# EFFECTS OF ABACUS SKILLS ON ARITHMETIC ATTAINMENT OF PUPILS WITH VISUAL IMPAIRMENT IN SPECIAL EDUCATION SCHOOL,TUDUN MALIKI, KANO.

**BY**

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**DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES THROUGH THE DEPARTMENT OF SPECIAL EDUCATION, FACULTY OF EDUCATION, BAYERO UNIVERSITY, KANO. IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MATERS OF EDUCATION IN (SPECIAL EDUCATION)**

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## CERTIFICATION

This dissertation titled "Effect of abacus skills on arithmetic attainment of pupils with visual impairment in special education school Tudun Maliki, Kano." Meets regulations governing the award of masters in Special Education of Bayero University, Kano and approved for its contribution to knowledge.

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# APPROVAL PAGE

This dissertation has been read and approves as meeting the requirements for the award of masters in special education of Bayero University, Kano.

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# DEDICATION

This work is dedicated to my parents, husband, my entire family and well wishes.

## DECLARATION

I hereby declare that this research is the product of my research efforts undertaken under the supervision of Dr. Jibrin Isa Diso and not been presented anywhere for the award of a degree or certificate. All sources have been duly acknowledged.

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This study attempted to justify the effectiveness of the use of abacus in the improvement of arithmetic performance of pupils with visual impairment. The population of the study was all primary five pupils of Special Education School, Tudun Maliki, Kano. Hence, purposive sampling technique was utilized to draw a sample size of 12 subjects of equal number of both sexes (6) six boys and (6) girls. A one group pre-test–post test quasi-experimental was used. The analysis of the data was made using descriptive and inferential statistics (mean and t-test) respectively. The findings reveal that there is significant mean difference in the arithmetic performance between the pre-test and post test scores. Also, the t-cal was higher than the t-critical. Hence, the null hypotheses were rejected in favour of alternate hypotheses. The researcher therefore, recommended that teachers and stake holders of education to provide and encourage visually impaired pupils to practice and master abacus in addition of 3 digit numbers.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background to the Study

Abacus in teaching –learning arithmetic previously, calculators were not allowed on standardized arithmetic examination. Therefore, student with visual impairment are at a distinct disadvantage as they did not have an equivalent to the sighted student's pencil and paper. For the child with a visual impairment, the abacus is comparable to the sighted child's pencil and paper and therefore should be considered a fundamental component of his arithmetic instruction. Pupils with visual impairment could also learn to use a device like calculator; however total reliance on the calculator should be avoided, because the calculator does not allow a child to learn problem solving skills in arithmetic. The child with visual impairment will not have a backup plan when the battery goes down. Additionally, children who are deaf blind and who may not be able to hear the voice of a talking calculator, may also not benefit from it.

An abacus can be procured through quota funds from the American Printing House for the Blind if you have access to quota funds. There are several abacus that are available through other venders including Amazon. Although it is entirely appropriate to expose students at an early age to the abacus, prior to beginning formal instruction in the abacus, it is important to ensure that the student has foundational skills. These include a solid knowledge of addition facts, knowledge of place value, and the ability to define terms used for addition problems.

The abacus is a calculation tool but it should not be confused with a calculator. A better comparison is that it is used like paper and pencil for students with vision. The Cranmer Abacus was designed specifically for individuals who are visually impaired. What makes it unique is the piece of soft fabric or rubber that is placed behind the beads so that they will not inadvertently move while the person performs calculations.

Once students have a basic understanding of addition and subtraction and has mastered their basic Arithmetic facts, it is important to teach abacus skills to the student. It can't be stressed enough that a student needs to be able to do mental arithmetic with some ease before the abacus can be a useful tool. Talking calculators should also be avoided until a student understands arithmetic processes. Students should only be permitted to use a calculator if all students in the class are permitted to use their calculators. There is a common misunderstanding that the abacus is comparable to a calculator. A better comparison is its similarity to using fingers to count or paper and pencil. The abacus is a wonderful tool that can assist students in performing arithmetical operations.

The abacus teaches Arithmetical skills that can't be replaced with talking calculators as it teaches the student the process of the calculation and leads to a better understanding of numbers and number sense. The Cranmer abacus is available through APH quota funds as well as Abacus Basic Competency: A County Method available from APH. For those who do not have access to quota funds, it can be purchased through a variety of retailers.

The essence of using abacus is to provide a means of demonstration of computation in arithmetic by pupils with visual impairment. This practical skill must be acquired before the abstract stage of a higher level, this research is therefore necessitated by the need to ascertain the effect of proper Abacus computational skills on arithmetic performance of pupils visual impairment students using Special Education primary school at Tudun Maliki, Kano.

## 1.2 Statement of the problem

Many students with special needs experience difficulties in their education. These difficulties pose challenges to their academic success. Arithmetic is one of the core subjects taught in primary and secondary schools and the pupils/students with visual impairment participate in offering this subject. The problem visually impaired children go through is the lack of sight. Sight is a very important sense organ in arithmetic computation. Hence, many visually impaired experience poor academic performance in arithmetic. This problem prevents them from securing admission in higher institutions as well as hinder them from getting promotion from one level to another. As such it affect their daily activities in relation to arithmetic. This study was undertaken to determine whether access to skills in Abacus could improve arithmetic attainment for visually impaired primary school pupils in Tudun/Maliki special Education School, Kano.

**1.3 Objectives of the study**

**Is to find out:-**

1. whether or not abacus could improve in learning addition of 3 digit numbers among pupils with visual impairment in Tudun Maliki Special Education School, Kano
2. Gender differences in the efficacy of abacus computation skill on arithmetic attainment of pupils with visual impairment in Tudun Maliki Special Education School, Kano.
3. Whether there are challenges in using abacus for learning addition of 3 digit numbers among pupils with visual impairment in Tudun Maliki Special Education School, Kano.

**1.4 Research Questions**

1. To what extent can abacus skills improve learning addition of 3 digit numbers among pupils with visual impairment in Tudun Maliki Special Education School, Kano.

2. To what extent gender differences can be established in the effect of abacus computation skills on arithmetic attainment among pupils with visual impairment in Tudun Maliki Special Education School, Kano?

3. How far challenges can be determined using abacus to learn addition of 3 digit numbers by pupils with visual impairment in Tudun Maliki Special Education School, Kano?

## 1.5 Hypotheses

1. There is no significant difference in arithmetic attainment between pre-test and post-test scores of pupils taught addition of 3 digit numbers using abacus.

2. There is no mean score difference in gender difference in arithmetic performance between pupils with visual impairment taught addition of 3 digit numbers using abacus and those not taught with the abacus.

## 1.6 Significance of the study

There exist few data and literature in Nigeria on abacus computation skills in arithmetic. Therefore, this study would add value to the body of knowledge already in existence. It is hope that the findings and recommendations would be of helpful to pupils with visual impairment and teachers in acquiring abacus skills for proper understanding of computational skills in arithmetic, thus, improve their academic performance. Teachers will benefit from this study as it brought out the gains of using abacus in teaching arithmetic to pupil with visual impairment. It will enable children with visual impairment to be aware of abacus computation skills which they can use to enhance their learning of arithmetic. The study will motivate the school to make adequate provision for abacus to enhance teaching and learning arithmetic it will help other researchers to conduct studies and factors related to arithmetic using abacus in teaching pupils with visual impairment. It will also be of help to educational administrators who will provide resource materials example abacus to the school for pupils with visual impairment as well as to employ more teachers with special training in teaching children with visual impairment.

### 1.7 Scope and Delimitation of the study

The research study was carried out in Kano metropolis, Nigeria; Samples were drawn in one public primary school in the context of a case study i.e Tudun Maliki Special Education School, Kano. The study was specifically on 6-8 year old pupils in class 3 of primary school. The school has 2 sections, the visually impaired section and the hearing impaired section. The study was restricted to children with visual impairment. However, the study did not extent to children with visual impairment outside the school setting

### 1.8 Operational definition of terms

Effect: is the result or outcome of a device.

Abacus: As used in the work a mechanical device for making calculation of a frame mounted with rods along with beads or balls as used in this study.

Visual Impairment: Refers to impairment of vision with total or partial sighted.

Arithmetic: is a branch of mathematics that deals with addition, subtraction, multiplication and division.

# CHAPTER TWO

# REVIEW OF RELATED LITERATURE

## 2.1 Introduction

This chapter presents a review of related literature in accordance with the following sub-topics: Concept background, Historical Development of Abacus, Types of Abacus, Anatomy and construction of Abacus, Importance of Abacus in the Learning of Arithmetic by Visually Impaired, Concept of Visual Impairment, Empirical studies and Summary and uniqueness of the study.

## 2.2 The Concept background

An individual with visual impairment is one whose eyes are occupationally, educationally and medically certified not fit for any visual activity, (Bayode 2010). This means that the individual cannot do things that have to do with the eyes normally like every other person, as a result of some deficits or disorders which might have been adventitiously acquired. Ozoji (2005), describes visually impaired children as children in whom sense of vision is defective and this could range from ability to see a little to total blindness. Okeke (2011), in her submission says that there are children who have difficulty with their vision and they are referred to as children with visual impairment. This is however against the holding of Ozoji's notion on the fact that anyone who deviates from the normal way of seeing is a visually impaired individual. Thus, they could range from ability to see partially to total inability to see. The understanding of visual impairment as a unique impairment, calls for great attention to better their life in totality. The education of visually impaired needs proper plans to attain set objectives. It requires simplicity of task to be learnt. Oridupa (2011), further states that this, simplicity requires modification and adaptation of materials, methodology and curriculum. Reason for this is to help maximize their potentials and make learning meaningful to them as they interact in the different environments they find themselves.

**2.3 Challenges Experienced By Pupils with Visual Impairment**

According to (Qatrain for student (q4s) in www.g4s.eu (2007) some of the difficulties experienced by the visually impaired persons include: Visually impaired persons are likely to be more dependent on their hearing in order to communicate with others. They may not be able to match the tone of voice with facial expressions and gestures that make conversations easier to follow,

A pupil with visual impairment is likely to be more dependent on his or her hearing in order to get information. So high level background noise can cause problem for the individual.-The individual's understanding of distance and scale is probably different to people who see and have experienced those concepts in a practical sense. When they are given a direction they may misjudge how long it takes them to get there. They miss out on gathering everyday practical information about the world around them which the sighted take for granted and may therefore; need to be introduced to new situations in a practical way. Those who are partially sighted may have trouble seeing in low light levels or have problems judging speed and distance. Bright light may affect their eyes. They also have difficulties getting information from charts, presentations practical sessions, written text, observations, etc Chart can also cause difficulties if one sees only part of the whole diagram at a time, If one has no sight at all, even with technology, such as screen magnifiers, then it is likely that one will need to use text to speech synthesizers or other means of reading such as Braille. In the case of writing, most people who have visual impairment these days may make note using some technology. This can be through using a laptop with brail keys or a normal keypad, or through using a Dictaphone or digital recorder.

**Setting & Clearing Numbers**

Numbers are "set" when they are recorded and "cleared" when they are removed or erased.

- To set 1, move the top bead on the unit rod toward the separation bar.
- To set a 2, move the second bead on the unit rod toward the separation bar.
- To set a 3, move the third bead on the unit rod toward the separation bar.
- To set a 4, move the fourth bead on the unit rod toward the separation bar.
- To set a 5, clear all four beads by moving them away from the separation bar and moving the single bead with the value of 5 toward the separation bar.
- To set 6, move the top most bead below the separation rod up toward the separation bar.

- To set 7, move the second bead on the unit rod toward the separation bar.
- To set 8, move the third bead on the unit rod toward the separation bar.
- To set 9, move the fourth bead on the unit rod toward the separation bar.
- To set 10, clear all four beads in the unit rod as well as the single bead and move the top most bead in the tens column, the second column from the right, toward the separation bar.

### 2.3.1 How Visual Impairment Affects Numeracy Skills

Numeracy skills involve understanding mathematical information such as knowing how number system works, and understanding what whole numbers means, decimals, fraction and percentages, how one uses money how to tell time etc A visually impaired person especially the congenitally blind may have little understanding of visual and spatial concepts. This means that the individual would need different methods and far more time to learn these concepts. The individual may also need more support to understand three dimensional objects. If the individual is partially sighted, although he/she may have developed these concepts he/she may still need different technologies to help the individual with arithmetic.

### 2.3.2 How Visual Impairment Affect Practical Skills

The visually impaired individual may have difficulty with mobility and or performing practical task accurately and safely. With residual sight the individual may just need some extra verbal instructions or explanation to undertake practical activities effectively and safely, with no sight at all, the individual may just need some extra help and support. Having visual impairment does not mean that one cannot do practical activities, it just means that one just has to find different ways of getting information.

### 2.3.3 Arithmetic Deficit Area Among Pupils with visual impairment

In the absence of intensive instruction and intervention, students with arithmetic difficulties and disabilities lag significantly behind their peers (Jitendra et al., 2013; Sayeski & Paulsen, 2010). Conservative estimates indicate that 25% to 35% of students struggle with arithmetic knowledge and application skills in general education classrooms, indicating the presence of arithmetic difficulty (Mazzocco, 2007)., additionally, 5% to 8% of all school – age students have such significant deficits that impact their ability to solve computation and /or application problems that they, require special education services (Geary 2004.

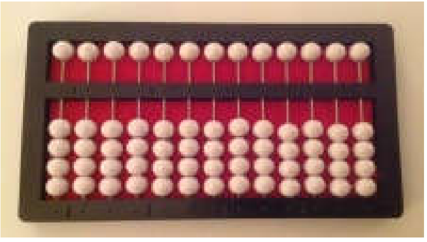
Special education teachers and general education teachers need to have strategies to help students who struggle with arithmetic to gain access to the general education curriculum and to meet with success in all areas of arithmetic including arithmetic literacy and conceptual knowledge (Gargiulo & Metcalf, 2013; Powell, Fuchs, & Fuchs, 2013).

## 2.4 Concept of Abacus

Abacus as a device for mathematical calculations has undergone series of transformation from its original design since it was first invented by the

Chinese in 3000 B.C. Abacus is a Latin word that has its origin in the Greek words “abax” or “abalcon” (meaning “table” or "tablet") which in turn, possibly originated from the semitic word abq meaning "send"
(George, 2000). Aspray (1990) defined Abacus as a device used for the related operations for multiplication and division. To Livingston (1997), Abacus is a mechanical aid used for counting. From the above given definitions of Abacus, two facts can be derived including that (1) It is important to point out from the above given definitions that abacus is not a calculator as it is erroneously assumed today, and (2), It cannot be imagined how difficult it could have been doing the task of counting without number.

An abacus is a device, dating back to ancient times used in various forms of basic mathematical calculations, including addition, subtraction, multiplication division and square roots. Consisting of vertical rods, horizontal beams and moveable beads usually made of wood or plastic, all held in a rectangular frame. Abacus is not a mathematical version of a modern adding machine or calculator. That is to say, it does not perform the calculations in his or her oven head. It does this by keeping track of quantities at various stages of multi-step calculations (The Abacus, 2001).The Cranmer Abacus has thirteen vertical rods. On each rod are five moveable beads. A horizontal separation bar divides the top-most bead on each rod from the bottom 4 beads.



**Zero Position of Abacus before use**

The zero position is when all the single beads are positioned at the top of the frame, and the four lower beads on each rod are on the bottom. There are raised dots along the separation line at each rod, and a raised vertical line after every third dot. The lines, called unit marks, serve as commas and decimal points depending on the math problem. The first rod or column on the far right is the units rod. Each bead below the separation bar on this rod has the value of one. The single bead on that rod has a value of 5. The abacus is based on the decimal system so as you move to each rod on to the left the pattern continues. The second column is the tens column, the third column is the hundreds column and so on. Therefore, in the tens column, each bead below the separation bar has a value 10 and the single bead above the bar has a value of 50. This pattern continues up to the trillion column.

**2..4.1 Basic Skills to be Developed by using Abacus**

The learning of the procedures with which the numerical operations with natural numbers are being executed is one of the main goals during the elementary school years. At first the students learn to use their numerical or computational abilities with simple operations and then move to more complex procedures such as algorithms. An “algorithm” is the repetitive procedure which is implemented using predetermined steps. In order for the algorithm of an operation to be executed good knowledge of the partial simple operations required is essential. According to the contemporary scientific opinions of the didactics of Arithmetic, the understanding of numbers, the estimation and the ability to criticize the computations’ results and the kind of the necessary computations need to be more emphasized during teaching than the procedures of the computations themselves. In order for the structural properties of the operations to be perceptive, the students should able to consider the numbers as beings which exist and can be used, independently of the content in which they are presented. This is implemented at first with the use of material objects and next with visual representations and symbols so that the relations and bonds between the numbers can be conquered. The use of multiple representations and concepts, during the teaching of the addition and subtraction, is very useful in the classroom, since students learn in different ways and different strategies are required.

Although the goal of addition and subtraction is concepts’ understanding, mastering of these “basic facts” is essential for the further development of mathematical concepts and problem solving. By the term “basic facts” for addition we mean combinations to which both addends are less than 10. The facts of subtraction match to the addition’s ones.

The drift of the emphasis to mental computations and estimations makes good knowledge of the facts more important than ever. The teacher has in his disposal two main tools to help his students develop the operations' concepts: a) problems with plot, since the introduction to the algorithms has a meaning when it belongs to a problem's situation b) models. In models the execution of operations includes objects that can be moved, images of groups in different order, tables and different approaches of these basic ideas. The different ways in which models can represent these procedures can help children in this process.

According to the national curriculum of Arithmetic, in the end of the school year first grade students should be able to articulate, read, write and put in order the numbers up to 100 and to execute the operations of addition and subtraction until the number 20. The structure of the school book for the first grade includes numbers up to 20, addition up to 5 and then up to 10, ones and tens, numbers up to 50, subtractions up to 10, additions and subtractions over 10, numbers up to 100, additions and subtractions two-digit with one-digit numbers. Additions and subtractions are taught in a mental way without having to show the typical written algorithms of these operations.

For addition's and subtraction's algorithms students should be able to learn and understand the basic arithmetic combinations up involving sums or minuends to 18.

The mastery of basic facts relies to a minimal degree to the drill or its techniques but mainly to the construction of the relations between the numbers and the understanding of numerical operations, with the development of effective strategies for basic facts' recall and also with the drill in use and the choice of strategies."Children do not learn and store basic number combinations as so many separate entities or bonds but as a system of rules, procedures, and principles as well as arbitrary associations. In this view, "mastering the basic facts" largely involves discovering, labeling, and internalizing relationships -processes encouraged by teaching thinking strategies."

In order for the children to develop the concept of "ten" as a single entity but at the same time as a sum of 10 units, appropriate models are used. These models do not show the concept to the children but children construct and express it through models. The models are distinguished in proportional and on proportional. Proportional models are usually ten based (e.g., base 10 blocks, bundling sticks). Abacus is a non-proportional model in which the numbers are represented but not the idea of number 10 as a base. This doesn't help children see why 10 ones are the same as a ten piece, since this relation should be in the model.

The construction of the concept of place value should begin primarily with activities based on proportional models and then with non proportional, since the use of multiple subjects or teaching aids help student organize and apply to action the acquired knowledge. Hands-on experiences of both proportional and non proportional (e.g., abacus, money, and colored counters) models is necessary to understand the complexity of our arithmetic system.

Different models support different developmental progressions for students representing different strategies. Vertical abacus can be a useful educational material in which a student can easily see not only the number of ones and tens but also their relative position. In the abacus tens are seen using the base of ten and not one as used in the horizontal abacus.

Students' familiarization with the presentation of numbers using the base often should be done in a gradual way. The abacus is a tool which can help in the materialistic representation of double digit or multiple digit numbers. Abacus' use is especially helpful for the algorithms of the addition and the subtraction over 10 because it allows the visualization of the exchange of a class of 10 units with a unit of the next order. Additions and subtractions using the abacus are done very quickly and easily.

The use of digital tools for the exploration of the execution of addition and subtraction of basic facts "Technology is an essential tool for teaching and learning arithmetic effectively; It extends the arithmetic that can be taught and enhances students' learning" The New Program of Studies includes regarding the operations the following: recognition and execution of the operations in different frameworks and in different ways (mentally, orally and writing), their use in problem solving and the development of evaluation methods. It is also suggested the inquiry of the students to be done using digital tools.

The digital abacus is a version of a manipulative tool in a computer with increased abilities in relation to these that the same material has in its natural condition. Its basic advantage is found in the way the conceptual idea of a ten is presented. According to de Walle from the characteristics that digital models of manipulative tools should have in relation with the natural ones so that they can be included in the educational program, we can distinguish the following:

a) the flexibility which allows the students to use it without too much guidance or feedback from the computer,

b) the possibility of appearance or disappearance of the screen depending on students' will of the numbers that belong to the results of the additions and the subtractions they execute. One disadvantage is however the fact that there is no space in the bottom of the screen where children could write along with the inability to save or print.

In the website it is proposed to be used for place value and for the meanings of “add” and “subtract” for the addition and the subtraction respectively. The design of the teaching approach First grade students during the school year get familiarized with addition and subtraction through problem solving. In the mean time multiple activities with proportional and non proportional models are done referring to addition and subtraction up to 20. Since the drill of basic facts is meaningful only after the development of effective strategies for the facts in which they practice (otherwise it is considered a waste of time), digital abacus was used just before the end of the third trimester. Digital abacus is an applet and has the following advantages: it is a targeted program, freely accessed on the internet, which gives students the ability to execute additions and subtractions on a visual model. According to de Walle, "even when there is not enough evidence the drill on a computer is more effective than the one without it, a great advantage is in the form which can motivate an otherwise boring practice.

The specific application was accomplished, in order to cultivate students' skills that had already been taught before they used it. Similar activities were implemented with relative applications of the same website, e.g. "save the whale" for sums up to ten. Because it does not include problem solving and in order to be ensured that the attractive presentation on the monitor actually increases learning opportunities, the specific applet was presented to students as a pc-game.

Children were separated to groups of two and each group had a laptop to its possession. The activity with the digital abacus was implemented in the context of the subject of Informatics. Design, development, application and evaluation of a teaching approach were implemented in order to find out if and how much digital abacus's use can contribute to the improvement of first grade students' achievements in the operations of addition and subtraction of basic facts. The approach's design was based on the constructivism's model, working in groups. In addition some historical data about abacus were exploited. The application was implemented in the form of "micro-experiment", which was embodied to the teaching material at the end of the third trimester. Teaching applications' goals were: a) for Arithmetic: to find out if students are able to add and subtract basic facts, b) for Informatics: to be familiarized with the mouse's use along with the digital abacus and to relate abacus with the operations of addition and subtraction and c) to be able to cooperate in small groups. The teaching course referring to abacus was implemented with the filling of a worksheet of a constructivist type. In this there were six pictures from which students had to choose those who, according to their opinion, represented abacus (motivation and involvement). Then students discussed and wrote down their opinions about what they thought abacuses are useful to us (record students 'ideas). The digital abacus's activity was followed. The next steps were again the discussion and the transcription of their ideas about abacus's utility (ideas' reconstruction). After that, they solved two problems with basic facts with the optional use of digital abacus (problem solving application). At the end students discussed what, in their opinion, was the fact that made them change their attitude about abacus's use

## 2.5 History of Abacus

There was time in history when written number did not exist. George (2000) documented a review on earliest counting of device which was 5 and its fingers. The limitation of this method did as counting of larger quantities more than the total number of human finger and "toes" developed. This led to employing other various natural items like pebbles and twines. Yet, as George (2000) further revealed a means to quantifying both the cost of goods bought and s became one of the many counting devices invented as a result. Probably, the first device was a counting board. This appeared at various times in several places around the world. The earliest counting board consisted of a tray made of sun dries clay or wood (Heffeifinger & Flom, 2007). A thin layer of sand would be spread evenly on the surface and symbols would be drawn in the sand with a stick or ones finger. To start anew, one would simply shake the tray or even out the sand by hand eventually; the use of sand was abandoned. Instead, pebbles were used and placed in parallel grooves carved into stone counting boards.

According to George (200), the oldest surviving counting board is Salamis tablet used by Babylonians Circa 300B.C. It was discovered in 1846 on the Island of white marble and is in the National Museum of Epigraphy, Athens. Later, counting boards were made of various other materials. Besides the marble used by the Greeks, bronze was used by the Romans. As part of their primary education, young boys in both Greece and Rome learned at least some arithmetic using an abax or abacus. In fact, Plato suggested that this would be applied “As much as is necessary for the purpose of war and household management and the work of government" (Heffelfinger & Rom, 2007). At some point, the Romans added additional grooves between each decimal position. So now, the grooves would signify 1s, 5s, 10s, 50s, 100s, 500s, 1000s etc. This corresponded to the Roman numerals l,V,X,C,L,D,M. The Latin term for pebbles is calculus. So, while calculus is considered higher arithmetic, the term actually refers literally to the ancient counting boards and pebbles.

In the quest for an easily portable counting device, the Romans invested the board the hand abacus (Heffelfinger & Flom, 2007). This consisted of a metal plate with metal beads that ran in slots. The beads were held to the device by flanging on the back but left loose enough to allow movement of metal beads in the slots. The bead arrangement is like the modern sorban in that it has one bead in the relatively short upper slots and four beads is abacus slots. Some people believe that the Roman pre-dates the Chinese suan-pan, was introduced into china early in the Christian era by trading merchants. In the Middle Ages, counting tables were common throughout Europe, In France, the counting pebbles were called jetons inspiring this little rhyme (Heffelfinger & Flom 2007).

It is important to distinguish the early abacuses (or abaci) known as counting boards from the modern abaci. The counting board is a piece of wood, stone or metal with carved grooves or painted lines between which beads, pebbles or metal dices were moved (Georges 2000). The earliest preserved because of the perishable materials used in their construction. However, educated guesses can be made about their construction, based on early writings of Plutarch (a priest at the oracle at Duphi) and others (Bagley, 2003).

In outdoor markets of those time, according to Bagley (2003) the simplest counting board involved drawing lines in the sand with ones fingers or with a stylus and placing pebbles between those lines as placeholders representing numbers (the space units, 10s, 100s, etc). This also confirms what Heffelfinger & Rom said in their book (Abacus: Mustard of the Bead). The more affluent people could afford small wooden table having raised borders that were filled with sand (usually, cloured blue or green). A benefit of these counting boards on table was that the table was that the table could be picked up and carried indoors.

The evaluation of the abacus can be divided into three ages: Ancient Times, Middle Ages and Modern Time. The time line below traces the developing abacus from its beginning circa 500B.C. to the present.

This time-lines show the evolution from the earliest counting board the rate of progress in the last one thousand years of civilization was rather slow.

**2.5.1 Ancient Times:** The Salami's Tablet, the Roman Calculi and Hand abacus are from the period (300B.C to 500A.D). During Greek and Roman hand-abacus, that survive are constructed from stone and metal (Bagley 2003).

**2.5.2 Middle Ages:** The Apices, the coin-board and the line-board are from which counting boards were manufactured, the primary material from which counting boards were manufactured, the orientation of the horizontal. An arithmetic (counting using written numbers) game popularity in the letter part of the middle ages, the use of the abacus began to diminish in Europe.

**2.5.3 Modern Times:** The suanpan, the soroban and the schoty are from the period C.1200 A.D. to the present the abacus as we know it today, appeared (was chronicled) circa 1200 A.D. in China. In Chinese, it is called suan-pan. It is different from the European abacus in that the board is split contains only five counters on each wire. Digits from 0 through 4 are represented solely by counters in the lower part. The other five digits need an upper counter.

There have been recent suggestions of a Mesoamerica abacus called the Nepohualtzitin, Circa 900-100 A.D., where the counters were made from kernels of maize threaded through strings mounted on a wooden frame. There is also debate about the Incalchipu, was it a three-dimensional binary calculator or a form of writing? (q.v. Talking knots of the Incas). The schoty, is a Russian abacus invented in the $17^{th}$ century and still used today in some part.

**2.5.4 The Abacus Today:** a manual published in 1958 by Lec. Kaichen, the investor of new abacus designed with 4 decks. It combines two abaci, the top abacus is a small soroban and the bottom one is a 2/5 sucam-pam (Wauda 1997). According to Wauda (1997), multiplication and division are j includes instructions for determining square roots and cubic roots numbers. The device is typically constructed of various types of hard-woods and comes in varying sizes. The frame of the abacus has a serious rods on which a number of wooden beads are allowed to slide freely. A horizontal beam separates the frame into sections, known as deck and the lower deck. The abacus was most probably imported by merchants travelling to China, in migrated to Korea (app. 1400) and later Japan (app. 1600). The abacus in Europe use in the orient (Abacus Middle East, 2002). The use of the Abacus is still taught in Asia Schools and some few schools in the west. Blind children are taught to use the be taught to use the abacus while their sighted counterpart will be taught to use paper and pencils to perform calculations.

One particular use of Abacus is teaching children simple Abacus is an excellent ion for note memorization of multiplication tables, particularly detestable task for young children. It is also an excellent tool for teaching others based on numbering systems since it easily adopts itself to any base (Jim, 3007).

### 2.5.5 Types of Abacus

It is presumed that the earliest Abacus was invented as at 5000 years ago (Heffelfingers & Flom, 2007). Some historian believed that the Abacus was invented by the ancient Chinese while some believed that it s invented by the Babylonians or Egyptians. The claims are supported historical evidences such as ancient test and archeological excavation (Bagley, 2003).

Looking at the time line of the Abacus below it shows that there are different types of Abacus.

**3000B. C:** An early from of finds its origin in China

**1000 B.C.;** The counting boards are used by the Chinese - ;

**500 B.C.:** Counting boards are used by Romans and Greeks.

**300 B.C.:** Abacus finds extensive usage as counting device in China

**500 A.D.:** Europe starts using Abacus (The Great Ideal Finder,(2006)).

**babylonian Abacus:** Abacus was used by Babylonians for mathematical operations of addition and subtraction but was difficult to use for complex calculations.

**Egyptians Abacus:** According to Greeks historian Herodus, ancient Egyptian used abacus. Many archaeologists have found some point of their claims.

**Greek Abacus:** In the year 1846, a table was found on the Greek to bea gaming board discovered so far.

**Roman Abacus:** In ancient Rome, normally the calculation was moving counters on a smooth table. Calculi or pebble ware used for this purpose. The counting system continued in the late Roman beside the counter method for calculations. It is believed that Roman made improvements in the primitive abaci. A Series of wire or rods were used for counting beads, which were made of wrong or stone. The calculation were made by moving these beads back and for the according to a particular set of rule (The Great idea finder (2006)).

**Chinese Abacus:** The Chinese abacus was coined as the greatest invention ever made in ancient China (Abacuslesson.com, 2008)). There Chinese abacus is properly termed as suan-pan. Its development can be from the modern times starting from 1200A.D. in China. Chinese counting rods are considered to sponsored links.

Suan-pan was first mentioned in the book entitled supplementary ant of figures authored by XU YUE (Abacus learning (n.d)). During $11^{th}$ Century, the Chinese abacus, or Suan-pan was invented. Pan is generally regarded as the earliest abacus with beads on modern term Suan-pan means calculating plate. A Suan Pan has above a middle divider called a beam and 5 beads below.

The suan-pan is almost similar in principle to the Roman abacus but physically they have different constructions. The fact that there is a similarity between the Roman abacus and Chinese abacus connotes the Romans could have inspired the Chinese in making the Suan-pan. According to Sponnored link (n.d.), the Roman abacus is apparently made before the Chinese abacus and there are some evidence that will support between China and the Romans. This could have been the reason of the Romans having influence on the Chinese abacus.

Gordon (n.d) documented that the Chinese abacus consists of columns of beads. A crossbar separate the beads, each column has two beads above the cross bar and five beads below it. Each bead below crossbar has a value of five ones (5). The ten's column represents 10 to 90. Each bead below the crossbar has a value of ten (10). The beads above the crossbar has a value of fifty (50). The hundred represent numbers from 100 to 900. Each lower bead equals one hundred (100) and each upper bead equals five hundred (500).

### 2.5.6 Anatomy and Construction of Abacus

The abacus is typically constructed of various types of hard woods and comes in varying sizes. The frame of the abacus has a series of vertical rods on which a number of wooden beads are allowed to slide freely. A horizontal beam separates the frame into two sections known as the upper deck and the lower deck (Wauda, 1997).

**Basic:** the abacus is prepared for use by placing the flat on a table or one's lap and pushing all the beads on both the upper and lower decks always from the beam. The beads are manipulated with either the index finger or the thumb or one hand.

**The Beam:** one a modern-day abacus, two bead sit above the beam are often called heaven beads and each has a value of 5. The beads below are often called earth beads and each has a value of 1. Along the length of the beam. One will notice that every third rod is marked with a dot. These specifically marked rods are called unit rods because any one of them can be designated to carry the unit number (Heffeifinger & Flom (2007)). While the abacus operator makes the final decision as to which rod just to right of center on the abacus. The dots also serve as markers by which larger number can be quickly and efficiently recognized. According to Heffeifinger & Flom (2007), they give an example, “rod I is the designated unit rod, when given a number such as 23,456,789 an operator can quickly identify rod B as the 10 million rod and go ahead and set the first number 2 on rod". This ensures that all subsequent numbers will be set on their correct rod and that the unit number 9 will fall neatly on unit rod I.

**Bead Values:** Each bead in the upper deck has a value of 5; each bead in the lower deck has a value of 1. Beads considered counted when moved towards the beam that separates the two decks. The beads above the beads below are often called earth beads (Heffeifinger & Flom, 2007).

**Counting:** after 5 beads are counted in the lower deck (earth beads), the result is “carried” to the upper deck (heaven beads) after both in the upper deck are counted, the result (10) is then carried to the left-most adjacent column. The right-most column is the one's column, the most adjacent to the left is the hundreds column and so on. Floating point designating a space represent fractional portions while all rows to the left-most adjacent to the left represent whole number digits (Georges (2000).

**Technique:** proper finger technique is paramount in achieving proficiency on the abacus the thump and the index finger together with the middle finger are used to manipulate the beads. Beads in lower deck are moved up with thumb and down with the index finger. In certain calculations, the middle finger is used to move beads in the upper deck with the Japanese version (Wauda, 1997), only the index finger and thumb are used. The beads are moved up with the index finger. However, certain complex operations require that the index finger move beads up.

**Setting Numbers on the Abacus**

Only the number thump index fingers are used to manipulate beads on an abacus. The thumb moves the earth beads up towards the beam. The is everything else (all earth beads down away from the beam and all heaven beads up and down). When setting numbers on the abacus the slides beads up or down so that bead touch the beam. Bringing up one earth bead so that it touches the beam gives a rod a value of 1. Three earth beads touching the beam give that rod a value of 3. To make a value 5, one need to clear all the earth beads and move one heaven bead down so that earth beads sets a valise of 7 and so on (Heffelfinger & Flom, 2007).

**Clearing an Abacus:** Calculations normally begin with an empty or cleared abacus. The abacus is placed flat on the table then tilts the frame toward oneself. Gravity pupils ail the beads down. At this point only the beads have been cleared away from the beam. The abacus is placed back onto the table and hold with the left hand. Then, using the back of the right index finger, make a sweeping motion from left to right between the top of the beam and the bottom of the heaven beads. This forces the beam when none of the rods shows any as a cleared frame (Heffelfinger & Flom, 2007).

**Developing Skills in the Use of Abacus:** Student, especially the visually impaired student needs to understand the skills used in operating the abacus. Livington (1997), skill in the use of the abacus depends on several factors. One of these is readiness. This shows that for a child to begin working on the abacus, must understand basic number concepts, be able to count and know the patterns or complements that make up the numbers up to ten. These concepts should be taught concretely with manipulative, by forming and rearranging sets of objects. Millaway (1994), suggested that student need to learn that some beads on the abacus stand for one, some for five, some for ten and so on as well as knowing the basic concept of place value. As they become comfortable with all the patterns of the numbers up to ten, they can set simple number statements on the abacus. He also suggested that, the familiarity with the abacus should start early. Young student should be encouraged to use it in limited ways as they develop number concepts, they can use it as a calculating tool later as their skills progress. This is applicable to the visually impaired student also need the need the manipulative skills required to operate the abacus itself. It is advisable to start with enlarged abacus because of the larger beads and the greater space between the beads, students can then make the transition to the smaller abacus when appropriate (Project Math Access (2006)). A third requirement for the visually impaired student's success with the abacus is his/her teacher's competency and attitude. Teachers must take responsibility for developing their own skill to the level sufficient to teach their students the skills that will benefit them. Teachers must also convey a positive attitude about the use of the abacus, making its use and the effort required to learn it.

**2.6 Teaching Approaches:**

There are several approaches in teaching the use of abacus. Since one method might not work effectively for all student s, different method of teaching can be used. These four approaches can be used;

i. The partners or logic approach
ii. The secrets approach
iii. The counting method and
iv. Adaptation or combinations of these approaches (Project Math Access (2006)).

The logic method or partner approach method focuses on understanding the "what" and "why" in solving a problem on the abacus. It requires that the partners or compliments of the numbers up to ten. Verbalizing the steps and the reasons for each movement made on the abacus is an important feature of this approach. Livingston (1997), suggested that first, the teacher must explain the steps and reasons as the student works through the problem. Then the student should verbalize the process as he/she works the problem. Overtime, this "conversation" can be shortened and finally the process is internalized.

This approach would benefit visually impaired students who can follow the explanation and can understand and even enjoy the logical concepts involved. The secrets focus on the process of moving the abacus beads in a particular sequence, following a specific set of rules for different numbers and operations. It does not emphasize the understanding of that process, rather the note memory of the bead movements (Livingston, 1997). It would be appropriate for students who would benefit from a manipulative process they could rely on without having to fully understand the principles each step of that process. The counting method has the student each bead as it is added or subtracted moving from the unit beads 1 for all beads). There are also specific rules regarding certain number and operations but fewer than the full set secrets. It does not emphasize understanding the concepts behind the is approach could also be appropriate from youngsters who would benefit from a manipulative process they could rely on, without having to understand each individual step. Teachers of blind children need to make variety of modifications to all their approaches in order to meet the individual learning styles of their student. For example, student included in the regular classroom for much of the time can work their addition and subtraction problems from right to left to coincide with the way the teacher works through the problem with class. A modification of the logic method involves multiplication of one, or three digit multipliers and one or two digits multiplicands. For example 93 X 25, the first factor (93) is set in the billion places and the answer in the is and hundred places. Instead of working from the outside in, the entire multiplication is multiplied by the first digit of the multiplier, and then the entire multiplicand is multiplied by the second digit of the multiplier.

In the education of students with visual impairment, it is not always possible to meet these strict criteria when conducting research. The low-prevalence of visual impairment within the school-age population often hampers efforts to recruit homogeneous subjects and consequently makes randomization both costly and difficult. When strong scientifically-based research does not exist, Valentine and Cooper (2004) suggest that researchers produce syntheses of research summarizing the evidence pertaining to the effectiveness of educational interventions and approaches. The What Works Clearinghouse was established in 2002 by the U.S. Department of Education to identify and disseminate the effectiveness of various educational interventions, primarily by conducting meta-analyses of the literature. The low prevalence of visual impairment makes it unlikely that the Clearinghouse will examine the body of literature in visual disabilities, and in fact, none of the topics currently under study involve students who are blind or visually impaired (see http://www.whatworks.ed.gov/topics/current_topics.html).

One method often used for synthesizing a body of literature is meta-analysis. Meta-analysis is a statistical procedure used to identify trends in the statistical results of a set of existing studies examining the same research problem (Gall, Borg, & Gall, 2003). Through such a procedure, effects, which are hard or impossible to discern in the original studies because the sample sizes are too small, can be made visible, as the meta-analysis is equivalent to a single study with the combined size of all original studies. Meta-analytic reviews go beyond narrative reviews in the sense that they are systematic, explicit, and utilize quantitative methods of analysis (Rosenthal, 1984). Because of these features, meta-analytic reviews are considered to provide more thorough, comprehensive, and precise summative evaluations that entail greater objectivity than narrative reviews. Moreover, meta-analysis is consistent with American Psychological Association publication guidelines (2001) that call for reporting effect sizes, which allows for an evaluation of the practical significance of differences.

The American Printing House for the Blind asked the National Center on Low-Incidence Disabilities to conduct a meta-analysis of the literature in mathematics instruction for students with visual impairment. Consequently, the purpose of this research was to conduct an exhaustive review of the literature and a meta-analysis of mathematics research in the field of blindness and low vision. This report presents the results of the analysis. A three-step literature search strategy identified pertinent studies published from 1955 to 2005. First, computer searches in ERIC and PsychINFO were conducted. The search terms used were *blind*, *deaf blind*, *deaf blind*, *deaf-blind*, *eye disorders*, *optical aids*, *partially sighted*, *vision disorders*, *visual disabilities*, *blindness*, *visual impairment*, *large type*, *partial vision*, *low vision aids*, each paired with *math*, *mathematics*, *arithmetic*, *Nemeth*, *calculator*, and *abacus*.

Second, the reference list from every item identified in these searches was reviewed for any additional references that were not found in the computer search. Third, manual searches for articles related to mathematics and visual impairment were conducted of all issues of the *International Journal for the Education of the* Blind, *Journal of Visual Impairment & Blindness* (formerly the *New Outlook for the Blind*) and *RE: view* (formerly *Education of the Visually Handicapped*) from 1955 - 2005. *Dissertation Abstracts International* was also searched for relevant theses and dissertations. Reports submitted to the ERIC database were excluded from further analysis, but Appendix A provides a list of those citations. The resulting 125 articles, theses, and dissertations located by this search process were then reviewed to determine whether they met the criteria for inclusion in this analysis. Publications were classified by applying these seven criteria, in this order:

1. The study was published in a peer reviewed journal published in English between 1955 and 2005. Given the NCLB definition of scientifically-based research, we included only those studies that had been published and submitted for peer review, or which had been scrutinized through the thesis or dissertation process (n = 125).

2. Participants in the study were identified as students with a visual impairment of any degree (partial vision, low vision, partially sighted, blind) (n = 116; 9 studies investigated parents, families, or teachers).
3. Participants in the study were children and youth between 3 and 21 years of age (n = 110; 6 studies investigated individuals younger than 3 or older than 21 years of age).
4. The study reported some type of research (n = 42; 50 articles discussed a theory, belief, or practice, while 18 articles reported on a product review or evaluation).
5. The study described an educational intervention, defined as a systematic application of any program, product, practice, or policy with the intent of affecting an outcome (n = 16; 26 articles did not report on an intervention).
6. The study utilized a quantitative research design (n = 15; 1 study utilized a qualitative design).
7. The study included a control or comparison group of some type (n = 10; 5 studies did not have a comparison group, or utilized an inappropriate comparison group (see Warren, 1994).

Three team members had to agree that these criteria were met; where there were differences of opinion, the team members met to establish consensus. This process yielded 10 research studies that met the criterion for inclusion in the meta-analysis. Citations to the 125 articles identified by this search procedure and their resulting classification for this analysis are found in Appendix B.

## 2.7 Strategies for Use of Abacus in Teaching

In addition to modifying general approaches to teaching the abacus, teachers have found several strategies that can help to facilitate students learning of this skill, these include familiarity with the abacus should be started at an early stage as the child begins working on number concepts in the used to support the learning and calculations, as well as the use of fractions and decimals. In can easily be used in conjunction with the braillewriter, by middle school, students should be proficient at using the abacus, making less writing with the braillewriter necessary (Project Math Access). It is important that the student develop a positive attitude about using his/her abacus. When a teacher motivates student by saying good, excellent making him/her feel special and eager to use it. Providing simple but relevant tasks in which the student uses the abacus would also be in motivating the student. The abacus can be used for a variety of functional and motivations, classroom activities such as keeping scores for games, tabulating scores on daily quizzes, using in simple money games. Games such as an abacus "bee" can add to the fun of learning the abacus. Terms can be elected in a variety of ways. Individuals can complete predetermined order that could rotate. Scores or winning teams can be variety of ways. Each student have his/her own abacus in this or similar games (Project Math Access (2006)). Since blind students cannot see the pattern of where their beads are placed on the abacus, it is extremely important to teach them place-keeping habits. This will be especially critical when they are dealing with problems involving multiplication, division, decimals, fractions and any problems involving multiplication, division, decimals, fraction and any problems involving zeros

**2.7.1Complimentary Numbers:** In competent hands, an abacus is a very powerful and efficient Calculating tool. Much of its speed is attributed to the concept of mechanization. The idea is to minimize mental work as much as possible and to perform the task of adding and subtracting beads mechanically, without thought or hesitation in a sense to develop a process of thoughtlessness. With this in mind, one technique employed by the operator is the use of complementary numbers with respect to 5 and 10. In the cease of 5, the operator uses two groups of complimentary numbers 4 & 1 and 3 & 5 while in the case of 10; the operator uses five groups of complimentary numbers 9&1, B&2, 7&4, 6&4 and 5&5.

(Helffelfilnger & Flom (2007)) notice that with time and practice, the use of numbers become effortless and mechanical. Once these techniques are learned, a good operator has little difficulty in keeping up with (even surpassing). Someone doing the same addition and subtraction an electronic calculator. They also illustrate how complementary numbers are used to help solve problems of addition and subtraction. “In all cases try not to beforehand what the answer to a problem will be. Learn these simple large strings of numbers”

**Addition:**

In addition, always subtract the complement. Add: 4 + 8 = 12

Set 4 on rod B

Add 8.

Because rod B does not have 8 available, use the complementary number. The complementary number for 8 with respect to 10 is 2.

**Subtraction:**

In subtraction, always add the complementary.

Subtraction 11 – 7 = 4

11 is set on rod AB

Subtract 7

Since rod B only carry a value of 1 use complement. The complementary number for 7 with respect to 10 is 3. Begin by subtracting 1 from the tens rod on A, then add the complementary 3 to rod 3 to equal 4 (Heffelfinger & Flom, 2007)).

**2.7.2 Technique:** Proper finger technique is paramount in achieving proficiency on the abacus. With a Chinese abacus, the thumb and the thumb and the index finger together with the middle finger are used to manipulate the bead. Beads in lower deck are moved up with thumb and down with the index finger. In certain calculations, the middle finger is used to move beads in the upper deck with the Japanese version (Wauda, 1997) only the index finger and thumb are used. The beads are moved up with the thumb and down with the index finger. However, certain complex operations require that the index finger move beads up.

## 2.8 Importance of Abacus in Teaching and Learning Mathematic for pupils with Visual Impairment

The importance of abacus in teaching arithmetic to visually impaired students cannot be over-emphasized. Among the relevance or importance of abacus in teaching visually impaired students include; according to project Access (2006), the use of abacus for a child with a visual impairment is comparable to the sighted child's pencil and paper, and should be considered a fundamental component of his/her math instruction. Children who are deaf blind and who many not be able to hear the voice of talking calculator, many benefit from using an abacus. Equally the abacus can be used as against teaching arithmetic with other devices (Susan, 2005). It is also non-consumable compare to paper and pencil. It can be used for fractions where as the calculator cannot (Sewell, 2007).

Besides being used for effective arithmetic problems, visually save also found it useful for temporary storing of telephone numbers. Also, the Gramer Abacus in particular, is certainly one of the most effective calculation tools for blind children (Sewell, 2007). It allows concrete manipulation, leading to more meaningful understanding of number, then the use of calculators. It proved an alternative to lengthy and involved calculation done on the braillewriter. For some students, picturing the working of problems on the s has even increased their ability to carry out calculation mentally. It is also useful because of its speed, accuracy, portability and flexibility. It allows concrete manipulation, leading to more meaningful understanding of number, then use of calculators. It proved an alternative to lengthy and involved calculation done on the braillewriter.

For more students, picturing the working of problems on the abacus has even increased their ability to carry out calculation mentally. It is also useful because of its speed, accuracy, portability and flexibility. According to Smith and Le Veck (1996) and Sewell (2007), some of the of Abacus in teaching mathematic to the visually impaired include that, it can be used for educational purposes to the support a good foundation in addition, subtraction, multiplication and can also be used to carry out calculation involving fractions and decimals, as well as an aid in completing arithmetic operations included in higher level arithmetic. Also, it helps in independent living skills such as recording phone numbers or tabulating cost while shopping. It teachers scalars since the beads stand for unit of 5 (Sewell, 2007). Abacus is an excellent tool for developing the concepts of place value, base ten stuff and many numerical relationships for visually impaired student. It helps the visually impaired student to develop a well number sense. It allow visually impaired to learn problem solving skills in reinforce arithmetic (Sewell, 2007). The abacus is extremely low maintains and reinforce mathematical concept in the visually paired students. Is also much more efficient and practical, so it helps the visually impaired students to practicalize what they have been taught.

**2.9 Empirical studies**

Visual functioning levels, additional disabilities, and cognitive abilities. Specialized schools, once the greatest source of research samples, no longer offer the homogeneous population and curriculum they once did, as the largest proportion of students with visual impairments (86.55%) now attend general education classes in public schools (U.S. Department of Education, 2005, p. 169). Manipulation of variables in a controlled study often interferes with meeting the standards of the No Child Left Behind Act, and school districts are reluctant to consent to research because it takes away from other instruction.

Four studies over 50 years that meet at least some evidence standards suggest that the field of visual impairment has a weak foundation for its practice in mathematics education. The American Speech-Language-Hearing Association (ASHA) 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 designs; (c) well-designed non-experimental studies (i.e., correlational and case studies); and (d) expert committee report, consensus conference, and experience of respected professionals (ASHA, 2004). Applying these levels to the research in visual impairment, most studies have been conducted at levels (c) and (d). The field of visual impairment has an active literature, but the largest proportion of articles seems to be reports, program evaluations, or descriptive studies.

There are several observations about the literature that seem pertinent:

- While 18 articles reported on a program or product, the authors apparently never pursued a scientific trial that would yield definitive information on its effectiveness.
- Several studies utilized a sighted comparison group. These studies did not pass our evidence screening, since we could not respond affirmatively to the fair comparison question ("Were the participants in the group receiving the intervention comparable to the participants in the comparison group?"). We have been profoundly influenced by Warren's (1994) individual differences approach and do not believe that comparison to a sighted standard is either fair or appropriate.
- Many studies, even ones that qualified for our analysis, failed to include pertinent information about the participants in the study. While omitting gender and additional disability status might be attributable to historical social conventions and the changing population of students with visual impairments, articles were also missing information about the ages of participants, their levels of

visual function, their IQs, and their visual disorders. This information is critical to determine generalizability and to understand the results.

- The dearth of evidence for successful strategies in teaching mathematics has grave implications for the preparation of teachers and the continuation of practices that have not yet been established as effective. As C. Craig (personal communication, July 17, 2006) stated:

In our field, the central question must always be . . . if this strategy or product for performing mathematical calculations is not taught, and the student does not learn to use it, will someone else have to do it for him or her for the rest of [his or her] life?

The lack of knowledge about how to teach mathematics means that successive generations of teachers have been teaching with strategies that do not yield the hoped-for results. The poor performance of students with visual impairments on statewide mathematics assessments (National Center on Low-Incidence Disabilities, 2006) should serve as a call to action for teacher preparation programs and researchers as well.

The ten studies suggest that there is at least some evidence for the following statements. These conclusions are extremely tentative, however, given the technical inadequacies of some of the studies, the small size of the sample studied, and the failure to replicate the studies in multiple environments with multiple subjects. All of these generalizations mandate further research and testing.

Concrete mathematics aids can increase computation accuracy (Belcastro, 1993; Champion, 1977; Hatlen, 1977). Concrete materials have been recommended when teaching students with visual impairments for at least 30 years, as Lowenfeld (1972) and Koenig and Holbrook (2000) recommend, and in this analysis, aids and devices do seem to assist with the acquisition of mathematics skills. Hatlen's concrete augmentation board, in spite of the success documented in his dissertation, has never been commercially produced. The Belcastro rods no longer seem to be commercially available, although similar manipulatives are incorporated into instructional programs. The talking calculator is not generally considered a concrete material, and in fact Kapperman, Heinze, and Sticken (2000) recommend against its use until mathematics skills are mastered: During initial instruction in arithmetic operations, manipulatives, paper and pencil or the braillewriter, and the abacus are the major tools used in calculations. The talking calculator should be used only as a reinforcer for skills learned using one of these approaches until a student masters the fundamental concepts involved in computation. (p. 386)

The accurateness of Braille computation (Kapperman, 1974) was also promising and addresses the importance of developing Braille reading and writing skills at an early age.

Comprehension of mathematics concepts can be increased with use of the Talking Calculator (Champion, 1977). While the greatest effect for Champion's study was for computation, the talking calculator was shown to impact math concepts as well. However, the Champion study employed only 9 participants and has never been replicated. Further investigation is warranted, particularly in light of Kapperman et al.'s (2000) recommendation above. Instruction in fingermath may increase computation accuracy (Maddux, Cates, & Sowell, 1984). Maddux et al. studied only 3 students utilizing a single subject design. While the uncorrected effect size was promising, adjusting the effect size for the small number of subjects reduced the effect size to zero. Once again, the study deserves to be replicated with a larger number of students. There is conflicting evidence for the effectiveness of the abacus (Kapperman, 1974, Nolan & Morris, 1964). While Nolan and Morris demonstrated higher test scores after 8 months of training in the use of the abacus, Kapperman found greater results for braille computation and mental calculation. Yet it continues to be used in classrooms today, without the rigorous research that would document its effectiveness. It is not known whether the time spent in teaching the mechanics of the abacus actually result in improved computation, or whether another intervention with another device might be more effective.

The difficulty in suggesting next steps is that there are so many steps to take. At the very least, the qualifying studies should be replicated with a greater variety and number of children. Studies that did not meet evidence standards should be designed and implemented to produce greater confidence in the results. New studies should be designed and conducted within the principles of scientifically-based research. The list of studies that are needed is long, but the stakes are high. In an environment where the education of students with visual impairment is continually questioned about efficacy and outcomes, the manner in which we meet this challenge may determine the future of specialized services as much as it determines the futures of children and youth who are visually impaired.

## 2.10 Summary and Uniqueness of the Study

The review related works, shows that abacus is a very important devices which has been for ages and it is the foundation of counting and the computer we are using today. The type varies from one different country to another. It also shows that it is a very important device in the education of the visually impaired students especial in arithmetic/arithmetic. It significantly, allows them (visually impaired) to compete favourably with their contemporary (Sighted) in arithmetic and technology.

This study is unique with all other studies due to following ie difference of subject, geo political area, cultural difference, time of the study and oral environmental social amenities

## CHAPTER THREE

## METHODOLOGY

This chapter describes the procedure adopted in conducting the research. It is done under the following sub-headings, Research Design, Population and Sampling, Technique Sample, Sampling Size, Instrumentation for data Collection, Procedure for data Collection and instrument for data analysis.

### 3.2 Research design

The research design adopted was experimental of pre-test post test. The randomized groups, pretest post-test design involved assigning subjects to the experimental and control groups by random procedures and administer a pre-test as a measures of the dependent variable (i.e. arithmetic performance and after treatment a post-test of the same variable was administered so as to given room for comparison. The treatment for the experimental group was the use of abacus, while the control group used the conventional method which is the verbal instruction.

### 3.3.1 Population

The population of this study comprised 89 pupils in Special Education School, Tudun Maliki (Visually impaired section) Kano who had received at least two years of primary education. The sample of pupils to be selected for this study comprised of twelve (12) primary three (3) pupils who already acquired the skill of counting numbers up to 100. The children are between the age of 6 and 8 years. The sample was made up of an equal number of both sexes- 6 boys and 6 girls. The subject would be selected irrespective of their socio-economic background and ethnicity.

### 3.3.2 Sampling technique

The samples would be drawn from the population of the visually impaired section of Special Education School Tudun Maliki using purposive sampling technique. This is because every member of the sample was assumed to have the same typicality

### 3.3.2 Sample size

Sample size for this study comprised of twelve (12) subjects of equal number of both sexes six (6) boys and six (6) girls.

## 3.4 Data Collection Instruments

The instrument used in collecting data for this study was arithmetic achievement test. The items were drawn from a special school curriculum for the primary School. The teacher made achievement test used for evaluating of students contained five (5) questions in respect to the topic treated in the class were, addition and subtraction of hundred, tens and unit of numbers. Abacus were also utilized for solving arithmetic problems.

### 3.4.1 Validation of the instrument

The data collection instrument was validated by conducting a pilot study of the instrument. The instrument was first given to Senior lecturers of the department for face and content validity. Furthermore, the supervisor allowed the researcher to pilot test the instrument in order to verify it validity.

The score obtain after administering the instrument was correlated using person product moment correlation. The reliability index stood at 1.000 while credibility index stand at .976 hence the reliability index stand at 971 in conclusion the validity content was established, because there is a strong positive correlation.

### 3.4.2 Reliability of data collection instrument

The reliability of an instrument would mainly depend on the extent of stability to provide same result. That is to say when a pupils with visual impairment had a varying score at different intervals and the scores agree with one another, it could be agreed that, there is a high reliability of the instrument. This instrument had undergone test-retest over period of time and proved to agree with the previous performance of pupils. Hence, test-retest reliability of this instrument overtime provides evidence of its reliability, which can be accounted for its adequacy, and appropriateness to the subjects of this study.

## 3.5 Data collection Procedure

A test of five (5) question constituting problem in addition and subtraction was administered to the sample group of twelve (12) pupils of primary School. The sample group was taught the use of Abacus in solving addition and subtraction of hundred, tens and units. A test of five (5) questions constitution of problem of addition and subtraction of hundred, tens and units were administered to the group using abacus. The pupils were to answer the five (5) questions under 30 minutes. Their results were collected. Pupils were allowed to engaged in other activities which include break and play time for two (2) hours. Thereafter, a second test was administered without the use of Abacus. Five (5) questions of similar value on addition and subtraction were given to the treatment scheduled which covered a period of four weeks for thirty minutes four times a week (i.e. twice for each group) between 10.00 am to 10.30 am. A test of five (5) questions constituting problem in addition was administered to the sample of (12) pupils. The experimental group were taught the use of abacus in solving addition of hundred, tens and units. The pupils answered the five (5) questions under 30 minutes.

Therefore, a second test was administered without the use of abacus for control group. Five (5) questions of similar value on addition were given to pupils to solve under 30 minutes and the results was collected. Results of the pre-test (before treatment) and that of the post-test (after treatment) were compared for difference

### 3.5.1 Materials for intervention

The addition lessons of 3 digit numbers was adopted from arithmetic text book for Nigerian primary school book 2 for the pupils to solve under 30 mins, and the results were collected. The result of the pretest and posttest were compared.

The mean score was 3. Any students score below 3 is not accepted while those at 3 and above were accepted.

The formula used for the above figure was;

$$X = \frac{\sum X}{N}$$

Where:

X = mean of the score

∑X = summation of the mark

N = numbers of question(s)

**3.5 Data analysis procedure**

The data collected was statistically analyzed using t-test techniques and the personal data collected from the achievement test was analyzed using simple mean of the scores.

$$X = \frac{\sum X}{N}$$

Where:

X = Mean of the scores

∑X = Summation of the marks

N = Number of questions

The simple rule guiding the comparisons or the decision was that, if the calculation value is greater than critical value, we reject the null-hypothesis ($H_o$) and accept the alternative hypothesis ($H_1$). The response from the achievement test result was analyzed using the t-test while formula is:

D

$S_D^2$

N

Where:

D is the means of difference of means,

$S_D^2$ is the variance of the difference of score and is given by $S_D^2 = \frac{(D - D^2)}{N - 1}$

N is the number of sample.

The rational for the selection of these texts were due to their relevance within the context of the study (i.e. taking into consideration the pupils background and environment). Inferential statistics was used to compute the effect of abacus on computational skill of addition of 3 digit numbers. The t –test of independent samples was use to determined the degree of differences in the outcome of the two instructional materials used in this study. The alphabetic level was at 0.05 level of significance

# CHAPTER FOUR

# PRESENTATION AND ANALYSIS OF DATA

## 4.1 **Introduction**

This chapter presents data analyzed in accordance with the research questions and hypotheses

4.2. Research question one: Is Abacuses skills effective in learning addition of 3 digits numbers among pupils with visual impairment?

Table 1Mean difference between the pre-test and post-test of abacus skills effectiveness

| Variable | N | X | Sd |
|---|---|---|---|
| Pre-test group Test | 6 | 12.29 | 3.40 |
| Post-test group | 6 | 14.71 | 5.59 |

The table above revealed that, the mean score as at the pre-test was 12.29 while at the post –test level was 14.71, this indicated that there is a significant difference between the two tests in favour of the post-test, in other words it indicated was an improvement on part of the pupils.

4.3 Research question two: Is there gender difference in the effect of Abacus on arithmetic attainment among pupils with visual impairment ?

Table 2: (4.3) mean difference between gender pre-test and post-test scores

| Variable | N | X | Sd |
|---|---|---|---|
| Male Students | 6 | 14.000 | 3.7859 |
| Female students | 6 | 13.000 | 5.4160 |

Table 2 above indicates that male pupils mean score was 14.00 while that of female pupils was 13.00. this shows that the arithmetic attainment of male pupils is significantly better than that of the female pupils.

**Research question three**: Are there challenges in using abacus to learning addition of 3 digit numbers among pupils with visual impairment

**Table 3 challenges encountered by pupils**

| | **N** | **Yes** | **%** | **No** | **%** |
|---|---|---|---|---|---|
| Did you encounter any problem | 6 | 5 | 83.33% | 1 | 16.66% |

Table 3 above revealed that six subject that equals to 83.33% claimed that did not encounter any problem during learning alternative using abacus while one subject which was equals to 16.66% claimed he had faced some problem of using abacus to learning 3 digits numbers.

**4.4 Hypothesis one**: There is no significant difference in arithmetic attainment between pre-test and post-test scores of pupils with visual impairment taught addition of 3 digit numbers using Abacus.

Table 3 Difference between pre-test and post-test of pupils with visual impairement taught with abacus.

| Variable | N | X | Sd div | Tcal | P value | Sig | Decision |
|---|---|---|---|---|---|---|---|
| Pre-test | 6 | 12.29 | 3.40 | | | | |
| | | | | 4.64 | 5<br>.002 | 0.05 | 4<br>rejected |
| Post-test | 6 | 14.71 | 5.59 | | | | |

The table above revealed that the mean score at the pre-test was 12.29 while that of the post-test was 14.71, this indicated that there is a significant difference in the pupils performance, that is there is an improvement in their mathematic skills , while the t- calculated value stand at 4.64 and the t-critical value 2.228 at 0.05 level of significance indicated that, there is a significant difference in the pupils arithmetic attainment was in favour of the post-test score Hence, the null hypothesis which stated that there is no significant difference between the two samples was therefore rejected.

**4.5 Hypothesis two**: There is no significant gender difference in arithmetic attainment between pupils with visual impairment taught addition of 3 digit numbers using Abacus.

Table 4 gender difference between pre-test and post-test of visually impaired students taught with abacus.

Table 4. Gender and learning Abacus Performance

| Variable | N | X | Sd div | Tcal | P value | Sig | Decision |
|---|---|---|---|---|---|---|---|
| Male Student | 6 | 14.000 | 3.7859 | 2.400 | 5 .046 | 0.05 | 4 rejected |
| Female students | 6 | 13.000 | 5.4160 | | | | |

The above table showed that, the mean score of male pupils was 14.00 while that of female pupils mean score was 13, this indicated that there is a significant difference at the mean was in favuor of the post-test level. The t-calculated value which was 2.400 while the t-critical value stands at 2.228 at 0.05 level of significance, since t–calculated was greater than the t- critical, it implied that there is a significant difference in the arithmetic attainment between male and female and the significant difference was in favour of male pupils. It can be argued that the performance of male pupils was more appreciating than that of the female pupils. Therefore the null hypothesis was rejected and the alternate hypothesis was uphold.

### 4.6 Summary of findings

1. The mean score between the pre-test and post-test score reveal significant level of difference in favour of the post-test score.

2. there is a difference between gender, due to the result of the mean score of male pupils was 14.00 while that of female was 13.00 hence male score is slightly higher than the female score.

3: there is no much challenges faced by pupils with visual impairment in the school.

Hypothesis 1. there is a significant difference in the pupils arithmetic attainment which was in favour of the post-test, hence the null hypothesis was rejected.

Hypothesis 2. indicated, there is a significant difference in the arithmetic attainment between male and female and the significant difference was in favour of male pupils.

### 4.7 Discussion on Findings

The first finding addressed the issue of abacus skills as effective in learning addition of 3 digit numbers has proved to be effective to the pupils with visual impairement pupils because it had improved or influenced the pupils arithmetic attainment. Nevertheless the pupils had acquired the skills of using the abacus for their Arithmetic skills .This finding was in agreement with the view of Heffelfing and Flom (2007) Further it had demonstrated that the skill acquisition, can be employed anywhere irrespective of geographical locations, ideology or cultural difference. The second findings that investigated on gender difference, have prove to be of benefit to the male pupils. Because there is a significant difference in the Arithmetical attainment of male but many factors can be attributed to this significant difference that of the female pupils. This findings, had supported the view of Livilingston (1997) That was to say in the case male pupils those that came from high socio-economic and educational background did better in arithmetic while female pupils did better in linguistic. But this finding had disagreed with many findings that portrays no significant difference in attaining any skill between male and female especially individuals with gifted and talented. Though many reasons were accounted to the significant difference in relation to this study, such as socio-economic factors parental educational background etc. while on the other study socio-political amenities, educational, ideology and economic factors as confounding variable were been controlled.

The third finding revealed that six subject out of seven did not encountered any challenges, hence, it had become a fact that using abacus can aid pupils with visual impairment to learn three digits with number with ease (Olukotun 2003) and Mccomiskely 1996) . though one subject has claimed that he had encountered a problem during using the abacus to learning three digit number his problem was associated to individual differences in both their cognitive as well as their socio-economic and educational background. These factors played a significant role in affecting or influence academic performance as claimed by (Ekpunibi 1991, Guralnick 2001 Mccomisley 1996)

The first hypothesis: which was a null hypothesis sought to find out the significant difference in arithmetic attainment between pre-test and post –test of pupils clearly this indicated that, there was an improvement on the pupils arithmetic attainment, and also there had developed interest in manipulating the abacus. Therefore the null hypothesis was rejected because there is a significant difference in the arithmetic attainment. Based on this result, it concluded that since there is a significant difference between the pre-test and post-test the pupils with visual impairment had benefited. This finding supported that of Millaway,(1994).That of abacus skills could be taught to child or pupils with visual impairment, it would greatly help to understand and learn at ease in addition therefore this study had established that fact.

The second hypothesis, that addressed the issue of gender difference in arithmetical attainment had proved to be efficacious to this pupils arithmetic attainment. But the improvement was in fovour of the male pupils who benefited most. The finding proved that the Null hypothesis stands rejected, establishing space the findings of Livingston (1997)

Through many studies like Darma (2014) proved that, the potential abilities of both male and female in most respect was insignificant, even if it exist the difference had to be accounted on many factors not on the ability of the individuals per-say. But in the case of this study, factors like their present condition, illness, teachers factors can affect the female pupils performance, though this not withstand a significant difference had existed in this study

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# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATION

## 5.1 Introduction

This chapter highlighted on the summary, conclusion and recommendation of this study.

## 5.2 Summary

The first chapter discussed the background of the study, statement of the problems, objective of the study, research questions, hypotheses, significance of the study, scope and delimitation and operational definition of terms.

Chapter two, presents the conceptual framework of the study historical development of abacus significance of abacus, types of abacus in learning arithmetic, visual impairment, empirical studies, summery and uniqueness to of the study. Chapter three described the methodology of the study, populations and sample. Population, the study sampling technique, sample size, instrumentation for data collection. procedure for data collection and instrument for data analysis, chapter four present data analysis, summary of findings and discussion of findings.

Chapter five discussed the summary, concluding and recommendation of the study.

### 5.3 Conclusion

This study was concluded by the following findings, that abacus skill was very effective in learning addition of three digit number among pupils with visual impairment, that there is significant gender different in arithmetic performance in favour of male pupils. There was no any challenges in using abacus to learn addition of three digit number in arithmetic by pupils with visual impairment. There is significant improvement of the pupils academic performance on arithmetic skill after administering the instrument, hence there post-test level showed an improvement in there arithmetic as against their former arithmetic skills. Also in second hypothesis both the mean and t-obtain value were in favour of male students. Where the hypotheses was rejected. This study concluded by the following, it was established that there is a significant improvement of arithmetic attainment of pupils visual impairement at the post-test level after treatment. While on the second hypothesis there was also a significant difference between male and female pupils with visual impairment, and the significance difference was in favour of male pupils.

### 5.4.2 Major Contribution of the study

*Using Abacus for pupils with visual impairment in order to achieves excel in arithmetic skills.

*Innovation in Special needs education.

*Motivation towards encouraging other researchers in exploring other areas for achieving competence and achievement of other students with visual impairement.

*Enhancing teacher  qualification for the researcher.

**5.4 Recommendations from the study.**

1. Parents need to help their child to practice abacus at home of their school activities when the student were on day school but students on board in must conduct precp of the evening and at night to mostes they had learned on abacas every day.
2. Both male/female students should be guided to develop good study habits and to have interest in arithmetic and in the use of abacus.
3. The teachers need to design their lesson plan to always through the lesson during learning of arithmetic especially the use of abacus.
4. The teachers need to  sensitize  pupils to develop competition in arithmetic achievement among  themselves in order to sustain high motivational level

MAJOR CONTRIBUTION OF THE STUDY

**5.4.1 Recommendations for further studies**

i. There is need to investigate this type of study with a large sample size

ii. There is need to further investigate gender issues on arithmetic attaining among pupils with special needs.

iii. There is need to study the effect of developing high achievement motivation by both parents teachers of the pupils.

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