel happy when ever somebody helps me with geometry. The mean score as shown on the bar chart for pre-test was 3.3. The mean score as shown on the bar chart for post-test was 4. Therefore both at the pre-test and post-test levels the respondents accepted the statement.

Item number 17 stated that: I don’t like studying geometry. The mean score for item 17 for pre-test was 5.1. The mean score for item 17 for post-test was 3.4. Therefore both at the pre-test and post-test levels the statement was accepted.

Item number 20 stated that: I feel bad when learners with visual impairment offer geometry. The mean score for item 20 on the bar chart for pre-test showed 5. The mean score for item 20 on the chart for post-test showed 4.2. Therefore both at the pre-test and post-test levels the statement was accepted.

Item on belief number 23 stated that: I hate geometry. The mean score on the bar chart for pre-test showed 3.7. The mean score on the bar chart for post-test showed 4.5 Both at the pre-test and post-test levels the statement was accepted.

Item number 26 stated that: Geometry is a subject that makes me sick. The total mean score on the bar chart for pre-test showed 4. The total mean score on the bar chart for post-test showed 4.2. Therefore both at the pre-test and post-test the statement was rejected.

Item number 29 stated that: I dislike geometry teachers. The total mean score on the bar chart for pre-test showed 3.9. The total mean score on the bar chart for post-test showed 3.

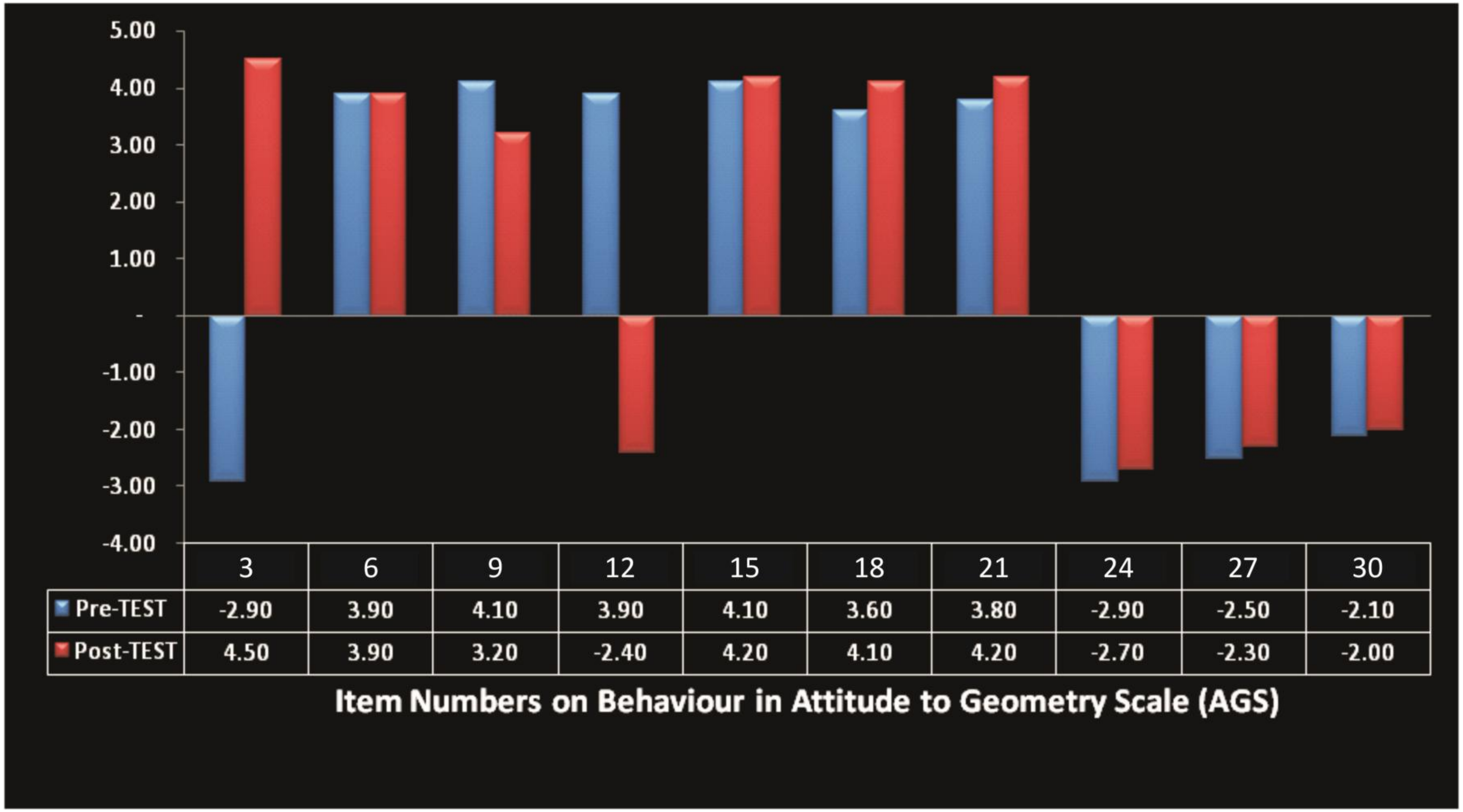


Figure 10: Pre test and Post test for Control Group (Behaviour)

Figure 10 Item number 3 stated that: If any learner with visual impairment wishes to offer geometry I will stop him or her. From the bar chart the mean score for pre-test was 2.9. The mean score at post-test was 4.5. While at pre-test, the respondents rejected the statement; at the post-test they accepted the statement.

Item number 6 stated that: I feel I may not work where geometry skill is required. The bar chart showed that the mean score for statement number 6 for pre-test was 3.9. The bar chart showed that the mean score for statement number 6 for post-test was 3.9. Therefore both at the pre-test and post-test the respondents accepted the statement.

Item number 9 stated that: I cheat in geometry exams to pass. The mean score on the bar chart for pre-test showed 4.1. The mean score on the bar chart for post-test showed 3.2. Therefore the st atement was accepted at the pre-test level but rejected at the post-test level.

Item number 12 stated that: I run away where studying geometry is required. The mean score for this item for pre-test was 3.9. The mean score for this item for post-test was 2.4. Therefore while at the pre-test the statement was accepted, the statement was rejected at the post-test level.

Item number 15 stated that: I will fight who ever forces me to offer geometry. The mean score as shown on the chart was 4.1. The mean score as shown on the chart for post-test was 4.2. Therefore the statement was accepted both at the pre-test and post levels.

Item number 18 stated that: One should work hard even when one fails geometry exam. The mean score for item 18 for pre-test was 3.6. The mean score for item 18 for post-test was 4.1. Therefore both at the pre-test and post-test the statement was accepted.

Item number 21 stated that: It is normal being angry when asked to offer geometry. The mean score for item 21 on the chart for pre-test showed 3.8. The mean score for item 21 on the chart for post-test showed 4.2. Therefore both at the pre-test and post-test the statement was accepted.

Item number 24 stated that: I am not tired during geometry lessons. The mean score on the chart for pre-test showed 2.9. The mean score on the chart for post-test showed 2.7. The statement is rejected both at the pre-test and post-test levels.

Item number 27 stated that: I study geometry on my own. The total mean score on the chart showed 2.5 at pre-test level. The total mean score on the chart for post-test showed 2.3. Therefore the statement is rejected both at the pre-test and post-test levels.

Item number 30 stated that: I practice geometry. The total mean score on the bar chart for pre-test showed 2.1. The total mean score on the chart for post-test showed 2. Therefore both at the pre-test and post-test levels respondents rejected the statement.

Table 9: Pre-Test Mean Attitude Direction of Learners with Visual Impairment towards Geometry

	Total No. of items of Questionnaire	$\overline{X}$	$\overline{X}$ for decision	Result of Attitude Direction
Experiment	30	3.5	3	Positive
Control	30	3.33		Positive

Table 10: Post-Test Mean Attitude of Learners with Visual Impairment towards Geometry Showing the Nature of their Attitude

Post-Test	Total No. of items of Questionnaire	$\overline{X}$	$\overline{X}$ for Decision	Result of Attitude Direction
Experiment	30	3.14	3	Positive
Control	30	3.36		Positive

Table 9 above shows that the mean score for pre-test for the experimental group is 3.5. Table 10 shows that the mean score for post-test of the experimental group is 3.14. Table 9 above shows that the mean score for pre-test of the control group is 3.33 and the mean score for post-test of the control group is 3.36. The criterion for decision making is 3 and above mean score is positive. Any mean score less than three is negative. The result of the opinion of the respondents on both the pre-test and post-test on learners with visual impairment geometry attitude questionnaire therefore showed the nature of their attitude to be positive directions.

4.1.2: Hypotheses

Hypothesis one

There is no significant difference in extent of geometry tasks performance of learners with visual impairment trained in the use of applied orientation and mobility programme skills and those not trained.

Table 11: Result of the t-Test Analysis of Adapted Geometry Task Performance Test (AGTPT) of Experimental and Control Groups

	Group	N	$\bar{X}$	df	t – cal	t- crit	P	Decision
Achievement Score	Experimental	10	75.1	18	5.88	2.10	0.001	S
	Control	10	45.1					

Sig level = 0.05

Table 11 shows that the result of the independent-samples t-Test in table 11 indicated that there was significant mean difference in the task performance on Task Performance Test (AGTPT) of learners with visual impairment who were in the experimental group and those in the control group. The p-value of (0.001) is less than the level of significant (0.05). Hence there is substantial evidence not to fail to reject the null hypothesis. In other words, the calculated t value is 5.88. The critical t value is 2.10. The P-value or sig (2 tailed) is 0.00. The df is 18. Since the Critical t value 2.10 at df of 18 and P = 0.05 is less than the Cal t value of 5.88, there is enough evidence to reject the null hypothesis.

Hypothesis Two

There is no significant difference in extent of geometry tasks performance of learners with congenital visual impairment and those with adventitious visual impairment trained in applied orientation and mobility programme.

Table 12: t-Test Result for Adapted Geometry Task Performance Test (AGTPT) of Congenital Group Compared with Adventitious Group

	Learners Status	N	$\overline{X}$	df	t – cal	t - Crit	p	Decision
Achievement Score	Congenital	10	58.3	18	-0.42	2.10	0.683	NS
	Adventitious	10	61.9					

Sig level = 0.05

The output above in table 12 vividly indicates that there is no significant difference in the task performance on task performance test (AGTPT) of congenital and adventitious groups. Since the P-value of (0.683) is higher than the level of significant (0.05).We do have sufficient evidence not to fail to accept the null hypothesis. In other words, Calculated t value = 0.42; Critical t value = 2.10; Sig level = 0.05; P value or Sig (2 tailed) = 0.68; df = 18.

The Calculated t Value of 0.42 is less than the Critical Value of 2.10 at df of 18 and P = 0.05. Therefore we cannot fail to accept the null hypothesis.

Hypothesis 3

There is no overall significant difference in value in the use of applied orientation and mobility programme skills in training learners with visual impairment in geometry tasks.

Table 13: Result of the t-Test Analysis for Utility Value in Applied Orientation and Mobility Programme of Experimental and Control Groups

	Group	N	$\bar{X}$	df	t – cal	t- crit	P	Decision
Achievement Score	Experimental	5	67.6	8	6.15	6.72	0.000	S
	Control	5	26.2					

Sig level = 0.05

The output above in table 13 revealed the mean difference in utility value of applied orientation and mobility programme (APOMP) of experimental and control group. The t-Test shows that experimental group had mean score of 26.20 and a standard deviation of 12.28. This shows that there is a difference between experimental group and control group, while the p – value is 0.000. Since the p – value is less than 0.05, it means that there is less than 1% chance that the difference between the experimental and control groups occurred by chance.

Therefore, the researcher rejects the null hypothesis and concludes that there is a significant mean difference in utility value of applied orientation and mobility programme (APOMP) of experimental group and control group.

Hypothesis Four

There is no significant difference in the attitude towards geometry tasks of learners with visual impairment trained in applied orientation and mobility skills and those not trained.

Table 14: Result of t-Test for Attitude to Geometry of Experimental Group Compared with the Control Group

	Group	N	$\bar{X}$	df	t – cal	t- crit	P–v	Decision
Attitude score	Experimental	10	95.9	18	-3.086	2.10	0.006	S
	Control	10	102.4					

Sig level = 0.05

The output above in table 14 indicates that there is a statistical significant mean difference between the learners in experimental group in terms of attitudes towards geometry and the control group. The p-value of (0.006) is less than the level of significant (0.05). Hence there is enough evidence not to fail to reject the null hypothesis. In other words, the calculated t value is 3.08. The critical t value is 2.10. The Significant level is 0.05. The P-value or Significant (2 tails) is 0.006. The df is 18. Calculated t value of 3.08 is greater than table or critical t value of 2.10 at df of 18 and P = 0, 05. Therefore we cannot fail to reject the null hypothesis.

Hypothesis 5

There is no significant difference in attitudes towards geometry tasks of learners with congenital visual impairment and those with adventitious visual impairment trained in applied orientation and mobility programme skills.

Table 15: Result of t-Test for Attitude towards Geometry Task of Congenital Group Compared with Adventitious Group.

	Learner's status	N	$\overline{X}$	df	t – cal	t crit	P – v	Decision
Attitude total score	Congenital	10	99.1	18	0.97	2.10	0.97	NS
	Adventitious	10	99.2					

Sig level = 0.05

The output of t-Test of attitude towards geometry between congenital and adventitious groups in table 15 above clearly indicates that no statistical Significant mean difference exist between the two groups in terms of attitudes to geometry. The p-value of (0.97) is greater than the level of significant (0.05). Therefore we have quality evidence not to fail to accept the null hypothesis. In other words, the calculated t value is 0.97. The critical t value is 2.10. Significant level is 0.05. The p value or Significant (2 tailed) = 0.97. df is 18. Calculate t value of 0.97 is less than critical value of 2.10 at df of 18 and P 0.05 therefore we cannot fail to accept the hypothesis.

4.2 DISCUSSION

4.2.1 Effects of Applied Orientation and Mobility Programme on Geometry

Applied orientation and mobility programme enhanced high task performance in geometry of learners with visual impairment. The experimental group performed better than the control group. This was because their exposure to applied orientation and mobility programme (APOMP) made them to be able to translate those geometry related concepts and skills embedded in orientation and mobility to solving geometry problems. Therefore applied orientation and mobility programme (APOMP) as an intervention and an adapted teaching strategy enhanced task performance in geometry of learners with visual impairment. It can be used in teaching mathematics in general and geometry in particular to enable learners with visual impairment participate and achieve in mathematics (geometry) to avoid their exemption or non participation in the subject in Nigeria and other parts of the world.

The study revealed that all learners with visual impairment in the experimental group (10) (100%) scored 50% and above in the adapted geometry task performance test. None of them scored below 50%. 7 (70%) of the learners with visual impairment in the experimental group scored 70% and above in the adapted geometry task performance test. 3 (30%) of the learners with visual impairment in the experimental group scored between 50% to 6o% on the adapted geometry task performance test. The highest score achieved was 92% by a candidate (N_6). The least score was 58% by (N_3).

For the control group, number of learners with visual impairment that scored 50% and above in the adapted geometry task performance test were 4(40%) (N_{12}, N_4, N_7, and N_8). 6 (60%) of the learners with visual impairment scored below 50% in the adapted geometry task performance test. None of the candidates scored 70% and above.

The highest score achieved by candidates in control group was 65% by N_7. The least score achieved by control group was 29% by N_{20} (see figure 1).

The result revealed higher task performance even in the construct area of orientation and mobility. Therefore applied orientation and mobility programme enhances task performance both in geometry and orientation and mobility. Looking at questions that the constructs were directly drawn from orientation and mobility skills; experimental group performed higher than the control group in all the questions. None of the two groups performed below 50% in all the orientation and mobility related questions. Question one aimed at identifying objects in the environment. The task performance score for experimental group was 90%. The control group scored 73%. Question 2 was a question that demanded walking through routes. Experimental group scored 78%. Control group scored 66%. Question 3 was about identification of shapes of given polygons. The experimental group scored 85%, the control group scored 66%. Question 5 was on identifying the shapes of given objects in the environment. The experimental group scored 94% while the control group scored 86%.

The result of the research showed that applied orientation and mobility programme (APOMP) encouraged the participation of learners with visual impairment in teaching and learning of geometry. This is an aspect of mathematics a subject that learners with visual impairment do not participate in teaching and learning in Nigeria and other parts of the world as reported by RDII (2013), NERDC (2009), Tanti (2012), and Velera (2010). It is on record that learners with visual impairment did not sit for West African examination council (WAEC) examination in mathematics (Geometry) in Nigeria. Mathematics especially geometry is a field which has often been considered beyond the capacity of learners with visual impairment to master (Kapperman 2003). Unfortunately those who avoid, or do not participate in mathematics are cut off from full participation in society and have not only failed in school but have failed to a life – long feeling of intellectual inferiority. (Buhagiar, 1993, p. 10)

The research on the effects of orientation and mobility programme on attitude and achievement in geometry of learners with visual impairment has added to the few existing empirical studies on learners with visual impairment in the world. According to Ferrell (2011), Cochran in collaboration with “what works clearing house” (WWC) investigated researches in visual impairment and found that it was difficult to meet researches that employed systematic, empirical methods that were drawn on observations or experiment; involving rigorous data analyses that were adequate to test the stated hypotheses and justify the general conclusions drawn. Most researches on visual impairment found were built on case studies, anecdotal reports, individual philosophies, common sense, and clinical practices etc which are more descriptive than empirical.

This research on the effects of applied orientation and mobility programme (APOMP) on attitude and task performance in geometry of learners with visual impairment without being immodest is the first of its kind in Nigeria and in Africa. Any research about teaching and learning geometry to learners with visual impairment is a mixed area spread between disability studies (visual impairment) and mathematical (geometry) educational studies (Klingenberg 2007). The study is about using geometric concepts and skills embedded in orientation and mobility which is an adapted teaching strategy to enhance task performance in geometry with learners with visual impairment. Applied orientation and mobility concepts and skills are related to geometry concepts and skills. Geometry concepts and skills on the other hand have the same concepts and skills with spatial concepts and skills. Therefore concepts and skills in applied orientation and mobility, geometry and spatial process are the same. Their concepts and skills are linked to many subject areas in school.

Similarly the research study is about attitude of learners with visual impairment towards geometry and the impairment is based on age at onset. The study has multi directional approach since it covers many interrelated issues. It has value in attitude issues and promotes the teaching and learning of orientation and mobility skills. Applied orientation and mobility programme has value in teaching mathematics as a whole.

There is scarcity of literature on education of learners with visual impairment, mathematics or geometry and the mathematically/geometrical related areas of orientation and mobility as a field of study. As stated above, this research study delves into all the areas mentioned. Therefore the study has contributed in terms of literature in the area of education of learners with visual impairment, geometry, mathematics, attitude and orientation and mobility of learners with visual impairment.

4.2.2 Utility Value of Applied Orientation and Mobility Programme in Geometry for Learners with Visual Impairment

In determining the utility value of applied orientation and mobility programme (APOMP), the study revealed that there was mean difference in the geometry task performance in the geometry construct. The output of the t – Test showed that experimental group had a mean score of 67.60 while the control group had a mean score of 26.20. The p – value was 0.000. Since the p – value was less than 0.05, the null hypothesis was rejected.

There are many indicators of the usability value of applied orientation and mobility programme (APOMP) which are linked to performance in geometry task. When learners with visual impairment are able to perform in geometry, they are able to participate and perform well as revealed above in this study. Geometry is a subset of mathematics considered to be one of the most prominent school subjects. Mathematics is comprised of use values with respect to various economic and domestic practices (Dowling 1998). Applied orientation and mobility programme (APOMP) does not only give opportunity to learners with visual impairment to learn geometry or mathematics but also consequently get certified or obtain certificate in mathematics as stated in the background.

The study revealed that applied orientation and mobility programme (APOMP) has the utility value of developing and understanding concepts and skills in other subject areas. It prepares children for future understanding of higher mathematical concepts and skills like algebra, trigonometry, calculus and other higher mathematics. Learners with visual impairment have been exempted from participating in mathematics. Those that make efforts to involve them in mathematics often omit areas of mathematics that are considered complicated. Geometry in particular is such areas. It is thought of as having content that is rich with visually presented concepts and information therefore learners with visual impairment will not cope with it. Applied orientation and mobility programme opens up the opportunity for learners with visual impairment to participate in geometry in particular and mathematics in general. Basic geometry is critical to understanding of mathematics in general and spatial relationships. According to Kennedy and Tipps (1994), at the primary school level, the development of skills and understanding many topics depend on their spatial concepts. Spatial properties which are the same with geometry include: shape, size, and distance. Others are fractions, measurement, estimation and numbers. Kennedy and Tipps added that when a child manipulates objects in space, it provides background for understanding algebra, trigonometry, calculus and many topics in higher mathematics that require spatial thinking. Studies of human problem solving and language understanding have pointed out the importance of spatial representation and reasoning (Hobbs & Narayana, 2002, p. 2).

The research showed that applied orientation and mobility programme as an adapted method of teaching geometry and mathematics to learners with visual impairment, becomes an open door to learners with visual impairment to benefit from the utility values of acquiring mathematics skills. Mathematics is seen as a crucial intellectual endeavour (Dow;omg, 1998). It is believed to lay the foundations for thinking systematically (Agrawal 2004).

The value of applied orientation and mobility programme is that it gives the opportunity to learners with visual impairment to gain access to geometry and mathematics in general. This gives access to higher institutions and opportunity to highly respected and well paid jobs The importance of mathematics is equated to a ‘critical filter’ which apart from giving access to entry into higher institutions, it gives access to higher paying careers and professions especially in developed worlds. All the fields of science, technology and engineering consume mathematicians in large quantity. Companies that build automobiles, aeroplanes, national security agencies consume a lot of mathematicians.

International community talks so much of inclusive education. Applied orientation and mobility programme provides an inclusive value. A situation where learners with visual impairment go out of classroom during mathematics lessons amounts to exclusion. When applied orientation and mobility programme (APOMP) is used during mathematics lessons and learners with visual impairment do not need to go out of the class, they are included in the subject and in the classroom.

4.2.3 Attitude of the Respondents towards the Study of Geometry

The three components of attitude that this study concentrated on were: belief, affect and behaviour. The cognitive or belief component included opinion, information or strength of belief or disbelief. The affective component was comprised of emotional component of like or dislike and the third was the action component. This involved behaviour or habit or readiness to respond (Guimaraest, 2005).

The study looked at the attitude direction of learners with visual impairment towards the study of geometry. The result of the study showed that learners with visual impairment in both experimental and control group believed that the greatest problem in teaching and learning geometry for learners with visual impairment was the lack of adapted equipment for teaching geometry in our schools. Both the experimental and control groups had the highest mean scores on item 25 under belief (see figures 1 and 4). The mean scores of the experimental group both on pre-test and post-test were 4.8. The control group had mean score of 3.8 at the pre-test and mean score of 4.7 at the post-test.

Several researchers expressed similar opinions in their studies. When the researcher collaborated with the department of mathematics of the University of Jos to support the first student with visual impairment in the department who read mathematics, getting text books and other materials like talking scientific calculator were the greatest challenges faced. The textbooks and the talking calculators had to be imported through the support of some good Samaritans. Despite that, most of the textbooks arrived when the semester had past.

In a similar experience Yassalino as cited by Tanti (2012) a person with visual impairment (Abraham) in United State of America who read mathematics (geometry) stated that the roadblock that a person with visual impairment will face in terms of offering mathematics (geometry) is the lack of materials or equipment like non-visual accessible graphing calculators for persons with visual impairment and mathematics books. He further stated that getting mathematics books on time was tough for him. They never came in on time. When they came in late, he confessed that keeping up with the subject was difficult for him.

Rapp and Rapp (1992) conducted a survey of mathematics classes with learners with visual impairment. The teachers were asked about the services they were provided in terms of mathematics teaching tools and other issues. The results of the survey showed that teachers encountered continuous difficulties in the provision of materials and equipment which resulted in few students participating in mathematics. Similarly, Napier, (1974), found out that lack of textbooks and suitable equipment were often cited as reasons for failure to fully involve learners with visual impairment in mathematics lessons. Napier also found out that the specialist equipments for teaching mathematics or geometry to learners with visual impairment were only found in developed countries.

On his part, Gupta (1992) discovered that two things were responsible for lack of teaching mathematics/geometry to learners with visual impairment. The first was a comprehensive system of notation, capable of expressing all mathematical relationships. The second was apparatus or equipment. For example no material that could take the place of pencil and paper, which enables the seeing student of such a subject as geometry to draw the picture of the problem that he seeks to solve.

To meet the material and equipment needs in using applied orientation and mobility programme (APOMP) to enable learners with visual impairment participate in geometry, the researcher used the principles adopted by Hill and Jurmang (1993) in producing the materials locally. Hill and Jurmang (1993) stated that much standard measuring equipment can have tactile markings added. Notches can be cut with a razor at 1 cm intervals on a standard wooden ruler. Tape measure can be adapted by punching holes or fixing staples pins at 1 cm (1 inch) intervals. “T – squares” “set squares” and ‘protractors’ can be made from wood and supplied with tactile markings by hammering cut – off pins at 1 cm or 10 degrees intervals. A flat piece of wood with holes bored at 1 cm intervals makes an adequate compass for drawing arcs and circles. Using a smooth rubber mat certain sorts of polythene sheet and Braille stylus, pencil or “dead” biro raises fellable line. Polythene sheets used for drawing diagrams were locally obtained from the ones NASCO Company wraps its cornflakes with. Above all, applied orientation and mobility programme used all available objects within the environment which were easy available adapted teaching materials for learners with visual impairment.

The researcher observed from records and held discussions with International None Governmental Organisations (INGOs) particularly Christian Blind Mission (CBM). They now spent more money in training more ophthalmologists, ophthalmic nurses, optometrists and hardly any for special education materials. The INGOs used to donate educational materials like Braille machines, Thermoforming machines, Braille papers, calculating devices like abacus and drawing kits for children with visual impairment to residential special Schools for blind. Some of the INGOs went to the extent of liaising with manufacturing companies in USA, Germany and other countries to manufacture teaching and learning materials like slate and stylus for learners with visual impairment, and linked the special schools with the companies for possible supply of the equipment and materials. This has reduced. Their attention is on providing eye drugs, surgical equipment and financial top ups on the salaries of eye medical personals.

Schools do not have the required equipment to use in teaching children with visual impairment in subjects like mathematics (geometry).

In one of the CBM's meetings in their regional office in Lome Togo, the researcher complained of dwindling support (resources) to education. They said their present focus and priority for now was blindness prevention. Unfortunate it is not understood even by experts in the field of disability that providing education to children with visual impairment is also part of blindness prevention. Education provides the child with livelihood skills in life that would prevent the devastating effect of blindness on the child with visual impairment and the child would live a normal life as he or she never had any impairment.

There have been efforts here and there to meet the material needs for the education of learners with visual impairment especially text books in Nigeria. These efforts are yet to yield much fruits. Nigerian government and individuals made efforts towards providing Braille books to learners with visual impairment. The first was the establishment of a Braille press in Lagos in the 1960s. The equipment arrived but never got installed. The machineries are still laid waste in rust. There was a plan to have Braille production centres in all the zones of the country. This has not materialized too. National Education and Research Development Council established a computer Braille production unit. It is yet to commence massive production. Organisations like Church of Christ in Nations (COCIN) and Anglo-Nigerian Welfare Association for the Blind (ANWAB) have established material procurement and production centres where Braille books are produced. These private centres are not getting the desired support to maximise their production.

The result of the study showed that exposure of experimental group to applied orientation and mobility programme (APOMP) resulted in their change in opinion on superstitious issues on geometry. They rejected the usual superstitious beliefs, mythologies and taboos that are negative towards learners with visual impairment offering mathematics or geometry which dominated the minds of learners themselves and made them fear geometry or mathematics after treatment. Both the experimental and control group believed in superstitions at the pre-test level. The experimental group changed from believing superstition to disbelieving it at the post-test level. The control group held strong to those superstitious issues both at the pre-test and post-test levels thereby leading to fear of geometry.

This could be seen in their responses to the items of belief in the attitude to geometry scale (AGS) after treatment. Items numbers 16, 19, 22 and 28 were items probing some superstitious, taboos or myths about geometry which most people usually hold. The items were as follows: Number 16 stated that learners with visual impairment (LWVI) should be exempted from offering geometry. Number 19 stated that: it is not normal for learners with visual impairment to offer geometry. Item 22 stated that: geometry cannot be taught to learners with visual impairment in Nigeria and item 28 stated that: geometry brings bad luck.

Hembree (1990) conducted a study involving 151 studies concerning mathematics anxiety. He found out that negative attitude concerning mathematics was directly connected with poor performance which led to mathematics avoidance. Learners who avoid or lack participation in mathematics due to poor performance or exemption end up developing or maintaining negative attitude towards the mathematics/geometry.

Tanti (2012) in a study, found that a lot of failure in the previous mathematics examinations of learners with visual impairment and their inferior achievement caused them to feel that the achievement of good mathematics result was not so important for them since they were visually impaired. Therefore, this belief caused them to change to or maintain negative attitude towards mathematics (geometry). In the case of the control group, they were not exposed to mathematics (geometry) teaching and learning hence they maintained their stand on accepting superstitious beliefs.

As reported in the literature review, because the first learner with visual impairment to graduate from secondary school in Nigeria did not offer mathematics, other students that followed his footstep in the secondary school shunned mathematics. When some of them were compelled to offer mathematics, they were shocked and dismayed. As earlier reported one of them declared that “blind boys’ brains cannot do mathematics”. The students with visual impairment declared the teacher who wanted to force them into offering mathematics as being a mad white woman. This was a strong expression of superstitious belief by learners with visual impairment that they could not offer mathematics as a result of their brains naturally created not to participate or offer mathematics (geometry).

Veld (2010) reported that many teachers and other professionals in Netherland saw mathematics as unsuitable options for learners with visual impairment. This negative attitude in turn influenced the beliefs of the learners and so they admitted that mathematics was not for them. Velera (2010) also reported that in Peru; mathematics is a core subject in primary and secondary schools. However there was reluctance in accepting children with visual impairment in their mathematics classrooms. This did not give them the opportunity to offer the subject thereby ending up in believing on some superstitions that they could not offer mathematics.

Teachers are known to have caused mathematics anxiety in their children due to some superstitious beliefs they held and transferred on their children. Some of the students had negative opinion about mathematics because of negative behaviours of teachers or wrong experiences they had on mathematics. These students developed prejudice such as mathemaatics is a complicated lesson and only those that are intelligent that can learn mathematics. This affects the self confidence of the students in the subject (Koca and Sen 2006).

The study revealed that exposure to applied orientation and mobility programme (APOMP) resulted in obtaining and maintaining positive opinions or beliefs towards geometry. Experimental group obtained and maintained positive opinions or beliefs on statements or views that encouraged participation in geometry by learners with visual impairment. The result of the study showed that items on the learners with visual impairment geometry attitude questionnaire which probed views on positive statements that express like or give encouragement to offering geometry were all accepted by the experimental group. The same items were all rejected by the control group. The items were items, 1, 4, 7 and 10. Item 1 stated that: geometry is easy. Item 4 stated that: with the right support, learners with visual impairment can offer geometry. Item 7 stated that: Learners with visual impairment should be given the opportunity to offer geometry, item 10 stated that: people, who offer geometry, have better thinking ability. (see figure 5)

In a study conducted by Kawakami, Steele, Cifa, Phills, and Dovidio (2008) were they examined attitudes towards math and behaviour during mathematics examinations by some women. The results showed that women who were trained to approach rather than avoid mathematics showed a positive attitude towards mathematics. Exposure to applied orientation and mobility programme encouraged high task performance in geometry which led to positive attitude of learners with visual impairment towards geometry.

On the aspect of affection for geometry, the result of the study revealed that learners with visual impairment in the experimental group expressed emotion of like for geometry while control group expressed dislike for geometry. The experimental group had the highest mean scores in their like or affection in geometry at both the pre-test and post-test on item number 5 which stated that: I feel satisfied whenever learners with visual impairment make progress in geometry (See figure 6). Conversely what experimental group disliked most or rejected most which showed from their least mean score to reject the statement was in item number 23 which stated that: I hate geometry (See figure 6).

On their part, the control group expressed their emotion of affection or like for items that express dislike for geometry. Their highest mean scores were obtained on items 17 at the pre-test and item 23 for post-test (see figure 6). Item number 17 stated that: I don’t like studying geometry and Item number 23 stated that: I hate geometry. These two items checked each other to reconfirm the responses of the respondents on their dislike for geometry. The least mean score for control group both at the pre-test and post-test thereby rejecting the statement in the item was item 2 which stated: geometry is my favourite area in math. Therefore these three results revealed and reconfirmed the hate or dislike the control group expressed towards geometry. The study therefore further confirmed that exposure to applied orientation and mobility programme led to developing the attitude of like for geometry.

From the bar charts on ‘affect’, the result of the study showed that the opinions of the experimental group and control groups were in the opposite direction of each other. While control group declined or scored low in mean score for items 2, 5, 8, thereby rejecting all the statements which expressed like for geometry; experimental groups scored high in their mean scores thereby accepting all these items that express like for geometry. Item 2 stated that: Geometry is my favourite area in mathematics. Item 5 stated that: I feel satisfied whenever learners with visual impairment make progress in geometry. Item 8 stated that: I admire learners with visual impairment that offer geometry (see figure 6).

Conversely while experimental group declined, rejected or disliked at post-test level items 17, 20, 23, 26, and 29, control group progressed in, accepted or liked these items. Item 17 stated that: I don't like studying geometry. Item 20 stated that: I feel bad when learners with visual impairment offer geometry, item 23 stated that: I hate geometry, item 26 stated that: geometry is a subject that makes me sick and item 29 stated that: I dislike geometry teachers. While the control groups accepted these statements, the experimental group rejected the statements. Therefore this has further confirmed the like for geometry of experimental group and dislike for geometry of the control group (see figure 6).

The result of the study showed that experimental group behaved or responded more positively towards negative statements at pre-test level thereby accepting negative behaviours. They had a change of direction of behaviour or respond by behaving positively to items that express positive attitude towards geometry (see figure 7). The result of the study was that in pre-test, the experimental group had the highest mean scores in items 12, 15 and 21 thereby accepting the statements. Item 12 stated that: I run away where studying geometry is required. Item 15 stated that: I will fight who ever force me to offer geometry. Item 21 stated that: It is normal being angry when asked to offer geometry.

At the post-test level for the same experimental group, the highest mean scores of responses in behaviour were found in items 18 and 27 (see figure 7). Item 18 stated that: one should work hard even when one fails geometry exam. Item 27 stated: I study geometry on my own. As can be seen from the result, while experimental group scored highest on mean scores of items that expressed negativity at pre-test level, the same experimental group scored highest on the mean scores of items that express positivity at the post-test level.

Figure 7: The result of the study showed that experimental group maintained rejecting negative attitude towards geometry from pre-test to post-test levels. In other words they maintained positive attitude towards geometry from pre-test to post-test levels. The result showed that on items 3, 6, 9 which read: item 3, if any learner with visual impairment wishes to offer geometry I will stop him or her. Item 6 stated: I feel I may not work where geometry skill is required and item 9 stated: I cheat in geometry exams to pass. The experimental group had mean scores both at pre-test and post test of 2.4 for item 3; they had 2.7 for item 6 and 2.8 for item 9. Therefore the experimental group both at pre-test and post-test levels rejected the above statements (see figure 7).

Table 9 shows the main mean score for pre-tests for both the experimental and control group on geometry attitude questionnaire as compared showed 3.5 and 3.33 respectively. Similarly the main mean score for the post-test of the two groups showed 3.14 for the experimental group and 3.36 for the control group (see table 10).

The result therefore showed that the opinion of the respondents on the direction of their attitude towards the study of geometry both at the pre-test and post-test were positive. However looking at the mean score, the experimental group scored 3.5 at the pre-test which is slightly higher than 3.14 during the post-test after the treatment. For the control group the mean score during the pre-test and post-test remained slightly the same 3.3 and 3.5. There is the probability that the exposure of the experimental group to treatment further exposed them to a certain level of difficulty of geometry hence the slight decrease in the mean score at the post-test level.

The study compared the attitude of the experimental group and the control group towards geometry. The result indicated that there was a statistical significant difference between the two groups. The P-Value (0.006) is less than the significant level 0.05. Therefore the null hypothesis was rejected. However the mean score for experimental group from table 10 shows 95.9 and the mean score for the control group showed 102.4. This indicated that the mean score for control group was higher than the experimental group.

The result of the experiment comparing the attitude of congenitally visually impaired and adventitiously visually impaired towards geometry showed that there was no significant difference in the attitude of the two groups. Applied orientation and mobility programme had no influence on attitude towards geometry based on age at onset.

Attitude is a difficult issue of study. Many factors are responsible for people's attitude towards a particular thing. There are different sources of acquiring attitude. Attitude can be formed from cultural heritage, through people's proverbs, mythology, religion, instruction and some limited experiences. Others are superstitions, fairy tales, folklore, comic books, media etc. (Ihenacho 1985; Sardegna and Paul 1991; NIVH 1992). Attitude has different components. These components determine the participation and task performance in geometry in particular and mathematics in general of learners with visual impairment. Ozoji (1991), Guimaraest (2005) indicated the various components of attitude to include: cognitive component: beliefs, opinion, and disbelief; affective component: emotion, likes, and dislike and action component: behavior.

The researcher is of the opinion that these components and sources of acquiring attitude might have played great roles on the attitude of the respondents. The exposure of the experimental group to applied orientation and mobility programme resulting in some difficulties encountered with tasks in geometry during the treatment might have triggered their opinions or attitudes based on their past sources of attitude and the components of attitude they have towards geometry. This probably resulted in the experimental group recording lower mean in attitude while the control group had a slightly higher mean score in attitude towards geometry at the post test.

Researches indicated that, there is a positive relationship between mathematics (geometry) attitude and mathematics (geometry) achievement (Tanti 2012). However Klingenberg (2007) found out that students with visual impairment often say that they do not like mathematics (geometry). This was why a student with blindness testified strongly that their brains cannot do mathematics (geometry). This belief has resulted in non participation of learners with visual impairment in mathematics (geometry) in Nigeria and other parts of the world.

The negative attitude of people towards learners with visual impairment in relation to learning mathematics (geometry) influences the attitude of the learners towards mathematics (geometry). According to Nemeth, his guidance counsellors, wife, and friends told him that he could not cope with mathematics due to his visual impairment so he changed his mind to reading psychology. It was after graduating from psychology that he insisted and went ahead to read mathematics. Koca and Sen (2006) revealed that students developed prejudice such as mathematics is a complicated lesson; it can only be done by intelligent persons. These prejudices are due to the negative opinions the students have towards mathematics (geometry) as a result of the negative behaviour of teachers towards their desire to read mathematics or wrong experiences. In such a situation no matter the method or means one uses in teaching the learner mathematics the chances of succeeding are slim.

Several attitudinal issues affecting the participation and achievement in mathematics (geometry) have been discovered by various researchers. Intelligent quotient is identified as a factor to participating and achieving in mathematics (Blair, Gamson,Thorne, & Baker 2005; Bull and Scerif, 2001; Evans, Floyd, McGrew & LeForgee 2002; Grissmer, 2009). Many learners with visual impairment belief that their brains cannot do mathematics as reported earlier. According to Khoush-Bakht and Kayyer 2002; Yunus and Ali (2009) motivation is key to learning mathematics (geometry). Learners with visual impairment rather than being motivated, they experience discouragement from their guardians, parents, teachers, sighted peers etc from offering mathematics.

Mathematics anxiety in several researches is found to be one of the common attitudinal factors influencing participation and achievement in mathematics (geometry) (Baloglu & Kocak 2006; Betz, 1978; Jain & Dowson, 2009; Ma & Xu, 2004; Rodarte-Luna & Sherry, 2008, Alamolhodaei, 2009). The feeling of tension, apprehension, fear, emotional stress all interfere with mathematics (geometry) achievement (Tobias & Weissbrod 1980). Tobias and Weissbrod (1980) found out that due to anxiety in mathematics, the learners experienced panic; some paralyzed and some even experienced mental disorders. Mathematics fear or anxiety has caused diseases such as amnesia (memory loss), nausea, stomach ache, extreme nervousness (Ashcraft & Kirk, 2001; Ashcraft, & Faust 1998; Ashcraft, Krause & Hopko 2007; Alamolhodaei & Farsad, 2009). The researcher is of the view that as serious as attitude issues are, APOMP might need to be embedded with some attitudinal change procedures or methods rather than just teaching and learning geometry.

4.2.4 Age at Onset of Visual Impairment

The study confirmed that age at onset of visual impairment is not a factor in task performance in geometry of learners with visual impairment. The result of the study showed that there was no significant mean difference in the adapted geometry task performance test of congenitally and adventitiously visually impaired learners using applied orientation and mobility programme (APOMP). Therefore this study revealed that APOMP does not affect task performance in geometry base on age at onset of visual impairment. There have been different findings or results when it comes to comparing achievement on tasks on the basis of age at onset of learners with visual impairment. As was revealed in the theoretical frame work, Fletcher (1980) identified theories that had existed for long indicating lower performance of persons congenitally visually impaired than those that are adventitiously visually impaired on tasks that involve spatial concepts like geometry. The "deficiency" theory states that spatial concepts are impossible in people with visual impairment from birth. "Inefficiency theory on its part suggests that people who are visually impaired from birth develop concepts and representations of space that are inferior to those of sighted and those adventitiously visually impaired. However Van, wood, Retunes and Wilson (2010) investigated the performance of persons with visual impairment in a fibro tactile discrimination tasks and found out that persons congenitally visually impaired did better than those who became visually impaired at later life. They further discovered that the congenitally visually impaired participants were more accurate than the adventitiously visually impaired learners.

In another research, Cohen, Haven, Lanzoni, Meacham, Skaff, and Wissell (2014) using PC, investigated achievement differences between congenitally visually impaired and adventitiously visually impaired persons. The research found a significant mean difference between the overall time and total error count of those born visually impaired and those who became visually impaired at later life. However there was no significant difference between the error and time ratio shown by the congenitally and adventitiously visually impaired.

In a research by an international team from Bath University, Sabanci University (Turkey) and Taisho University (Japan) (as reported by Proulx 2014) the team compared responses of congenitally visually impaired people on visualizing number line and found no difference in performance between the congenitally and adventitiously visually impaired persons. The researcher from experience observed that tasks given to learners with visual impairment are often solved based on their remaining senses. The sense of touch or feeling is the major sense in use. The challenge is based on the type of the process of the touch or feeling used. There is the simple use of the fingers to feel a simple line or surface of an object. There is the grasping of an object in the palm and the fingers to identity surfaces, points or edges, and the size of the object matters, it could require grasping with the whole body or even too big to be grasped. In that case portrait, samples, models, representations are made. These factors could possibly cause the challenges and determines the differences in achievement on tasks between congenitally and adventitiously visually impaired learners. In the view of the researcher may be the task that involves ordinary feeling of embossed line with the finger, is easier than haptic process which involves grasping and identifying detail lines, corners, edges, surfaces, size etc with the palm, fingers and other parts of the body.

CHAPTER FIVE
SUMMARY OF FINDINGS, CONCLUSION, AND RECOMMENDATIONS

This chapter presents a summary of the findings already discussed, the conclusion drawn and recommendations made. Limitations of the study are pointed out; suggestions for further studies and contribution to knowledge are presented.

5.1 SUMMARY OF FINDINGS

The findings of this study include:

1. The experimental group scored higher in mean score than the control group in adapted geometry task performance test. Therefore the result of the study showed that applied orientation and mobility programme is an adapted teaching strategy that resulted in high task performance in geometry. It gave access to learners with visual impairment to participate in geometry as a subject and mathematics in general. It enhanced performance of learners with visual impairment in geometry tasks.

2. The study revealed that there was no significant difference in task achievement of congenital and adventitious groups on adapted geometry task performance test. Therefore applied orientation and mobility programme had no effect on achievement based on age of onset of visual impairment.

3. Exposure to applied orientation and mobility programme led to high performance in geometry tasks and that affected interest in the subject positively.

4. Applied orientation and mobility programme shaped the minds of learners on negative beliefs thereby resulting in experimental group performing high in adapted geometry task performance test (AGTPT). They rejected the usual superstitious beliefs, mythologies and taboos that are negative towards learners with visual impairment offering mathematics or geometry which dominates the minds of learners themselves and makes them fear geometry or mathematics or think that they cannot offer it.

5. The study showed that there was no significant difference in attitude towards geometry task based on the opinion of congenitally visually impaired learners and adventitiously visually impaired learners. The study revealed similar result in task performance based on age at onset of visual impairment as mentioned above.

6. Using applied orientation and mobility which gives access to environmental geometric experiences to both congenital and adventitious visual impairment led to high performance and attitude of like for geometry irrespective of age at onset of the impairment.

7. The study revealed that the greatest problem in teaching and learning geometry for learners with visual impairment was lack of adapted equipment for teaching geometry in our schools. Adapted teaching materials for teaching geometry are many. Applied orientation and mobility used locally adapted teaching materials. Some of the equipment include: the use of car foot mat to make for a drawing mat, polythene sheets as found in many corn flakes packages, wooden rulers made of notches by the side for the calibration, T-Square, pair of compass, protractor, and set square.

5.2 CONCLUSION

The study was on the effects of applied orientation and mobility programme on attitude and achievement in geometry of learners with visual impairment in Abuja and Gindiri schools for blind children. Prior to the study, the researcher observed that geometry and on larger scale mathematics were not taught to learners with visual impairment. The few institutions that attempted teaching mathematics to the learners with visual impairment lacked the adapted strategy and equipment. Therefore learners with visual impairment in Nigeria for some years now did not write public examinations in the area of mathematics (geometry) since they did not offer the subject. The researcher had to come up with a programme and adapted strategy or methodology of introducing geometry to learners with visual impairment. This programme is referred to as applied orientation and mobility programme. The programme is concerned with the attitude of learners towards teaching and learning of geometry and task performance in geometry by them.

Applied orientation and mobility programme (AP0MP) allowed for access to geometry and success in the subject. Learners with visual impairment in Nigeria through the use of applied orientation and mobility programme will have mathematics requirements that will qualify them entrance into tertiary institutions. Some will read mathematics as a course of specialisation and obtain certificate in it and many will be found in science technology and engineering courses or professions as a result of skills in geometry and mathematics.

Applied orientation and mobility programme as a teaching strategy, aimed at teaching geometry to learners with visual impairment. Basic geometry is critical to understanding of mathematics in general and spatial relationships. Much of the working of applied orientation and mobility programme involved interaction with the environment. Therefore applied orientation and mobility enhanced other skills and knowledge in most of the subjects taught at school which involved spatial process. It provided background for understanding many of the school subjects. Applied orientation and mobility programme in Nigeria can give access to learners with visual impairment to many subjects that they were denied from offering in the past. For example mathematics, science and other subjects that have practical activities.

Exposure to applied orientation and mobility programme led to high performance in geometry tasks and that affected interest in the subject positively. When learners perform well in geometry and mathematics, studies have shown that there is the tendency of the learner developing the habit of like for the subject. Failure in mathematics, results in mathematics anxiety in life which goes with hatred for the subject and often results in poor performance.

The study showed that there was no significant difference in attitude towards geometry task based on the opinion of congenitally visually impaired learners and adventitiously visually impaired learners. The study revealed similar result in task performance based on age at onset of visual impairment as mentioned above. There was no significant difference in task performance or achievement of congenital and adventitious groups on adapted geometry task test (AGTPT). Using applied orientation and mobility which gives access to environmental geometric experiences to both congenital and adventitious visual impairment led to similar high performance and attitude of like for geometry irrespective of age at onset of the impairment. This is a contribution to the deficiency inefficiency theory or controversy that has existed in special education for long thereby making special educationist to strongly believe that congenitally visually impaired persons perform lower in spatial concepts when compared with adventitiously visually impaired or sighted persons.

The study revealed that the greatest problem in teaching and learning geometry for learners with visual impairment was lack of adapted equipment for teaching geometry in our schools. Adapted teaching materials for teaching geometry are many. Applied orientation and mobility used locally adapted teaching materials. Some of the equipment include: the use of car foot mat to make for a drawing mat, polythene sheets as found in many corn flakes packages, wooden rulers made of notches by the side for the calibration, T-Square, pair of compass, protractor, and set square. Without adapted teaching strategy and adapted teaching materials it will be impossible teaching learners with visual impairment geometry or mathematics.

5.3 RECOMMENDATIONS

The followings are the recommendations for the study

Nigeria should adopt applied orientation and mobility programme (APOMP) as an adapted strategy for teaching and learning geometry in particular and mathematics in general to learners with visual impairment. This is because the adapted teaching strategy (APOMP) gave access to learners with visual impairment to participate in geometry and mathematics in general. It led to high performance in tasks performance in geometry with learners with visual impairment.

Applied orientation and mobility programme should be used to resolve the existing controversy and theory of deficiency and inefficient which states that congenitally visually impaired persons cannot benefit in spatial concepts or even if they do, their performances are inferior compared with their sighted and adventitious peers. Applied orientation and mobility programme gives access to the many environmental signals or information related to spatial concepts to learners with visual impairment through their remaining senses. Like applied orientation and mobility programme, several researches showed that when congenitally visually impaired have such opportunity to relate to the environment, they create their personal ways of interpreting the spatial concepts thereby giving the same result as those that are sighted or adventitiously visual impaired. This disproves the theory of deficiency and inefficiency which has resulted in excluding congenitally visually impairment persons in participating in tasks that are spatial concept related which are found in so many areas of disciplines.

Applied orientation and mobility should be used as a strategy for dealing with attitude problems learners with visual impairment experience when it comes to offering geometry/mathematics. It could be used as a source of motivating the learners in offering mathematics. When learners record success in mathematics, they become interested in the subject. This prevents mathematics anxiety which goes with hatred to mathematics leading to poor performance or non participation in mathematics as is the case with learners with visual impairment all over the world.

Applied orientation and mobility programme should be used as a means of identifying, adapting and using teaching materials locally within the environment to meet the non availability or gross inadequacy of adapted equipment needs for teaching and learning of mathematics and geometry for learners with visual impairment.

5.4 LIMITATIONS OF THE STUDY

The followings are the problems the researcher encountered during the study:

The study was concerned with task performance in geometry. There was skills dormancy which needed to be activated. Therefore t-Test only was used to determine whether there was significant difference between the two sample means in the task performance.

The study was on geometry related to using an adapted strategy in teaching the subject. The basis for the adapted strategy is environmental information. This involves collecting information from the environment through the use of senses. This has implication on spatial skills which in turn relate to many disciplines or subject areas. The study was only concentrate on geometry. It did not extend to other course areas as to see the general application of applied orientation and mobility programme (APOMP) in other fields of studies.

The study was only in Abuja and Gindiri. Based on the strata of age at onset of visual impairment used, it was difficult meeting the required sample size in one class, hence the use of classes four and five in the two schools. The sample size was handled such that the randomization involved in the selection of the sample did not affect the needed strata in terms of age of onset of visual impairment. Similarly the expectation today in the field of special education is the use of an inclusive environment. It is difficult coming by an inclusive school that can meet the research needs that are required in this study.

5.5 SUGGESTIONS FOR FURTHER STUDY

This study could further be replicated with other categories of impairment like learners with hearing impairment, children with mathematics disorders, and those with dyscalculia. There is need to investigate into pre-requisite skills that are often lacking in children with visual impairment when studying mathematics thereby leading to having difficulties in mathematics skills, and habits leading to mathematics anxiety. Such pre-requisite skills are found or developed through interaction with the environment as in the case of APOMP and are better introduced early in the life of the learner with visual impairment or else it will be affected due to maturational problem. When they are introduced to prerequisite skills in geometry and mathematics in future they would have already had the sub-mathematics skills that will help them in mathematics or geometry tasks.

A further investigation on the relationship between cognitive process and attitude related to mathematics as done by applied orientation and mobility in this study should be done. This can reveal the correlate between attitude and mathematics skills and also cognition which attitude is a big impediment in teaching and learning mathematics.

The summary of this study is all about psychology of mathematical abilities in learners with visual impairment, development of adapted teaching strategy, disability issues in mathematics, task performance reflecting in ability through unique instruction leading to developing, cultivating and improving abilities in mathematics of learners with visual impairment. Each of these aspects of the study could be done thoroughly on their own.

5.6 CONTRIBUTIONS TO KNOWLEDGE

Following the research study on the effect of orientation and mobility programme on attitude and achievement in geometry of learners with visual impairment in Abuja and Gindiri, the following contributions were made to knowledge in the field of special education; visual impairment and education in general.

1. The study has produced a new adapted teaching strategy for teaching geometry in particular and mathematics in general to learners with visual impairment in Nigeria and the world at large. It prevents the lack of teaching and learning of geometry and mathematics in general in Nigeria which led to lack of participation in national examinations like WAEC and NECO of learners with visual impairment in mathematics due to lack of adapted teaching strategy.
2. Applied orientation and mobility programme (APOMP) is a methodology that uses spatial concept which its applicability cuts across all disciplines. It can be used in teaching courses like: Agriculture, physics, geography, social studies, mathematics and all other school subjects that are offered in school.
3. Mathematics concepts and skills depend to an extent on skills and knowledge in geometry. Literature reviews in this work have shown that when learners are not taught geometry, that will jeopardize their understanding of mathematics. Applied orientation and mobility programme therefore is an adapted teaching strategy that uses a subset of mathematics (geometry) to enhance performance in the larger aspect of mathematics.

4. Applied orientation and mobility programme is an intervention method for teaching mathematics to children who experience difficulties in mathematics. It can be used with children who have mathematics disorders, mathematics anxiety and dyscalculia. This will open a new area of studies in special education in Nigeria in the area of mathematics. The department of special education and rehabilitation sciences of University of Jos and other higher institutions in Nigeria concentrate in so many researches in the area of literacy programmes. Many Doctoral degrees (PhDs) have been produced in the area of reading difficulties with different types of children and different categories of disabilities. There is virtually none in the area of mathematics. this study has filled the gap.

5. The research has shown that applied orientation and mobility is a two edged sword. The learners experience the teaching and learning of geometry in both practical and theoretical manner; it also gives the opportunity for the learners to experience concepts and skills in orientation and mobility practically. It will now give opportunity for schools to start teaching geometry to their learners with visual impairment as well as orientation and mobility which both are often neglected.

6. Applied orientation and mobility gives opportunity to impart into the children pre-requisite skills in geometry and mathematics which will later be of great use at higher level of the subject area. Their contact with the environment (landmarks) enriches their cognitive process especially in the area of memory which is a requirement for process of calculation, acquiring basic concepts and habits in mathematics.

7. Applied orientation and mobility programme enhances tasks performance in geometry as well as changes negative attitude of learners with visual impairment to positive attitude towards geometry. Attitude is related to performance in mathematics. When children experience high task performance in mathematics due to the use of suitable or

appropriate adapted teaching strategy, they form positive attitude towards mathematics. Failure in mathematics, or non participation in mathematics due to lack of adapted teaching strategy for learners with visual impairment it results in mathematics anxiety.

8. The research work has contributed to the age long controversy of the deficiency and inefficiency theory where many specialists in special education believe that congenitally visually impaired learners cannot benefit from any spatial concept. The study has proven that there is no significant difference in performance of congenitally visually impaired and those that are adventitiously visually impaired on spatial tasks.

9. This study has succeeded in promoting the culture of mathematics in Nigeria. The realm of application of mathematics is unlimited. Countries of the world have realised that all sciences have become mathematical. Mathematical method and style of thinking are penetrating everywhere. Mathematical application is found in areas like: Physics, astronomy, chemistry, biology, archaeology, medicine, meteorology, economics, and linguistic. Therefore developing the mathematical ability and interest of children who have high ability in mathematics, those that are slow learners in mathematics and those with one impairment or disabilities or the other or mathematical disorders thereby requiring adaptation in mathematics method and materials results in raising mathematical culture in the country.

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APPENDIX A1

ADAPTED GEOMETRY TASK PERFORMANCE TEST (AGTPT)

INSTRUCTIONS: ANSWER ALL TEN QUESTIONS

1. LWVI identify two objects in the environment and take measurement between the objects.
2. Walk through routes and identify routes that are: i. Straight routes, ii. Curve routes, iii. Horizontal routes, iv. Vertical routes.
3. From given Polygons, LWVI identify them and put Braille name tags on each: triangle, rectangle, parallelogram, and trapezium.
4. With the use of the face of a clock LWVI show the following: i. 90^0, ii. 180^0, iii. 45^0, iv.$190^{0,}$ between the two hands of the clock.
5. Given objects in the environment, the LWVI identify the following shapes: i. Circle or Round, ii. Rectangular shapes, iii. Triangle, v. Square
6. Given the following embossed lines and using adapted measuring rulers, measure their lengths: i. (2cm) __________ ii. (4cm) ____________________ iii. (6cm) ____________________________________
7. Using drawing Kits draw by embossment: i. Horizontal line of 4cm; ii. Vertical line of 2cm iii. Two parallel lines of 6cm each.
8. With the use of adapted protractors, measure and name the following special angles: (right angle), (Straight angle), (Obtuse angel), (reflex angel).
9. Tactilely identify and name the following embossed shapes: (Triangle), (Pentagon), (Hexagon), (Rectangle), (Octagon).
10. Using adapted drawing instrument, draw by embossment the following shapes: i. Rectangle, ii. Triangle iii. Square

APPENDIX A2

GEOMETRY TASK PERFORMANCE TEST (AGTPT) MARKING SCHEME

INSTRUCTIONS: ANSWER ALL TEN QUESTIONS

1. LWVI identify two objects in the environment and take measurement between the objects. (Identifying two objects = (2,1/2 marks each); taking measurement = (2,1/2 each.) Total = (5 x 2 = 10 marks).

2. Walk through routes and identify routes that are: i. Straight routes, ii. Curve routes, iii. Horizontal routes, iv. Vertical routes. (The act of walking through the routes = 2 marks; (i. Straight routes = 2 marks, ii. Curve routes = 2 marks, iii. Horizontal routes = 2 marks, iv. Vertical routes 2 marks. Total 2 x 5 = 10).

3. From given Polygons, LWVI identify them and put Braille name tags on each: triangle, rectangle, parallelogram, and trapezium. (Act of putting name tag = 2marks, triangle = 2marks, rectangle = 2marks, parallelogram = 2marks and trapezium = 2marks. Total = 2 x 5 = 10marks)

4. With the use of the face of a clock LWVI show the following: i. 90^0, ii. 180^0, iii. 45^0, iv.$190^{0,}$ between the two hands of the clock. (Each demonstration = 2.5; total 2.5 x 4 = 10)

5. Given objects in the environment, the LWVI identify the following shapes: i. Circle or Round, ii. Rectangular shapes, iii. Triangle, iv. Square (2.5 x 4 = 10marks)

6. Given the following embossed lines and using adapted measuring rulers, measure their lengths: i. (2cm) ___________ ii. (4cm) _____________________ iii. (6cm) ____ (each length is 3; (total = 3 x 3 = 9) + 1= 10 marks)

7. Using drawing Kits draw by embossment: i. Horizontal line of 4cm; ii. Vertical line of 2cm iii. Two parallel lines of 6cm each. (3 marks each = 3 x 3= 9) + 1 = 10)

8. With the use of adapted protractors, measure and name the following special angles: (right angle), (Straight angle), (Obtuse angel), (reflex angel). (2.5 marks each = 2.5 x 4 = 10 marks)

9. Tactilely identify and name the following embossed shapes: (Triangle), (Pentagon), (Hexagon), (Rectangle), (Octagon). (2 marks each = 2 x 5 = 10 marks)

10. Using adapted drawing instrument, draw by embossment the following shapes: i. Rectangle, ii. Triangle iii. Square (3 marks each = 3 x 3 = 9 marks) + 1 =10

APPENDIX A3

ATTITUDE TO GEOMETERY SCALE (AGS)

Introduction

According to Ozoji (1991) attitude is a tri – element concept. This simply means attitudes are made up of three inter – related parts (Ozoji 1996). They are our beliefs, our feelings and our behaviours or actions towards a person, or object. Sardegna and Paul (1991) similarly put it that attitude is a measured disposition, feeling, position etc. with regard to a person or thing. It is a learned predisposition to behave in a consistent evaluative manner towards a person, an object or a group of objects. This evaluation can be favourable or unfavourable, positive or negative directed to certain people, issues or institutions. This mathematics attitude scale for learners with visual impairment is to find out whether they have negative or positive attitude towards mathematics. The questions cover the three areas of concept of attitude i.e. beliefs, feelings and behaviours.

ATTITUDE TO GEOMETERY SCALE (AGS)

S/N	**Attitude to Geometry Scale (AGS)**	**SA**	**A**	**UD**	**D**	**SD**
1	Geometry in Mathematics is easy.					
2	Geometry in Mathematics is my favorite subject.					
3	If any Learner with visual impairment wishes to offer Geometry I will stop him or her.					
4	With the right support, Learners with visual impairment can offer Geometry in mathematics.					
5	I feel satisfied whenever Learners with visual impairment make progress in Geometry.					
6	I feel I may not work where Geometry is required					
7	Learners with visual impairment should be given the opportunity to offer mathematics.					
8	I admire Learners with visual impairment who offer Geometry in mathematics.					
9	I cheat in Geometry exams to pass					
10	People, who offer Geometry, have better thinking					

	ability.					
11	I will love to be a qualified mathematician with Geometry skills.					
12	I run away where studying Geometry is required.					
13	The knowledge of Geometry helps in solving our daily activities.					
14	I feel happy when ever somebody helps me to do Geometry.					
15	I will fight who ever forces me to offer Geometry.					
16	Learners with visual impairment should be exempted from offering Geometry.					
17	I don’t like studying Geometry.					
18	One should work hard even when one fails Geometry.					
19	It is not normal for Learners with visual impairment to offer Geometry.					
20	I feel bad when Learners with visual impairment offer Geometry.					
21	It is normal being angry when asked to offer Geometry.					
22	Geometry cannot be taught to Learners with visual impairment in Nigeria.					
23	I hate Geometry					
24	I am not tired during Geometry lessons.					
25	There are no equipment for teaching Geometry in our schools.					
26	Geometry is a subject that makes me sick					
27	I study Geometry on my own.					
28	Geometry brings bad luck.					
29	I dislike Geometry teachers					
30	I practice Geometry.					

APPENDIX A4

Analysis of items in Attitude to Geometry Scale (AGS) Constructs (belief, affect and behavior)

S/N	Item No.	Belief	Affect	Behavior
1	1	Geometry is easy.	2. Geometry is my favorite area in Math.	3. If any Learner with visual impairment wishes to offer Geometry I will stop him or her.
2	4	With the right support, Learners with visual impairment can offer Geometry.	5. I feel satisfied whenever Learners with visual impairment make progress in Geometry.	6. I feel I may not work where Geometry skill is required
3	7	Learners with visual impairment should be given the opportunity to offer Geometry.	8. I admire Learners with visual impairment that offer Geometry.	9. I cheat in Geometry exams to pass
4	10	People, who offer Geometry, have better thinking ability.	11. I will love to be a qualified mathematician with Geometry skills.	12. I run away where studying Geometry is required.
5	13	The knowledge of Geometry helps in solving our daily activities.	14. I feel happy when ever somebody helps me with Geometry.	15. I will fight who ever forces me to offer Geometry.
6	16	Learners with visual impairment should be exempted from offer Geometry.	17. I don’t like studying Geometry.	18. One should work hard even when one fails Geometry exam.
7	19	It is not normal for Learners with visual impairment to offer Geometry.	20. I feel bad when Learners with visual impairment offer Geometry.	21. It is normal being angry when asked to offer Geometry.
8	22	Geometry cannot be taught to Learners with visual impairment in Nigeria.	23. I hate Geometry	24. I am not tired during Geometry lessons.
9	25	There are no equipments for teaching Geometry in our schools.	26. Geometry is a subject that makes me sick	27. I study Geometry on my own.
10	28.	Geometry brings bad luck.	29. I dislike Geometry teachers	30. I practice Geometry.

APPENDIX A5

TRAINING PROGRAMME FOR RESEARCH ASSISTANTS

The research assistants assisted the researcher with the administration of APOMP (the treatment) and the two instruments used in the study: Attitude to Geometry Scale (AGS) and Geometry Task Performance Test (AGTPT).

.The research assistants were selected and trained from the two selected schools Gindiri and Abuja. A total of three research assistants were selected for each of the schools.

Qualifications of Research Assistants

The research assistants were selected based on qualifications and also on their experiences that are related to skills in APOMP. There were those with special education B. Ed degrees specialising in the area of education of visual impairment and are involved in the orientation and mobility training in the school. One research assistant was selected from this group. One research assistant was selected from those with skills in Braille mathematical codes or notations. They had their thesis in the area of mathematics with the blind during their B.Ed degree programme. They are conversant with mathematics with learners with visual impairment. The third research assistant was selected from the schools' resource rooms. The research assistants were trained so that they will be able to be skilful in both the content and methodology of the APOMP programme. They need to be skilful in the use of the equipment and materials involved in teaching APOMP, and in arranging and organising the equipment.

Duration of the Training

The training was for one week in each school from Monday to Saturday. It took a total of three hours every day. From Monday to Friday, the training started from 2:00 p.m to 5:40 p.m and on Saturday, it was from 8:00 a.m. to 4: 00 p.m with break.

Scope of Training:

1. Orientation on the equipment/materials used for APOMP.
2. Observation and discussion on the content of themes, topics and the entire composition of APOMP and items in Questionnaire on attitude towards geometry.
3. Practical demonstration of relevant Orientation and Mobility skills related to geometry as contained in APOMP.
4. Practical demonstration of relevant geometry skills related to orientation and mobility skills as contained in APOMP.
5. Process of assessment and scoring of questionnaire on attitude towards geometry and achievement test in geometry.

APPENDIX A6

ONE WEEK TRAINING PROGRAMME FOR RESEARCH ASSISTANTS

S/N	DAY	TIME	TOPIC	CONTENT
1	Monday	2:00 – 3:00	Observation and discussion on APOMP themes, topics and entire composition	Line identification: landmarks and cues, tactile identification of routes, drawing of lines, measurement non standard and standard, cardinal points, angles and shapes
		3:00 – 3:30	COFFEE TIME	
		3:30 – 4:30	Observation and discussion of the equipment/materials to use in APOMP/ Questionnaire items	Embossed straight lines, curve lines, horizontal lines, vertical lines, parallel lines, contents of drawing kits: drawing mat, plastic sheets, embossed rulers, protractor, pair of compass, T-square, Braille cardinal point, embossed clock faces, shapes
		4:30 – 5:30	Free practical demonstration of the use of the equipment/materials	Hands on the use of the equipment/materials. Practical trials on the use of the equipment in measurement, drawing lines and shapes
2	Tuesday	2:00 – 3:00	Practical demonstration of relevant orientation and mobility skills related to geometry as contained in APOMP.	Identification and observation of land marks, cues, different objects in the environment, noting different shapes, (polygons, quadrilaterals) different parts of the body, walking from one

				landmark to the other, and one object to the other.
		3:00 – 3:30	COFFEE TIME	
		3:30 – 4:30	Demonstration of measurement with LWVI using adapted measuring equipment.	Non standard and standard measurement of body parts, length and width of objects in the environment with non standard measurement eg arm span, knee high, finger pacing, leg pacing and with adapted rulers, measuring tapes, pair of compass
		4:30 – 5:30	Demonstration of tactile identification of embossed routes (Lines).	Identification of embossed lines: straight lines, horizontal lines, vertical lines, parallel lines.
3	Wednesday	2:00 – 3:00	Practical demonstration of relevant geometry skills related to orientation and mobility skills as contained in APOMP	Drawing of routes (lines) not to standard or scale using drawing mat, polythene sheets, stylus, adapted rulers etc.
		3:00 – 3:30	COFFEE TIME	
		3:30 – 4:30	Practical demonstration of drawing routes (lines) using standard unit to specified length.	Drawing different types of lines: straight, horizontal, vertical, parallel lines with the use of the drawing mat, polythene sheet etc.
		4:30 –	Practical demonstration	Practical identification of shapes, three

		5:30	of tactile identification of shapes of different objects.	"D" shapes polygons and quadrilaterals.
4	Thursday	2:00 – 3:00	Practical demonstration of tactile identification of shapes, polygons, and quadrilaterals.	Practical identification of shapes, polygons and quadrilaterals by shapes, sides and names.
		3:00 – 3:30	COFFEE TIME	
		3:30 – 4:30	Practical demonstration of drawing of shapes using adapted drawing kits.	Drawing of different shapes: triangles, rectangles using drawing mats, polythene sheets, stylus etc
		4:30 – 5:30	Practical demonstration of drawing of polygons and quadrilaterals using adapted drawing kits.	Drawing of different polygons and quadrilaterals using drawing mats, polythene sheets, embossed pair of compass, rulers, T-squares, protractor etc.
5.	Friday	2:00 – 3:00	Demonstrating Compass bearing by facing, pointing and walking the direction	Walking towards the main cardinal points
		3:00 – 3:30	COFFEE TIME	
		3:30 – 4:30	Demonstrate relating the cardinal point to rotation.	Practically make rotations: ¼ rotation, ½ rotation, ¾ rotation, and demonstrate on the face of a clock.

		4:30 – 5:30	Demonstrating cardinal point and the degree on an embossed face of a clock.	Identifying the degrees from one cardinal point to the other on clock face and recording the result on Braille sheets.
6	Saturday	8:00 – 9:00	Process of assessment and scoring of questionnaire on attitude towards geometry and achievement test in geometry.	Demonstration of assessment and scoring of questionnaire on attitude towards geometry and achievement test in geometry.
		9:00 – 10:00	Revision of practical demonstration of drawing routes (lines) using standard unit to specified length.	Revision of drawing different types of lines: straight, horizontal, vertical, parallel lines with the use of the drawing mat, polythene sheet etc.
		10:00– 11:00	BREAK FAST	
		11:00 - 12:00	Revision of practical demonstration of drawing of shapes with adapted drawing instruments.	Revision of drawing of different shapes: triangles, rectangles using drawing mats, polythene sheets, stylus etc
		12:00 - 1:00	Revision of practical demonstration of drawing of polygons and quadrilaterals using adapted instruments.	Revision of drawing of different polygons and quadrilaterals using drawing mats, polythene sheets, embossed pair of compass, rulers, T-squares, protractor etc.

		1:00 - 2:00	LUNCH	
		2:00 - 3:00	Revision of demonstrating cardinal point and the degree on a face of an embossed clock.	Revision of identifying the degrees from one cardinal point to the next on clock face and record.
		3:00 - 4:00	Revision of process of assessment and scoring of questionnaire on attitude towards geometry and achievement test in geometry.	

APPENDIX A7

EIGHT WEEKS TREATMENT PROGRAMME FOR EXPERIMENTAL GROUP

S/N	WEEK	LESSON/ DURATION	TOPIC	PERFORMANCE OBJECTIVE: LWVI should be able to:	TEACHER /LWVI ACTIVITIES: Research Assistant supports LWVI to:	TEACHING AND LEARNING MATERIALS	EVALUATION: LWVI should:
1	ONE	1 (40 Minutes)	Body Parts	Identify by pointing at and naming six parts of the body	Identify point and name their body parts and that of their peers.	Body parts. Paper, pieces of clothes, balloons	Identify by pointing with either finger, piece of clothes, or paper any given six parts of the body: arm, leg, head, waist etc
2.	ONE	2 (40 Minutes)	Non standard measurement of body parts	Use any convenient non standard measure eg arm span, finger pacing, waist high, leg pacing etc to measure six parts of the body.	Take non standard measurement of any given six body parts: arm legs, head knee waist, fingers etc	Body parts: arm span, knee high, waist high, finger pacing, leg pacing etc.	Take measurement of six body parts using any of the following: arm span, knee high, waist high, finger pacing, leg pacing etc.
3	ONE	3 (40 Minutes)	Standard measurement of body parts	Use standard adapted measuring equipment: rulers, measuring tapes, meter rules etc to practically measure six parts of the body in centimetres and meters.	Take standard measurement of any given six parts of the body with adapted rulers, measuring tapes and meter rules.	Body parts, adapted rulers, measuring tapes and meter rules.	Take measurement of six body parts using any of the following adapted measuring equipment: rulers, measuring tapes and meter rules.
4	ONE	4 (40 Minutes)	Standard measurement of body parts based on laterality (left-right	Use standard adapted measuring equipment to measure three parts of the body on the right side, and three parts of the body on the left side of the body.	Take standard measurement of any given three parts of the body on the left and three on the right side of the body with adapted rulers, measuring tapes and meter	Body parts, adapted rulers, measuring tapes and meter rules.	Take measurement of three body parts on the right side and three on the left side of the body.

			body parts)		rules.		
5	TWO	1 (40 Minutes)	Land Marks	Identify ten of the following cues and landmarks in the environment: tress, houses, routes, roads/paths etc	Identify trees, houses, routes, roads, paths, stones, verandas, etc	trees, houses, routes, roads, paths, stones, verandas, etc	Identify ten cues and landmarks in the environment.
6	TWO	2 (40 Minutes)	Distances between Land Marks	Identify six of the following land marks and walk through them: roads, paths, between two land marks	Identify and walk through roads and paths.	Routes, roads, paths	Identify six routes (road, path) and walk through them.
7.	TWO	3 (40 Minutes)	Non Standard measurement of distances between land marks.	Identify six land marks (Houses, tress, stones, bridges etc) and measure using non standard measures (leg pacing, arm span, finger spacing etc.	Identify and measure between land marks using non standard measurement (leg pacing, arm span, finger spacing etc.	Houses, trees, stones, bridges, etc	Identify a total of six land marks and use non standard measurement to measure between each other.
8	TWO	4 (40 Minutes)	Standard measurement of distances between land marks.	Take measurement between two landmarks for a total of six landmarks (houses, trees, roads etc) using standard unit measurement: (rulers, measuring tapes, meter rule etc).	Take measurements using standard unit of measurement between landmarks.	Rulers, measuring tapes, meter rules etc	Identify a total of six landmarks and take measurement of the distances of the landmarks with standard unit of measurement.
9	THREE	1 (40 Minutes)	Tactile identification of embossed routes.	Tress with the finger and identify four given embossed lines: Straight line, curve line, vertical line, horizontal line and parallel lines.	Tactually identify embossed lines: Straight line, curve line, vertical line, horizontal line and parallel lines.	Embossed lines: Straight line, curve line, vertical line, horizontal line and parallel lines.	Tactually identify, and differentiate four embossed lines: Straight line, curve line, vertical line, horizontal line and parallel lines.
10	THREE	2 (40 Minutes)	Comparison of identified embossed routes (lines).	Feel four embossed lines with the finger and identify them by shapes or forms and names.	Feel and identify by shape and name embossed lines: curves, horizontal lines, vertical lines, parallel lines etc	Embossed lines: curves, horizontal lines, vertical lines, parallel lines etc	Feel with fingers, compare and identify by shapes and names the following embossed lines: curves, horizontal

							lines, vertical lines, parallel lines
11	THREE	3 (40 Minutes)	Free drawing of tactile embossed lines.	Use a rubber mat, nylon or polythene sheets and stylus to draw to no specification : horizontal line, Vertical line, Parallel lines	Place the rubber mat, polythene sheet and use stylus and embossed ruler to draw the lines.	Rubber mat, Polythene sheet, Stylus, ruler	Use rubber mat, stylus and embossed ruler to draw the following lines: horizontal line, Vertical line, Parallel lines
12	THREE	4 (40 Minutes)	Drawing of embossed line to specification	Use a rubber mat, nylon or polythene sheets and stylus to draw to given measurement: 2 cm long horizontal line, 4 cm vertical line, 6 cm long two parallel lines	Place the rubber mat, polythene sheet and use stylus and embossed ruler to draw the lines.	Rubber mat, Polythene sheet, Stylus, ruler	Use rubber mat, stylus and embossed ruler to draw the following lines: 2 cm horizontal line, 4 cm Vertical line, 6 cm Parallel lines
13	FOUR	1 (40 Minutes)	Identification of objects based on shapes in the environment	Identify the shape of the following objects in the environment: Round buckets Rectangular tables Round tray Square from cube of sugar	Explore objects and identify type of shape of the object.	Tables Buckets Trays Boxes Cubes	Identify the following objects by shapes and names: Round buckets Rectangular tables Round tray Square from cube of sugar
14	FOUR	2 (40 Minutes)	3 “D” Objects Cube, cuboid, cylinder sphere, cone	Identify and name four 3 “D” shapes with the use of fingers: Cube, cuboids, cylinder, sphere, cone	Identify and name 3 “D” shapes.	Cube, cuboids, cylinder, sphere, cone	Identify and name four 3 “D” shapes: Cube, cuboids, cylinder, sphere, cone
15	FOUR	3 (40 Minutes)	Polygons	Identify and name five polygons tactually: Pentagon Hexagon	Identify and name five polygons tactually: Pentagon Hexagon	Shape and embossed polygons: Pentagon Hexagon	Identify and name five polygons tactually: Pentagon Hexagon

				Octagon Nonagon Decagon	Octagon Nonagon Decagon	Octagon Nonagon Decagon	Octagon Nonagon Decagon
16	FOUR	4 (40 Minutes)	Identification of Quadrilateral s	Identify and name four quadrilaterals with the use of fingers: Squares Rectangles Parallelogram Trapezium	Identify and name the following quadrilaterals: Squares Rectangles Parallelogram Trapezium	Squares Rectangles Parallelogram Trapezium	Identify and name four quadrilaterals: Squares Rectangles Parallelogram Trapezium
17	FIVE	1 (40 Minutes)	Free hand practice on drawing with rubber mat	Freely practice drawing of embossed shapes with rubber mat, polythene sheet and slate and stylus with water.	Freely practice drawing with rubber mat, polythene sheet and slate and stylus with water.	Rubber mat, polythene sheet slate and stylus water	Freely practice drawing with rubber mat, polythene sheet and slate and stylus with water.
18	FIVE	2 (40 Minutes)	Drawing of shapes	Draw four types of embossed shapes using rubber mat, polythene sheet, stylus and water: Rectangles Triangles Squares Circles	Draw four types of embossed shapes using rubber mat, polythene sheet, stylus and water	Rubber mat, polythene sheet slate stylus water	Draw four types of embossed shapes using rubber mat, polythene sheet, stylus and water: Rectangles Triangles Square Parallelogram Trapezium
19	FIVE	3 (40 Minutes)	Drawing of Polygons	Draw four types of embossed Polygons using rubber mat: Pentagon Hexagon Octagon Nonagon Decagon	Draw four types of embossed Polygons using rubber mat: Pentagon Hexagon Octagon Nonagon Decagon	Rubber mat, polythene sheet slate stylus water	Draw four types of embossed Polygons using rubber mat, polythene sheet, stylus and water: Pentagon Hexagon Octagon

							Nonagon Decagon
20	FIVE	4 (40 Minutes)	Drawing of quadrilaterals	Draw two types of embossed quadrilaterals using rubber mat: Parallelogram Trapezium	Draw two types of embossed quadrilaterals using rubber mat: Parallelogram Trapezium	Rubber mat, polythene sheet slate stylus water	Draw two types of embossed quadrilaterals using rubber mat: Parallelogram Trapezium
21	SIX	1 (40 Minutes)	Main Cardinal Points	Identify, face and walk towards the direction of the main cardinal points: North South East West	Identify, face and walk towards the direction of the main cardinal points: North South East West	Embossed main cardinal points: North South East West	Identify, face and walk towards the direction of the main cardinal points: North South East West
22	SIX	2 (40 Minutes)	Identification of other cardinal points	Identify, face and walk towards the direction of all the other cardinal points: North North-West North-East South South-West South-East East West	Identify, face and walk towards the direction of all the other cardinal points: North North-West North-East South South-West South-East East West	Embossed cardinal points: North North-West North-East South South-West South-East East West	Identify, face and walk towards the direction of all the other cardinal points: North North-West North-East South South-West South-East East West
23	SIX	3 (40 Minutes)	Rotation	Demonstrate relating the cardinal point to the following rotation physically and with a face of a clock: ¼ rotation ½ rotation	Demonstrate relating the cardinal point to the following rotation physically and with a face of a clock: ¼ rotation ½ rotation	Clock face	Demonstrate relating the cardinal point to the following rotation physically and with a face of a clock: ¼ rotation ½ rotation

				¾ rotation	¾ rotation		¾ rotation
24	SIX	4 (40 Minutes)	Special Angles	Identify and name the following special angles: Right Angle Straight Angle Obtuse Angle Reflex Angle	Identify and name the following special angles: Right Angle Straight Angle Obtuse Angle Reflex Angle	Embossed Angles	Identify and name the following special angles: Right Angle Straight Angle Obtuse Angle Reflex Angle
24	SEVEN	1 (40 Minutes)	Degree identification in cardinal points	Identify the degrees from one cardinal point to the next on clock face: North-East = 90^0 North-South= 180^0 North-West=270^0 North- North=360	Identify the degrees from one cardinal point to the next on clock face: North-East = 90^0 North-South= 180^0 North-West=270^0 North- North=360	Clock face	Identify the degrees from one cardinal point to the next on clock face: North-East = 90^0 North-South= 180^0 North-West=270^0 North- North=360
25	SEVEN	2 (40 Minutes)	Setting given set of degree on clock face	Set four given degrees on a face of a clock: 12 to 3 = 90^0 12 to 6 = 180^0 12 to 9 = 270^0 12 to 12 = 360^0	Set four given degrees on a face of a clock: 12 to 3 = 90^0 12 to 6 = 180^0 12 to 9 = 270^0 12 to 12 = 360^0	Clock face	Set four given degrees on a face of a clock: 12 to 3 = 90^0 12 to 6 = 180^0 12 to 9 = 270^0 12 to 12 = 360^0
26	SEVEN	3 (40 Minutes)	Measurement of angles	Use embossed protractor to measure four given angles and identify the name of the angles: Right angle =90^0 Straight angle=180^0 Obtuse angle Reflex angle	Use embossed protractor to measure four given angles and identify the name of the angles: Right angle =90^0 Straight angle=180^0 Obtuse angle Reflex angle	Embossed Protractor	Use embossed protractor to measure four given angles and identify the name of the angles: Right angle =90^0 Straight angle=180^0 Obtuse angle Reflex angle
27	SEVEN	4 (40 Minutes)	Drawing of angles	Draw angles within the four main cardinal points using	Draw angles within the four main cardinal points:	Rubber mat Polythene sheet,	Draw angles within the four main cardinal points:

				embossed equipment: Angle 90^0 Angle 180^0 Angle 270^0 Angle 360^0	Angle 90^0 Angle 180^0 Angle 270^0 Angle 360^0	Stylus, Embossed- protractor Embossed ruler	Angle 90^0 Angle 180^0 Angle 270^0 Angle 360^0
28	EIGHT	1 (40 Minutes)	Revision of measurement of Distances between landmarks	Take measurement between two landmarks for a total of six landmarks (houses, trees, roads etc) using standard unit measurement: (rulers, measuring tapes, meter rule etc).	Take measurement between two landmarks for a total of six landmarks (houses, trees, roads etc) using standard unit measurement: (rulers, measuring tapes, meter rule etc).	houses, trees, roads rulers, measuring tapes, meter rule	Take measurement between two landmarks for a total of six landmarks (houses, trees, roads etc) using standard unit measurement: (rulers, measuring tapes, meter rule etc).
29		2 (40 Minutes)	Revision of identification and naming quadrilaterals .	Identify and name four quadrilaterals with the use of fingers: Squares Rectangles Parallelogram Trapezium	Identify and name four quadrilaterals with the use of fingers: Squares Rectangles Parallelogram Trapezium	Shapes and embossment of quadrilaterals: Squares Rectangles Parallelogram Trapezium	Identify and name four quadrilaterals with the use of fingers: Squares Rectangles Parallelogram Trapezium
30	EIGHT	3 (60 Minutes)	Administration of ATG	Answer ten questions contained in Achievement test in Geometry (ATG)	Take achievement test in geometry (ATG) under the supervision of the research Assistants.	ACHIEVEMENT TEST IN GEOMETRY	Answer ten questions contained in Achievement test in Geometry (ATG)
31	EIGHT	4 (40 Minutes)	Administration of LWVIGAQ	Respond to thirty items on the Learners with visual impairment Geometry Attitude Questionnaire (LWVIGAQ)	Respond to thirty items on the Learners with visual impairment Geometry Attitude Questionnaire (LWVIGAQ)	LEARNERS WITH VISUAL IMPAIRMENT GEOMETRY ATTITUDE QUESTIONNAIRE	Respond to thirty items on the Learners with visual impairment Geometry Attitude Questionnaire (LWVIGAQ)

APPENDIX A8

CRITERION FOR DECISION ON ATTITUDE DIRECTION ON ATTITUDE TO GEOMETRY SCALE (AGS)

Criterion Mean for Decision: The items are responded on a 5 point scale quantified 5, 4, 3, 2 and 1. The mean is 5 + 4 + 3 + 2 + 1= 15 ÷ 5 = 3

If the mean for each item is 3, or greater than 3, the research item is positive. If the item is less than 3 the item is negative. To find out the direction of attitude of LWVI towards geometry, the cluster mean or grand mean of the items was determined. To determine that, all the means for the thirty items were added up and divided by thirty the total number of items on the questionnaire.

Grand Mean Pre-Test for Experimental Group

3.6+3.6+2.4+4.1+4.4+2.7+4.3+4.2+2.8+3.3+3+3.9+3.3+3.8+3.8+3.8+3.2+3.6+3.4+3+4.1+3+3.7+2.9+4.8+4.8+3.7+3.1+3.3+3.2+3.8 = 105÷30 = 3.5

Grand Mean Post-Test for Experimental Group

3.6+3.6+2.4+4.1+4.4+2.7+4.3+4.2+2.8+3.3+3.8+2.3+4+4.1+3+2.8+2.3+4.1+2.3+4.1+2.3+4.1+2.3+2.2+3.4+2.1+2+3.4+4.8+2.6+3.8+2.8+2.1+3.1 = 94.4 = 3.14

Grand Mean Pre-Test for Control Group

1.5+1.4+2.9+2.9+2.1+3.9+2.9+2.6+4.1+2.5+2.6+3.9+3+3.3+4.1+4.1+5.1+3.6+4.1+5+3.8+3.9+3.7+2.9+3.8+4+2.5+3.8+3.9+2.1=100÷30 = 3.33

Grand Mean Post-Test for Control Group

1.2+1.2+4.5+2.7+2.5+3.9+2.9+2.3+3.2+2.6+4.1+2.4+2.8+4+4.2+4.2+3.4+4.1+4.2+4.2+4.2+4.3+4.5+2.7+4.7+4.2+2.3+3.8+3.5+2 = 100.8÷30 =3.36

APPENDIX A9

Table 7: APOMP TABLE OF SPECIFICATION

APPLIED ORIENTATION AND MOBILITY PROGRAMME (APOMP)
THEME: ONE LINE IDENTIFICATION THROUGH ORIENTATION AND MOBILITY

Topic	Performance Objectives	Content	Teachers Activities	Pupils	Teaching and Learning Materials	Evaluation Guide
1. Land Marks	Learners with Visual impairment (LWVI) should be able to: 1. Identify familiar objects that are easily recognized, are constant and have permanent location in the environment such as Trees, houses, road, routes, paths E.T.C 2. Walk from one familiar object to the other	1. Identification of permanent objects in the environment 2. Walking from one object to the other e.g from a tree to a house, from one part of a path to the other etc	1. Leads learners with visual impairment to identify objects like Trees, houses, roads etc 2. Walk a distance from one object to the other	1. Identify objects like Trees, houses, paths, routes roads etc 2. Walk a distance from one landmark to the other e.g from road to the house, from a tree to the house etc	Land marks: Trees Houses Routes Paths Roads etc	Learners with visual impairment: 1. Identify landmarks: trees, houses, routes, paths roads etc. 2. Walk from one object to another: From the road to the house, from the house to a tree, from one part of a path to the other etc Note distance

2. Sighted Guide Technique	Learners with visual impairment should be able to walk to establish: 1. Straight lines 2. Curve lines 3. Horizontal lines 4. Vertical lines 5. Parallel lines	Walking through paths, roads, routes to establish. 1. Straight lines 2. Curve lines 3. Horizontal line 4. Vertical lines 5. Parallel lines	Supports learners with visual impairment to walk and identify: 1. Straight lines 2. Curve lines 3. Horizontal lines 4. Vertical lines 5. Parallel lines	Walk through routs to identify 1. Straight line 2. Curve lines 3. Horizontal lines 4. Vertical line 5. Parallel lines	1. Paths 2. Road 3. Verandah 4. Routes etc	Walk through paths, routes, roads verandah etc and identify 1. Straight lines 2. Curve lines 3. Horizontal lines 4. Vertical lines 5. Parallel line
3. Tactile identification of embossed routes	Learners with visual impairment should be able to tactually identify embossed: 1. Straight lines 2. Curve lines 3. Horizontal lines 4. Vertical lines 5. Parallel lines	Types of lines 1. Straight lines 2. Curve lines 3. Horizontal lines 4. Vertical lines 5. Parallel lines	Leads learners to tactually. Identify: 1. Straight line 2. Curve lines 3. Horizontal lines 4. Vertical line 5. Parallel	Tactually identify 1. Straight line 2. Curve lines 3. Horizontal line 4. Vertical line 5. Parallel line	Embossed straight lines Curve lines Horizontal lines Vertical lines Parallel lines	Tactually identify embossed: 1. Straight line 2. Curve line 3. Horizontal line 4. Vertical line 5. Parallel line

4. Drawing of lines	Learners with visual impairment should be able to use drawing kits to draw: 1. Straight line 2. Curve line 3. Horizontal line 4. Vertical line 5. Parallel line	Drawing of different types of lines 1. Straight lines 2. Curve lines 3. Horizontal lines 4. Vertical lines 5. Parallel lines	Demonstrates and guides learners in drawing 1. Straight line 2. Curve lines 3. Horizontal lines 4. Vertical lines 5. Parallel lines	Drawing of 1. Straight lines 2. Curve lines 3. Horizontal lines 4. Vertical lines 5. Parallel lines	Drawing kits containing 1. Drawing mat 2. Plastic sheet or polythene sheet 3. Embossed ruler. 4. Protractor 5. Pair of compass 6. T-square	Using drawing kits 1. Draw straight line 2. Curve line 3. Horizontal line 4. Vertical line 5. Parallel line

APPLIED ORIENTATION AND MOBILITY PROGRAMME (APOMP)
THEME TWO: BODY PARTS AND MEASUREMENT

Topic	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES TEACHERS	PUPILS	TEACHING AND LEARNING MATERIAL	EVALUATION GUIDE
1. Knowledge of body parts and non-standard measurement	Learners with visual impairment should be able to: 1. Identify body parts for non standard measurement i. Arm span ii. Knee high iii. Waist high iv. Finger pacing v. Leg pacing etc 2. Taking measurement with non standard units: i. Arm span ii. Knee high iii. Waist high iv. Finger pacing v. Leg pacing etc	The use of non standard units to measure: Guide learners to: i. Arm span ii. Knee high iii. Waist high iv. Finger pacing v. Leg pacing	Guides learners to: 1. Identify different part of the body parts for non-standard measurement i. Arm span ii. Knee high iii. Waist high iv. Finger pacing v. Leg pacing 2. Demonstrate and leads learners into measurement with non standard units.	1. Identify body parts for non-standard measurement i. Arm span ii. Knee high iii. Waist high iv. Finger pacing v. Leg pacing 2. Take measurement of things using body parts Arm, knee, waist, finger, leg, head etc.	body parts: Arm, knee, waist, finger, leg, head etc.	1. Identification of body parts: Arm, knee, waist, fingers, legs, head etc. 2. Take measurement of things using body part as non standard unit using: i. Arm span ii. Knee high iii. Finger pacing iv. Leg pacing v. Round the head
2. Practical standard measurement.	Practical measurement of Things with adapted measuring rulers and	use of adapted standard measuring equipment: rulers, tape measures to	Guides learners to use adapted standard measuring tools	Practically measure properties of objects e.g Length, distance in meter	Adapted rulers, Meter rules, Measuring	Practically take measurement of things in the environment using 1. ruler (in centimeters)

	tapes in meters and centimeters	measure things in meter and centimeter	to measure properties of objects like: Length, distance in meter and centimeter	and centimeters using rulers and measuring tape	Tape Body parts Books Doors Boxes Tables etc	2. meter rule (in meters) 3. measuring tape
3. Standard measurement of Embossed Lines	Learners with visual impairment should be able to: i. measure using standard measuring tools, ruler, measuring tape: 1. horizontal line 2. vertical line 3. parallel lines	using standard unit to measure drawn embossed lines of different lengths that are: 1. horizontal 2. vertical 3. parallel	Demonstrates and guides learners in drawing lines using adapted tools to measure 1. horizontal lines 2. vertical lines 3. parallel lines	Measure lines of different lengths that are horizontal, vertical, parallel Using adapted measuring tools	Embossed 1. horizonta l 2. vertical 3. parallel	The learner practically measure the following embossed lines using adapted measuring tools 1. horizontal lines 2. vertical lines 3. parallel lines
4. Drawing of Lines	Use tools in the drawing kit: 1. Drawing mat 2. Polythene sheet 3. Stylus/dead Biro 4. Adapted ruler 5. Pair of compass to draw 1. Straight lines 2. Vertical lines 3. Parallel lines 4. Curve lines	Drawing of different types of lines: 1. Straight lines 2. Horizontal lines 3. Vertical lines 4. Parallel lines 5. Curve lines	Demonstrates with and guides learners to draw 1. Horizontal lines 2. Vertical lines 3. Parallel lines 4. Straight line 5. Curve lines	Using adapted drawing tools to draw: 1. Horizontal line 2. Vertical line 3. Parallel lines 4. Curve lines 5. Straight line	Drawing kits Drawing mats Embossed rulers Protractor Pair of compass	Using adapted drawing tools: drawing mats, rulers, protractors, pair of compass, learners draw: 1. Straight lines 2. Horizontal lines 3. Vertical lines 4. Parallel lines 5. Curve lines

THEME THREE: COMPASS BEARING AND ANGLES

TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES TEACHERS	PUPILS	TEACHING AND LEARNING MATERIALS	EVALUATION GUIDE
1. Facing and walking towards the main cardinal points 1. North 2. South 3. East 4. West	Learners with visual impairment should be able to: 1. Identify by pointing at the four main cardinal points: North, South, East and West. 2. Face and walk towards the four main cardinal points: North, South, East and West	Identification, Facing and walking towards the four main cardinal points: North, East, South and West	Guides learners to: 1. Point at the four main cardinal points North, South, East and West. 2. Face and walk towards the four cardinal points	1. Point at the four cardinal points 2. Face and walk towards the four cardinal points: North, South, East and west	Cardinal point showing North, East, South and West in Braille	Learners with visual impairment to: 1. Point at the four main cardinal points: North, South, East and West 2. Face the four main cardinal points: North, South, East and West. 3. Walk towards a given cardinal point: North, South, East and West
2. Relating the cardinal point to rotation. 1. ¼ rotation 2. ½ rotation 3. ¾ rotation	1. Make ¼ rotation 2. make ½ rotation 3. make ¾ rotation	Demonstration of measure of amount of rotation 1. ¼ rotation 2. ½ rotation 3. ¾ rotation	Supports learners to demonstrate turning to show ¼ rotation ½ rotation ¾ rotation	Demonstrate 1. ¼ rotation 2. ½ rotation 3. ¾ rotation	Cardinal points: North, South, East and West in Braille	Practically demonstrate rotations: 1. ½ rotation 2. ¼ rotation 3. ¾ rotation
3. Cardinal points	1. show the cardinal	1. Set on a clock	Enables learners to	1. Set the	Cardinal points	1. Set the

and degree on clock face	point on the clock face: North, South, East and West (12, 6, 3 and 9) 2. identify the degrees from one cardinal point to the next on clock face 1. North to East $=90^0$ 2. East to South $=90^0$ 3. South to west $=90^0$ 4. North to West $= 90^0$ 5. 12 to 6 $=180^0$ 6. 12 to 3 $=90^0$ 7. 12 to 9 $= 270^0$	face the main cardinal points: North, South, East and West 2. Set given degrees on clock face. 12 to 3 $= 90^0$ 12 to 6 $= 180^0$ 12 to 9 $= 270^0$ 12 to 12 $= 360^0$	demonstrate the cardinal points on the clock face and identify quantity of degrees	cardinal points on the clock face 2. Identify degrees from one cardinal point to the other	in Braille clock faces	cardinal points on the clock face: North, South, East and West 2. Set the degrees from one cardinal point to the next one on the clock face. 1. North to East $=90^0$ 2. North to South $= 180^0$ 3. North through to West $= 270^0$ North to North $= 360^0$
4. Special Angles	Learners with visual impairment should be able to: Identify and name the following special angles: 1. Right Angle 2. Straight Angle 3. Obtuse Angle 4. Reflex Angle	Identification and naming angles: 1. Right Angle 2. Straight Angle 3. Obtuse Angle 4. Reflex Angle	Guides learners to identify and name special angles	Identify and name special angles	Clock face embossed special angles	Identify and name the following special angles: 1. Right angles 2. Straight angles 3. Obtuse angle 4. Reflex angles

THEME: FOUR SHAPES AND POLYGONS

TOPIC	PERFORMANCE OBJECTIVE	CONTENT	ACTIVITIES TEACHER	PUPILS	TEACHING AND LEARNING MATERIALS	EVALUATION GUIDE LEARNERS
1. Shapes	Learners with visual impairment should be able to: 1. Identify objects within the environment by shapes 2. Name the type of shape of the objects eg Round buckets, Rectangular tables Triangular bottles squared box etc.	1. Identifying by touch three dimensional objects by shape within the environment 2. Mention the name of the shape of the object eg Round Table Rectangular table Squared box etc	Guides learners to explore objects and identify their shapes	1. Use hands and fingers to explore objects in the environment 2. Identify and mention shapes of object	Houses, Windows, doors, tins, boxes, bottles, Tables, buckets etc	1. Identify objects by shapes and names Round bucket Rectangular table top Squared box top
2. 3D Shapes	Identify the following three dimensional shapes and names: 1. Cube 2. Cuboid 3. Cylinder 4. Sphere 5. Cone	Identifying and naming three dimensional shapes: 1. Cube 2. Cuboid 3. Cylinder 4. Sphere 5. Cone	Guides and supports learners to identify and name three dimensional shapes: Cube, Cuboids, Cylinder, Sphere and Cone	Identify and name 3D shapes: Cube, Cuboids, Cylinder, Sphere and Cone	Three dimensional shapes: Cubes, Cuboids, Cylinders, Spheres and Cones	Identify three dimensional shapes: Cube, Cuboids, Cylinder, Sphere, Cone and name them
3. Polygons	Identify the embossed	Identification of embossed	Guides	Identify by	Polygons	Identify

	polygons by number of sides and names. 1. Triangles 2. Pentagon 3. Hexagon 4. Octagon 5. Nonagon 6. Decagon	polygons by shapes, sides and names. 1. Triangle 2. Pentagon 3. Hexagon 4. Octagon 5. Nonagon 6. Decagon	learners with the identification of polygons by shapes, sides and names: Triangle Pentagon Hexagon Octagon Nonagon Decagon	touching the shape, sides and name of the following polygons: Triangle Pentagon Hexagon Octagon Nonagon Decagon	Triangle Pentagon Hexagon Octagon Nonagon Decagon	polygons by 1. Shapes 2. Sides 3. Names 1. Triangle 2. Pentagon 3. Hexagon 4. Octagon 5. Nonagon 6. Decagon
4. Quadrilaterals	Identify the following embossed quadrilaterals Squares Rectangles Parallelogram Trapezium by shapes sides and names	Identification of the names, shapes and sides of the following quadrilaterals squares, rectangles, parallelogram Trapezium	Guides learners in identifying the given quadrilateral squares Rectangles Parallelogram Trapezium by shapes, sides and names	Identify shapes, sides and names of the following quadrilaterals squares Rectangles Parallelogram Trapezium	Embossed Quadrilaterals: Rectangles Squares Parallelogram Trapezium	Identify the following quadrilaterals by their 1. Shapes 2. Sides 3. Names 1. Squares 2. Rectangles 3. Parallelogram 4. Trapezium

APPENDIX B1

H_{o1}: There is no significant difference in the mean task performance score in geometry of experimental group and control group.

t-Test for Hypothesis 1

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Achievement score	Experimental	10	75.1	11.2	3.55
	Control	10	45.1	11.6	3.67

Independent Samples Test

	Levene's Test for Equality of Variances			t-Test for Equality of Means						
									95% Confidence Interval of the Difference	
	F	Sig.		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Achievement score	Equal variances assumed	0.02	0.878	5.88	18	0	30	5.11	19.27	40.73
	Equal variances not assumed			5.88	18	0	30	5.11	19.27	40.73

H_{o2}: There is no significant difference in the task performance scores of the congenital group and adventitious group in geometry.

t-Test for Hypothesis 2

Group Statistics					
	Learners status	N	Mean	Std. Deviation	Std. Error Mean
Achievement score	Cognental	10	58.3	17.6	5.57
	Adventitious	10	61.9	21	6.66

Independent Samples Test										
		Levene's Test for Equality of Variances		t-Test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Achievement score	Equal variances assumed	0.7	0.41	-0.42	18	0.683	-3.6	8.68	-21.8	14.64
	Equal variances not assumed			-0.42	17.5	0.683	-3.6	8.68	-21.9	14.68

H_{o3}:
There is no significant difference in utility value of applied orientation and mobility programme (APOMP) of experimental group and control group.

t-Test

[DataSet0]

Group Statistics

groups		N	Mean	Std. Deviation	Std. Error Mean
score of students	experimental group	5	67.6000	8.53229	3.81576
	control group	5	26.2000	12.37740	5.53534

Independent Samples Test

		Levene's Test for Equality of Variances		t-Test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
score of students	Equal variances assumed	.580	.468	6.158	8	.000	41.40000	6.72309	25.89652	56.90348
	Equal variances not assumed			6.158	7.101	.000	41.40000	6.72309	25.54825	57.25175

H_{o4}: There is no significant difference in the attitude of Learners with visual impairment exposed to APOMP and those not exposed to APOMP towards Geometry.

t-Test for Hypothesis 4 (pretest attitude score)

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
Attitude score	Experimental	10	102.6	5.19	1.64
	Control	10	100.2	3.882	1.23

Independent Samples Test										
		Levene's Test for Equality of Variances		t-Test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Attitude score	Equal variances assumed	0.72	0.407	1.171	18	0.257	2.4	2.049	-1.9056	6.706
	Equal variances not assumed			1.171	16.7	0.258	2.4	2.049	-1.9304	6.73

t-Test for Hypothesis 4 (posttest attitude score)

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
Attitude score	Experimental	10	95.9	5.02107	1.5878
	Control	10	102.4	4.37671	1.384

Independent Samples Test										
		Levene's Test for Equality of Variances		t-Test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Attitude score	Equal variances assumed	1.085	0.311	-3.086	18	0.006	-6.5	2.10634	-10.925	-2.07474
	Equal variances not assumed			-3.086	17.671	0.006	-6.5	2.10634	-10.931	-2.06883

H_{o5}: There is no significant difference in the attitude of learners with visual impairment who were born with visual impairment (congenital) and those that became visually impaired at later life (adventitious) to Geometry.

t-Test for Hypothesis 5 (pretest score)

Group Statistics					
	learners status	N	Mean	Std. Deviation	Std. Error Mean
Attitude total score	Congenital	10	100.1	3.10734	0.983
	Adventitious	10	102.7	5.63816	1.783

Independent Samples Test										
		Levene's Test for Equality of Variances		t-Test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Attitude total score	Equal variances assumed	2.59	0.125	-1.277	18	0.218	-2.6	2.036	-6.877	1.677
	Equal variances not assumed			-1.277	14.01	0.222	-2.6	2.036	-6.966	1.766

t-Test for Hypothesis 5 (posttest attitude score)

Group Statistics					
	Learners status	N	Mean	Std. Deviation	Std. Error Mean
total Attitude score	Congenital	10	99.1	4.581	1.449
	Adventitious	10	99.2	6.844	2.164

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
total Attitude score	Equal variances assumed	2.162	0.159	-0.038	18	0.97	-0.1	2.60448	-5.5718	5.37182
	Equal variances not assumed			-0.038	15.72	0.97	-0.1	2.60448	-5.6294	5.42936

APPENDIX B2

ADAPTED GEOMETRY TASK PERFORMANCE TEST (AGTPT) SCORES FOR EXPERIMENTAL GROUP

S/N	EXPERIMENTAL GROUP (Congenitally Visually Impaired)	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8
1	N_1	9	7	8	5	8	6	6	5
2	N_2	10	9	10	7	10	9	7	7
3	N_3	5	6	8	5	8	6	5	5
4	N_4	10	8	9	7	10	7	6	7
5	N_5	10	8	7	7	10	7	3	2
	EXPERIMENTAL GROUP (Adventitiously Visually Impaired)	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 5**	**Q 6**	**Q 7**	**Q 8**
6	N_6	10	10	10	8	10	9	7	10
7	N_7	10	8	8	7	10	7	7	8
8	N_8	6	5	8	5	8	6	6	7
9	N_9	10	8	8	5	10	7	7	5
10	N_{10}	10	9	9	7	10	7	7	8

GEOMETRY TASK PERFORMANCE TEST (AGTPT) SCORES EXPERIMENTAL GROUP CONT

S/N	EXPERIMENTAL GROUP (Congenitally Visually Impaired)	Q 9	Q 10	TOTAL
1	N_1	6	10	**70**
2	N_2	8	10	**87**
3	N_3	4	6	**58**
4	N_4	8	7	**79**
5	N_5	4	6	**64**
	EXPERIMENTAL GROUP (Adventitiously Visually Impaired)	**Q 9**	**Q 10**	**TOTAL**
6	N_6	8	10	**92**
7	N_7	8	10	**83**
8	N_8	6	8	**65**
9	N_9	4	6	**70**
10	N_{10}	8	8	**83**

GEOMETRY TASK PERFORMANCE TEST (AGTPT) SCORES FOR CONTROL GROUP

	CONTROL GROUP (Congenitally Visually Impaired)	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 5**	**Q 6**	**Q 7**	**Q 8**
11	N_{11}	5	5	6	2	8	3	0	2
12	N_{12}	8	8	7	4	10	4	3	2
13	N_{13}	5	6	7	2	8	0	1	0
14	$_{14}$	10	10	8	4	10	3	3	5
15	N_{15}	8	6	7	2	8	4	4	2
	CONTROL GROUP (Adventitiously Visually Impaired)	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 5**	**Q 6**	**Q 7**	**Q 8**
16	N_{16}	6	5	8	4	8	3	3	2
17	N_{17}	10	8	7	5	10	7	6	5
18	N_{18}	8	9	5	4	8	3	4	2
19	N_{19}	8	5	6	2	8	3	3	0
20	N_{20}	5	4	5	0	8	0	3	0

GEOMETRY TASK PERFORMANCE TEST (AGTPT) SCORES FOR CONTROL GROUP CONT

	CONTROL GROUP (Congenitally Visually Impaired)	**Q 9**	**Q 10**	**TOTAL**
11	N_{11}	4	0	**35%**
12	N_{12}	6	3	**55%**
13	N_{13}	4	0	**33%**
14	N_{14}	4	0	**57%**
15	N_{15}	4	0	**45%**
	CONTROL GROUP (Adventitiously Visually Impaired)	**Q 9**	**Q 10**	**TOTAL**
16	N_{16}	4	0	**43%**
17	N_{17}	4	3	**65%**
18	N_{18}	4	3	**50%**
19	N_{19}	4	0	**39%**
20	N_{20}	4	0	**29%**

APPENDIX B3

PRE TEST LEARNERS WITH VISUAL IMPAIRMENT ATTITUDE TO GEOMETRY SCALE (AGS)

	EXPERIMENTAL GROUP(congenitally visually impaired)	Q ITEM	1	2	3	4	5	6	7	8	9	10
1.	N_1		2	2	4	5	5	4	5	4	4	3
2.	N_2		2	2	5	4	3	4	5	1	3	2
3.	N_3		2	2	2	2	2	4	3	4	4	3
4.	N_4		3	3	5	3	3	4	4	4	4	3
5.	N_5		2	2	2	2	3	3	4	3	3	3
	EXPERIMENTAL GROUP (adventitiously visually impaired)	**Q ITEM**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
6.	N_6		4	3	4	4	4	2	4	4	1	2
7.	N_7		2	4	4	4	2	2	4	4	3	3
8.	N_8		2	2	4	4	2	4	4	4	4	3
9.	N_9		3	3	2	3	4	3	4	4	4	2
10.	N_{10}		2	2	5	2	4	4	2	2	5	5
	CONTROL GROUP(congenitally visually impaired)	**Q ITEM**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11.	N_{11}		2	1	4	2	4	4	2	2	4	2
12.	N_{12}		1	1	4	2	2	4	2	4	4	3
13.	N_{13}		1	1	5	4	4	4	4	3	4	3
14.	N_{14}		2	2	3	3	3	4	3	3	4	3
15.	N_{15}		3	3	3	3	3	3	3	3	4	3
	CONTROL GROUP(adventitiously visually impaired)	**Q ITEM**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
16.	N_{16}		1	1	4	4	4	4	4	1	4	3
17.	N_{17}		1	1	3	3	3	3	4	4	4	3
18.	N_{18}		2	2	4	2	2	4	2	2	4	2
19.	N_{19}		1	1	4	3	2	4	3	2	4	2
20.	N_{20}		1	1	5	3	4	5	2	2	5	1

PRE TEST LEARNERS WITH VISUAL IMPAIRMENT ATTITUDE TO GEOMETRY SCALE (AGS)

	EXPERIMENTAL GROUP(congenitally visually impaired)	**Q ITEM**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1.	N_1		3	4	4	4	4	4	4	4	2	2
2.	N_2		2	3	3	4	5	4	4	4	4	4
3.	N_3		3	4	2	3	4	3	4	3	4	4
4.	N_4		3	4	4	4	4	4	3	4	4	2
5.	N_5		4	4	4	4	3	3	3	4	4	2
	EXPERIMENTAL GROUP(adventitiously visually impaired)	**Q ITEM**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
6.	N_6		2	4	2	3	4	4	4	3	4	4
7.	N_7		4	4	4	4	4	4	3	4	4	4
8.	N_8		3	4	2	4	4	4	2	4	4	4
9.	N_9		3	4	4	4	4	4	3	4	2	2
10.	N_{10}		3	4	4	4	2	4	2	2	2	2
	CONTROL GROUP(congenitally visually impaired)	**Q ITEM**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
11.	N_{11}		2	4	3	4	5	4	4	4	4	4
12.	N_{12}		3	4	3	4	4	4	5	4	4	4
13.	N_{13}		3	4	3	2	4	4	4	4	4	4
14.	N_{14}		5	3	4	3	3	4	4	3	3	3
15.	N_{15}		2	4	3	2	4	4	4	3	4	4
	CONTROL GROUP(adventitiously visually impaired)	**Q ITEM**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
16.	N_{16}		3	4	3	4	4	4	4	3	4	4
17.	N_{17}		4	4	3	4	4	4	5	4	5	2
18.	N_{18}		2	4	2	2	4	4	4	3	4	4
19.	N_{19}		2	4	3	5	5	5	5	5	5	5
20.	N_{20}		2	4	3	3	4	4	4	3	4	4

PRE TEST ATTITUDE TO GEOMETRY SCALE (AGS)

	EXPERIMENTAL GROUP(congenitally visually impaired)	Q ITEM	21	22	23	24	25	26	27	28	29	30
1.	N_1		4	2	4	2	5	4	2	1	1	2
2.	N_2		4	4	4	2	5	3	2	3	3	2
3.	N_3		4	4	4	3	5	4	3	3	3	3
4.	N_4		4	2	2	4	5	1	3	3	2	5
5.	N_5		5	2	5	2	4	4	3	3	3	3
	EXPERIMENTAL GROUP(adventitiously visually impaired)	**Q ITEM**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.	N_6		4	4	4	3	5	3	2	5	5	5
7.	N_7		4	4	4	5	5	5	3	2	2	5
8.	N_8		4	4	4	2	5	5	5	5	5	5
9.	N_9		4	2	2	2	5	4	4	4	4	4
10.	N_{10}		4	2	4	4	4	4	4	4	4	4
	CONTROL GROUP(congenitally visually impaired)	**Q ITEM**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
11.	N_{11}		4	4	4	2	4	4	2	3	4	2
12.	N_{12}		4	4	4	2	4	4	2	4	4	2
13.	N_{13}		4	4	4	3	4	4	4	4	4	2
14.	N_{14}		3	4	4	4	3	5	4	4	4	3
15.	N_{15}		4	4	4	3	4	3	2	3	3	2
	CONTROL GROUP(adventitiously visually impaired)	**Q ITEM**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
16.	N_{16}		4	4	4	4	4	4	2	4	4	2
17.	N_{17}		3	3	3	2	5	4	3	4	4	2
18.	N_{18}		4	4	4	3	4	4	2	4	4	2
19.	N_{19}		4	4	4	2	4	4	2	4	4	2
20.	N_{20}		4	4	2	4	2	4	2	4	4	2

APPENDIX B4

POSTTEST ATTITUDE TO GEOMETRY SCALE (AGS)

	EXPERIMENTAL GROUP(congenitally visually impaired)	**Q ITEM**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1.	N_1		2	2	4	5	5	4	5	4	4	1
2.	N_2		1	3	3	4	4	4	5	5	3	3
3.	N_3		4	3	3	3	4	4	4	4	4	3
4.	N_4		4	2	2	4	4	3	4	4	3	2
5.	N_5		3	3	2	5	5	2	4	4	3	3
	EXPERIMENTAL GROUP(adventitiously visually impaired)	**Q ITEM**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
6.	N_6		5	5	2	4	4	3	4	4	4	4
7.	N_7		4	4	2	4	4	2	4	4	2	4
8.	N_8		5	5	2	4	5	2	5	5	2	4
9.	N_9		4	4	2	4	5	1	4	4	1	4
10.	N_{10}		4	5	2	4	4	2	4	4	2	5
	CONTROL GROUP(congenitally visually impaired)	**Q ITEM**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11.	N_{11}		2	2	3	2	3	4	4	2	5	3
12.	N_{12}		1	1	5	4	3	4	2	2	4	2
13.	N_{13}		1	1	4	3	3	4	3	2	4	3
14.	N_{14}		1	1	5	1	1	5	1	1	4	1
15.	N_{15}		1	1	5	2	2	3	2	2	5	2
	CONTROL GROUP(adventitiously visually impaired)	**Q ITEM**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
16.	N_{16}		1	1	5	3	3	5	4	4	5	5
17.	N_{17}		1	1	5	3	3	4	4	4	3	2
18.	N_{18}		1	1	4	4	2	4	2	2	4	3
19.	N_{19}		2	2	4	3	3	4	3	2	4	3
20.	N_{20}		1	1	5	2	2	5	1	2	4	2

POST TEST ATTITUDE TO GEOMETRY SCALE (AGS))

	EXPERIMENTAL GROUP(congenitally visually impaired)	Q ITEM	11	12	13	14	15	16	17	18	19	20
1.	N_1		3	4	4	4	4	4	4	4	2	2
2.	N_2		4	2	4	4	4	4	4	4	3	2
3.	N_3		3	2	4	5	4	4	2	4	2	2
4.	N_4		4	3	4	4	4	2	2	4	2	2
5.	N_5		4	2	4	4	3	2	2	4	2	2
	EXPERIMENTAL GROUP(adventitiously visually impaired)		**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
6.	N_6		4	2	4	4	4	4	2	4	2	2
7.	N_7		4	2	4	4	1	2	2	4	2	2
8.	N_8		4	2	4	4	2	2	2	5	4	4
9.	N_9		4	2	4	4	2	2	2	4	2	2
10.	N_{10}		4	2	4	4	2	2	1	4	2	2
	CONTROL GROUP(congenitally visually impaired)		**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
11.	N_{11}		4	3	2	4	4	4	3	4	4	4
12.	N_{12}		4	3	4	3	4	4	4	4	4	4
13.	N_{13}		4	3	4	4	4	4	4	4	4	4
14.	N_{14}		5	1	2	5	5	5	5	5	5	5
15.	N_{15}		4	2	2	4	4	4	4	4	4	4
	CONTROL GROUP(adventitiously visually impaired)		**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
16.	N_{16}		4	3	4	4	4	4	4	4	4	4
17.	N_{17}		4	2	3	4	4	4	4	4	4	4
18.	N_{18}		4	2	2	4	4	4	3	4	4	4
19.	N_{19}		4	3	3	4	5	5	4	4	5	5
20.	N_{20}		4	2	2	4	4	4	4	4	4	4

POST TEST ATTITUDE TO GEOMETRY SCALE (AGS)

	EXPERIMENTAL GROUP(congenitally visually impaired)	Q ITEM	21	22	23	24	25	26	27	28	29	30
1.	N_1		4	2	4	2	5	4	2	1	3	2
2.	N_2		4	2	2	2	5	4	5	1	2	2
3.	N_3		4	2	1	4	5	5	4	2	2	4
4.	N_4		4	3	2	4	5	1	4	2	2	5
5.	N_5		4	2	2	2	4	2	3	2	2	3
	EXPERIMENTAL GROUP(adventitiously visually impaired)	**Q ITEM**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.	N_6		4	2	1	4	5	2	4	2	2	4
7.	N_7		2	2	2	4	5	2	4	2	2	4
8.	N_8		2	2	2	4	5	2	4	2	2	4
9.	N_9		4	2	2	4	4	2	4	2	2	4
10.	N_{10}		2	2	2	4	5	2	4	2	2	4
	CONTROL GROUP(congenitally visually impaired)	**Q ITEM**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
11.	N_{11}		4	5	5	3	5	4	2	3	4	2
12.	N_{12}		4	4	4	3	4	4	2	3	4	2
13.	N_{13}		4	4	4	4	4	4	4	4	4	3
14.	N_{14}		5	5	5	2	5	5	2	5	1	1
15.	N_{15}		4	4	4	3	4	4	2	5	5	2
	CONTROL GROUP(adventitiously visually impaired)	**Q ITEM**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
16.	N_{16}		4	4	4	3	5	4	2	3	3	2
17.	N_{17}		4	4	4	3	5	4	2	4	4	2
18.	N_{18}		4	4	5	2	5	4	3	4	4	2
19.	N_{19}		5	5	5	2	5	5	2	3	3	2
20.	N_{20}		4	4	5	2	5	4	2	4	4	2

APPENDIX B5

MEAN ($\bar{X}$) OF EACH ITEM ON PRE-TEST FOR EXPERIMENTAL GROUP ON ATTITUDE TO GEOMETRY SCALE (AGS)

Item 1.

	f	f x
5	2	10
4	5	20
3	1	3
2	1	2
1	1	1
	N= 10	Σfx = 36

$\bar{X}$ = Σfx/N = 36/10 = 3.6

Item 2.

	f	f x
5	3	15
4	2	8
3	3	9
2	2	4
1	0	0
	N=10	Σfx=36

$\bar{X}$ = Σfx/N = 36/10 = 3.6

Item 3.

	f	f x
5	0	0
4	1	4
3	2	6
2	7	14
1	0	0
	N=10	Σfx=2.4

$\bar{X}$ = Σfx/N = 24/10 = 2.4

Item 4.

	f	f x
5	2	10
4	7	28
3	1	3
2	0	0
1	0	0
	N= 10	Σfx= 41

$\bar{X}$ = Σfx/N = 41/10 = 4.1

Item 5.

	f	f x
5	4	20
4	6	24
3	0	0
2	0	0
1	0	0
	N= 10	Σfx = 44

$\overline{X} = \Sigma fx/N = 44/10 = 4.4$

Item 6.

	f	f x
5	0	0
4	3	12
3	2	6
2	4	8
1	1	1
	N= 10	Σfx= 27

$\overline{X} = \Sigma fx/N = 27/10 = 2.7$

Item 7.

	f	f x
5	3	15
4	7	28
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 43

$\overline{X} = \Sigma fx/N = 43/10 = 4.3$

Item 8.

	f	f x
5	2	10
4	8	32
3	0	0
2	0	0
1	0	0
	N= 10	Σfx = 42

$\overline{X} = \Sigma fx/N = 42/10 = 4.2$

Item 9.

	f	f x
5	0	0
4	3	12
3	3	9
2	3	6
1	1	1
	N= 10	Σfx= 28

$\overline{X} = \Sigma fx/N = 28/10 = 2.8$

Item 10.

	f	f x
5	1	5
4	4	16
3	3	9
2	1	2
1	1	1
	N= 10	Σfx= 33

$\overline{X} = \Sigma fx/N = 33/10 = 3.3$

Item 11.

	f	f x
5	0	0
4	2	8
3	6	18
2	2	4
1	0	0
	N= 10	Σfx= 30

$\overline{X} = \Sigma fx/N = 30/10 = 3$

Item 12.

	f	f x
5	0	0
4	9	36
3	1	3
2	0	0
1	0	0
	N=10	Σfx= 39

$\overline{X} = \Sigma fx/N = 39/10 = 3.9$

Item 13.

	f	f x
5	0	0
4	6	24
3	1	3
2	3	6
1	0	0
	N= 10	Σfx= 33

$\overline{X}$ = Σfx/N= 33/10 = 3.3

Item 14.

	f	f x
5	0	0
4	8	32
3	2	6
2	0	0
1	0	0
	N= 10	Σfx= 38

$\overline{X}$ = Σfx/N= 38/10 = 3.8

Item 15.

	f	f x
5	1	5
4	7	28
3	1	3
2	1	2
1	0	0
		Σfx= 38

$\overline{X}$ = Σfx/N= 38/10 = 3.8

Item 16.

	f	f x
5	0	0
4	8	32
3	2	6
2	0	0
1	0	0
	N= 10	Σfx= 38

$\overline{X}$ = Σfx/N= 38/10 = 3.8

Item 17.

	f	f x
5	0	0
4	16	16
3	12	12
2	4	4
1	0	0
	N= 10	Σfx= 32

$\overline{X}$ = Σfx/N= 32/10 = 3.2

Item 18.

	f	f x
5	0	0
4	7	28
3	2	6
2	1	2
1	0	0
	N= 10	Σfx= 36

$\overline{X}$ = Σfx/N= 36/10 = 3.6

Item 19.

	f	f x
5	0	0
4	7	28
3	0	0
2	3	6
1	0	0
	N= 10	Σfx= 34

$\overline{X}$ = Σfx/N= 34/10 = 3.4

Item 20.

	f	f x
5	0	0
4	5	20
3	0	0
2	5	10
1	0	0
	N= 10	Σfx= 30

$\overline{X}$ = Σfx/N= 30/10 =3

Item 21.

	f	f x
5	1	5
4	9	36
3	0	0
2	0	0
1	0	0
		Σfx= 41

$\overline{X}$ = Σfx/N= 41/10 = 4.1

Item 22.

	f	f x
5	0	0
4	5	20
3	0	0
2	5	10
1	0	0
	N=10	Σfx= 30

$\overline{X}$ = Σfx/N=30/10 = 3

Item 23.

	f	f x
5	1	5
4	7	28
3	0	0
2	2	4
1	0	0
		Σfx= 37

$\overline{X}$ = Σfx/N= 37/10 = 3.7

Item 24.

	f	f x
5	1	5
4	2	8
3	2	6
2	5	10
1	0	0
		Σfx= 29

$\overline{X}$ = Σfx/N = 29/10 = 2.9

Item 25.

	f	f x
5	8	40
4	2	8
3	0	0
2	0	0
1	0	0
		Σfx= 48

$\overline{X}$ = Σfx/N= 48/10 = 4.8

Item 26.

	f	f x
5	2	10
4	5	20
3	2	6
2	0	0
1	1	1
		Σfx= 37

$\overline{X}$ = Σfx/N=37/10 =3.7

Item 27.

	f	f x
5	1	5
4	2	8
3	4	12
2	3	6
1	0	0
	N= 10	Σfx= 31

$\overline{X}$ = Σfx/N= 31/10 = 3.1

Item 28.

	f	f x
5	2	10
4	2	8
3	4	12
2	1	2
1	1	1
	N=10	Σfx= 33

$\overline{X}$ = Σfx/N= 33/10= 3.3

Item 29.

	f	f x
5	2	10
4	2	8
3	3	9
2	2	4
1	1	1
	N= 10	Σfx= 32

$\overline{X}$ = Σfx/N= 32/10 = 3.2

Item 30.

	f	f x
5	4	20
4	2	8
3	2	6
2	2	4
1	0	0
	N= 10	Σfx= 38

$\overline{X}$ = Σfx/N = 38/10 = 3.8

APPENDIX B6

MEAN OF EACH ITEM ON POST-TEST FOR EXPERIMENTAL GROUP ON ATTITUDE TO GEOMETRY SCALE (AGS)

Item 1.

	f	f x
5	2	10
4	5	20
3	1	3
2	1	2
1	1	1
	N= 10	Σfx= 36

$\overline{X} = \Sigma fx/N = 36/10 = 3.6$

Item 2.

	f	f x
5	3	15
4	2	8
3	3	9
2	2	4
1	0	0
	N= 10	Σfx= 36

$\overline{X} = \Sigma fx/N = 36/10 = 3.6$

Item 3.

	f	f x
5	0	0
4	1	4
3	2	6
2	7	14
1	0	0
	N= 10	Σfx= 24

$\overline{X} = \Sigma fx/N = 24/10 = 2.4$

Item 4.

	f	f x
5	2	10
4	7	28
3	1	3
2	0	0
1	0	0
	N= 10	Σfx=41

$\overline{X} = \Sigma fx/N = 41/10 = 4.1$

Item 5.

	f	f x
5	4	20
4	6	24
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 44

$\overline{X}$ = Σfx/N= 44/10 = 4.4

Item 6.

	f	f x
5	0	0
4	3	12
3	2	6
2	4	8
1	1	1
	N= 10	Σfx= 27

$\overline{X}$ = Σfx/N= 27/10 = 2.7

Item 7.

	f	f x
5	3	15
4	7	28
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 43

$\overline{X}$ = Σfx/N= 43/10 = 4.3

Item 8.

	f	f x
5	2	10
4	8	32
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 42

$\overline{X}$ = Σfx/N= 42/10 = 4.2

Item 9.

	f	f x
5	0	
4	12	
3	9	
2	6	
1	1	
	N= 10	Σfx= 28

$\overline{X}$ = Σfx/N= 28/10 = 2.8

Item 10.

	f	f x
5	1	
4	4	
3	3	
2	1	
1	1	
	N= 10	Σfx= 33

$\overline{X}$ = Σfx/N= 33/10=3.3

Item 11.

	f	f x
5	0	0
4	8	32
3	2	6
2	0	0
1	0	0
	N= 10	Σfx= 38

$\overline{X}$ = Σfx/N= 38/10 = 3.8

Item 12.

	f	f x
5	0	
4	1	
3	1	
2	8	
1	0	
	N= 10	Σfx= 23

$\overline{X}$ = Σfx/N= 23/10 = 2.3

Item 13.

	f	f x
5	0	0
4	10	40
3	0	0
2	0	0
1	0	0
	N=10	Σfx= 40

$\overline{X}$ = Σfx/N= 40/10 = 4

Item 14.

	f	f x
5	1	5
4	9	36
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 41

$\overline{X}$ = Σfx/N= 41/10 = 4.1

Item 15.

	f	f x
5	0	0
4	5	20
3	1	3
2	3	6
1	1	1
	N= 10	Σfx= 30

$\overline{X}$ = Σfx/N= 30/10 = 3

Item 16.

	f	f x
5	0	0
4	4	16
3	0	0
2	6	12
1	0	0
	N= 10	Σfx= 28

$\overline{X}$ = Σfx/N= 28/10 = 2.8

Item 17.

	f	f x
5	0	0
4	2	8
3	0	0
2	7	14
1	1	1
	N= 10	Σfx= 23

$\overline{X} = \Sigma fx/N = 23/10 = 2.3$

Item 18.

	f	f x
5	1	5
4	9	36
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 41

$\overline{X} = \Sigma fx/N = 41/10 = 4.1$

Item 19.

	f	f x
5	0	0
4	1	4
3	1	3
2	8	16
1	0	0
	N=10	Σfx= 23

$\overline{X} = \Sigma fx/N = 23/10 = 2.3$

Item 20.

	f	f x
5	0	0
4	1	4
3	0	0
2	9	18
1	0	0
	N= 10	Σfx= 22

$\overline{X} = \Sigma fx/N = 22/10 = 2.2$

Item 21.

	f	f x
5	0	0
4	7	28
3	0	0
2	3	6
1	0	0
		Σfx= 34

$\overline{X}$ = Σfx/N= 34/10 = 3.4

Item 22.

	f	f x
5	0	0
4	0	0
3	1	3
2	9	18
1	0	0
	N= 10	Σfx= 21

$\overline{X}$ = Σfx/N= 21/10 = 2.1

Item 23.

	f	f x
5	0	0
4	1	4
3	0	0
2	7	14
1	2	2
	N= 10	Σfx= 20

$\overline{X}$ = Σfx/N= 20/10 = 2

Item 24.

	f	f x
5	0	0
4	7	28
3	0	0
2	3	6
1	0	0
	N= 10	Σfx= 34

$\overline{X}$ = Σfx/N= 34/10 = 3.4

Item 25.

	f	f x
5	8	40
4	2	8
3	0	0
2	0	0
1	0	0
	N=10	Σfx= 48

$\overline{X}$ = Σfx/N= 48/10 = 4.8

Item 26.

	f	f x
5	1	5
4	2	8
3	0	0
2	6	12
1	1	1
	N= 10	Σfx= 26

$\overline{X}$ = Σfx/N= 26/10 = 2.6

Item 27.

	f	f x
5	1	5
4	7	28
3	1	3
2	1	2
1	0	0
	N= 10	Σfx= 38

$\overline{X}$ = Σfx/N= 38/10 = 3.8

Item 28.

	f	f x
5	0	0
4	0	0
3	8	24
2	2	4
1	0	0
	N= 10	Σfx= 28

$\overline{X}$ = Σfx/N= 28/10 = 2.8

Item 29.

	f	f x
5	0	0
4	0	0
3	1	3
2	9	18
1	0	0
	N= 10	Σfx= 21

$\overline{X} = \Sigma fx/N = 21/10 = 2.1$

Item 30.

	f	f x
5	1	5
4	6	24
3	1	3
2	2	4
1	0	0
	N= 10	Σfx=31

$\overline{X} = \Sigma fx/N = 31/10 = 3.1$

APPENDIX B7

MEAN ($\overline{X}$) OF EACH ITEM ON PRE-TEST FOR CONTROL GROUP ON ATTITUDE TO GEOMETRY SCALE (AGS)

Item 1.

	f	f x
5	0	0
4	0	0
3	1	3
2	3	6
1	6	6
	N= 10	Σfx= 15

$\overline{X}$ = Σfx/N= 15/10= 1.5

Item 2.

	f	f x
5	0	0
4	0	0
3	1	3
2	2	4
1	7	7
	N= 10	Σfx= 14

$\overline{X}$ = Σfx/N= 14/10 = 1.4

Item 3.

	f	f x
5	2	10
4	5	20
3	3	9
2	0	0
1	0	0
	N= 10	Σfx= 29

$\overline{X}$ = Σfx/N= 2.9

Item 4.

	f	f x
5	0	0
4	2	8
3	5	15
2	3	6
1	0	0
	N= 10	Σfx= 29

$\overline{X}$ = Σfx/N= 29/10 = 2.9

Item 5.

	f	f x
5	0	0
4	4	16
3	3	9
2	3	6
1	0	0
	N= 10	Σfx= 21

$\overline{X}$ = Σfx/N= 21/10 = 2.1

Item 6.

	f	f x
5	1	5
4	7	28
3	2	6
2	0	0
1	0	0
	N= 10	Σfx= 39

$\overline{X}$ = Σfx/N= 39/10 = 3.9

Item 7.

	f	f x
5	0	0
4	3	12
3	3	9
2	4	8
1	0	0
	N= 10	Σfx= 29

$\overline{X}$ = Σfx/N= 29/10= 2.9

Item 8.

	f	f x
5	0	0
4	2	8
3	3	9
2	4	8
1	1	1
	N= 10	Σfx= 26

$\overline{X}$ = Σfx/N= 26/10 = 2.6

Item 9.

	f	f x
5	1	5
4	9	36
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 41

$\overline{X}$ = Σfx/N= 41/10 = 4.1

Item 10.

	f	f x
5	0	0
4	0	0
3	6	18
2	3	6
1	1	1
	N= 10	Σfx= 25

$\overline{X}$ = Σfx/N= 25/10 = 2.5

Item 11.

	f	f x
5	1	5
4	1	4
3	3	9
2	4	8
1	0	0
	N= 10	Σfx= 26

$\overline{X}$ = Σfx/N= 26/10 = 2.6

Item 12.

	f	f x
5	0	0
4	9	36
3	1	3
2	0	0
1	0	0
	N= 10	Σfx= 39

$\overline{X}$ = Σfx/N= 39/10 = 3.9

Item 13.

	f	f x
5	0	0
4	1	4
3	8	24
2	1	2
1	0	0
		Σfx= 30

$\overline{X}$ = Σfx/N= 30/10 = 3

Item 14.

	f	f x
5	1	5
4	4	16
3	2	6
2	3	6
1	0	0
	N= 10	Σfx= 33

$\overline{X}$ = Σfx/N= 33/10 = 3.3

Item 15.

	f	f x
5	2	10
4	7	28
3	1	3
2	0	0
1	0	0
	N= 10	Σfx= 41

$\overline{X}$ = Σfx/N= 41/10 = 4.1

Item 16.

	f	f x
5	1	5
4	9	36
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 41

$\overline{X}$ = Σfx/N= 41/10 = 4.1

Item 17.

	f	f x
5	3	15
4	7	36
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 51

$\overline{X}$ = Σfx/N= 51/10 = 5.1

Item 18.

	f	f x
5	1	5
4	4	16
3	5	15
2	0	0
1	0	0
	N= 10	Σfx= 36

$\overline{X}$ = Σfx/N= 36/10 = 3.6

Item 19.

	f	f x
5	2	10
4	7	28
3	1	3
2	0	0
1	0	0
	N= 10	Σfx= 41

$\overline{X}$ = Σfx/N= 41/10 = 4.1

Item 20.

	f	f x
5	1	5
4	7	42
3	1	3
2	1	2
1	0	0
	N= 10	Σfx= 50

$\overline{X}$ = Σfx/N= 50/10 = 5

Item 21.

	f	f x
5	0	0
4	8	32
3	2	6
2	0	0
1	0	0
	N= 10	Σfx= 38

$\overline{X} = \Sigma fx/N = 38/10 = 3.8$

Item 22.

	f	f x
5	0	0
4	9	36
3	1	3
2	0	0
1	0	0
	N= 10	Σfx= 39

$\overline{X} = \Sigma fx/N = 39/10 = 3.9$

Item 23.

	f	f x
5	0	0
4	8	32
3	1	3
2	1	2
1	0	0
	N= 10	Σfx= 37

$\overline{X} = \Sigma fx/N = 37/10 = 3.7$

Item 24.

	f	f x
5	0	0
4	3	3
3	3	3
2	4	4
1	0	0
	N= 10	Σfx= 29

$\overline{X} = \Sigma fx/N = 29/10 = 2.9$

Item 25.

	f	f x
5	1	5
4	7	28
3	1	3
2	1	2
1	0	0
	N= 10	Σfx= 38

$\overline{X}$ = Σfx/N= 38/10 = 3.8

Item 26.

	f	f x
5	1	5
4	8	32
3	1	3
2	0	0
1	0	0
	N= 40	Σfx= 40

$\overline{X}$ = Σfx/N= 40/10 = 4

Item 27.

	f	f x
5	0	0
4	2	8
3	1	3
2	7	14
1	0	0
	N= 25	Σfx= 25

$\overline{X}$ = Σfx/N= 25/10 = 2.5

Item 28

	f	f x
5	0	0
4	8	32
3	2	6
2	0	0
1	0	0
	N= 10	Σfx= 38

$\overline{X}$ = Σfx/N=38/10 = 3.8

Item 29

	f	f x
5	0	0
4	9	36
3	1	3
2	0	0
1	0	0
	N= 10	Σfx= 39

$\overline{X} = \Sigma fx/N = 39/10 = 3.9$

Item 30

	f	f x
5	0	0
4	0	0
3	1	3
2	9	18
1	0	0
	N= 10	Σfx= 21

$\overline{X} = \Sigma fx/N = 21/10 = 2.1$

APPENDIX B8

MEAN ($\bar{X}$) OF EACH ITEM ON POST-TEST FOR CONTROL GROUP ON ATTITUDE TO GEOMETRY SCALE (AGS)

Item 1.

	f	f x
5	0	0
4	0	0
3	0	0
2	4	4
1	8	8
	N= 10	Σfx= 12

$\bar{X}$ = Σfx/N= 12/10= 1.2

Item 2.

	f	f x
5	0	0
4	0	0
3	0	0
2	2	4
1	8	8
	N= 10	Σfx= 12

$\bar{X}$ = Σfx/N= 12/10 = 1.2

Item 3.

	f	f x
5	6	30
4	3	12
3	1	3
2	0	0
1	0	0
	N= 10	Σfx= 45

$\bar{X}$ = Σfx/N= 45/10 = 4.5

Item 4.

	f	f x
5	0	0
4	2	8
3	4	12
2	3	6
1	1	1
	N= 10	Σfx= 27

$\overline{X}$ = Σfx/N= 27/10= 2.7

Item 5.

	f	f x
5	0	0
4	0	0
3	6	18
2	3	6
1	1	1
	N= 10	Σfx= 25

$\overline{X}$ = Σfx/N= 25/10 = 2.5

Item 6.

	f	f x
5	3	15
4	6	24
3	1	3
2	0	0
1	0	0
	N= 10	Σfx= 39

$\overline{X}$ = Σfx/N= 39/10 = 3.9

Item 7.

	f	f x
5	0	0
4	3	12
3	2	6
2	3	6
1	2	2
	N= 26	Σfx= 26

$\overline{X}$ = Σfx/N= 26/10 = 2.6

Item 8.

	f	f x
5	0	0
4	2	8
3	0	0
2	7	14
1	1	1
	N= 10	Σfx= 23

$\overline{X}$ = Σfx/N= 23/10 = 2.3

Item 9.

	f	f x
5	3	15
4	6	24
3	1	3
2	0	0
1	0	0
	N= 10	Σfx= 32

$\overline{X}$ = Σfx/N= 32/10 = 3.2

Item 10.

	f	f x
5	1	5
4	0	0
3	4	12
2	4	8
1	1	1
	N= 10	Σfx= 26

$\overline{X}$ = Σfx/N= 26/10 = 2.6

Item 11.

	f	f x
5	1	5
4	9	36
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 41

$\overline{X}$ = Σfx/N= 41/10 = 4.1

Item 12.

	f	f x
5	0	0
4	0	0
3	5	15
2	4	8
1	1	1
	N= 10	Σfx= 24

$\overline{X}$ = Σfx/N= 24/10 = 2.4

Item 13.

	f	f x
5	0	0
4	3	12
3	2	6
2	5	10
1	0	0
	N= 10	Σfx= 28

$\overline{X}$ = Σfx/N= 28/10 = 2.8

Item 14.

	f	f x
5	1	5
4	8	32
3	1	3
2	0	0
1	0	0
	N= 40	Σfx= 40

$\overline{X}$ = Σfx/N= 40/10 = 4

Item 15.

	f	f x
5	2	10
4	8	32
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 42

$\overline{X}$ = Σfx/N=42/10 = 4.2

Item 16.

	f	f x
5	2	10
4	8	32
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 42

$\overline{X} = \Sigma fx/N = 42/10 = 4.2$

Item 17.

	f	f x
5	1	5
4	7	28
3	2	6
2	0	0
1	0	0
	N= 10	Σfx= 34

$\overline{X} = \Sigma fx/N = 34/10 = 3.4$

Item 18.

	f	f x
5	1	5
4	9	36
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 41

$\overline{X} = \Sigma fx/N = 41/10 = 4.1$

Item 19.

	f	f x
5	2	10
4	8	32
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 42

$\overline{X} = \Sigma fx/N=42/10 = 4.2$

Item 20.

	f	f x
5	2	10
4	8	32
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 42

$\overline{X} = \Sigma fx/N = 42/10 = 4.2$

Item 21.

	f	f x
5	2	10
4	8	32
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 42

$\overline{X} = \Sigma fx/N = 42/10 = 4.2$

Item 22.

	f	f x
5	3	15
4	7	28
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 43

$\overline{X} = \Sigma fx/N = 43/10 = 4.3$

Item 23.

	f	f x
5	5	25
4	5	20
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 45

$\overline{X} = \Sigma fx/N = 45/10 = 4.5$

Item 24.

	f	f x
5	0	0
4	1	4
3	5	15
2	4	8
1	0	0
	N= 10	Σfx= 27

$\overline{X}$ = Σfx/N=27/10 = 2.7

Item 25.

	f	f x
5	7	35
4	3	12
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 47

$\overline{X}$ = Σfx/N= 47/10 = 4.7

Item 26.

	f	f x
5	2	10
4	8	32
3	0	0
2	0	0
1	0	0
	N= 10	Σfx= 42

$\overline{X}$ = Σfx/N= 42/10 = 4.2

Item 27.

	f	f x
5	0	0
4	1	4
3	1	3
2	8	16
1	0	0
	N=	Σfx= 23

$\overline{X}$ = Σfx/N= 23/10 = 2.3

Item 28

	f	f x
5	2	10
4	4	16
3	4	12
2	0	0
1	0	0
	N= 10	Σfx= 38

$\overline{X}$ = Σfx/N= 38/10 = 3.8

Item 29

	f	f x
5	1	5
4	6	24
3	2	6
2	0	0
1	1	1
	N= 10	Σfx= 35

$\overline{X}$ = Σfx/N= 35/10 = 3.5

Item 30

	f	f x
5	0	0
4	0	0
3	3	3
2	16	16
1	1	1
	N= 10	Σfx= 20

$\overline{X}$ = Σfx/N= 20/10 = 2