University of Education, Winneba http://ir.uew.edu.gh

UNIVERSITY OF EDUCATION, WINNEBA

TEACHERS' APPROACHES TO TEACHING MATHEMATICS TO STUDENTS WITH VISUAL IMPAIRMENT AT ADIDOME SENIOR HIGH SCHOOL IN VOLTA REGION OF GHANA

MAVIS SAFORO

8160150006

A Thesis in the Department of SPECIAL EDUCATION, Faculty of EDUCATIONAL STUDIES, submitted to the School of Graduate Studies, University of Education, Winneba, in partial fulfillment of the requirements for award of the Master of Philosophy (Special Education) degree.

OCTOBER, 2018

University of Education, Winneba http://ir.uew.edu.gh

DECLARATION

CANDIDATE'S DECLARATION

I Mavis Saforo declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: .....

DATE: .....

SUPERVISOR'S DECLARATION

I, Dr. Nyadu Yaw Offei, hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Thesis as laid down by the University of Education, Winneba.

SIGNATURE: .....

DATE: .....

CO-SUPERVISOR'S DECLARATION

I, Dr. Awini Adam hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Thesis as laid down by the University of Education, Winneba.

SIGNATURE: .....

DATE: .....

University of Education, Winneba http://ir.uew.edu.gh

ACKNOWLEDGEMENTS

Throughout the process of doing this work, a lot of people have in one way or the other helped and I would like to express my sincere gratitude to them for their support. First of all, I would like to express my profound appreciation to my supervisors, Dr. Yaw Offei Nyadu, Dr. Adam Awini, for their guidance and encouragement for me throughout the period of doing this research. Their good suggestions shaped my thesis to what it is currently, and I appreciate their concern and commitment towards the success of this work.

My sincerest thanks also go to Mr. Dominic Kolbil (my husband) for his advice and the opportunity offered me to pursue the MPhil programme. Again, I wish to acknowledge good friends who offered great support for me in the process of writing this thesis: Miss Alice Avornyo, Miss Deborah Patience Ashiokor Ashietey, Mr. Ephraim Teye, Mr. Opoku Acheampong Nana. I would never forget our genuine friendship.

To my family, I say I appreciate your encouragement and prayers. Then to staff of Adidome Senior High School, and all the students with visual impairment in the University of Education, Winneba and Adidome Senior High School. Lastly, I would like to show my gratitude to all the lecturers in the Department of Special Education, not forgetting Dr. Essau Yao Yekple for contributions and suggestions towards the success of this work.

University of Education, Winneba http://ir.uew.edu.gh

DEDICATION

I dedicate this work to my lovely children, Andy-Edwin Sebig Kolbil and Lady-Gwyneth Afua Aseda Kolbil.

University of Education, Winneba http://ir.uew.edu.gh

TABLE OF CONTENTS

University of Education, Winneba http://ir.uew.edu.gh

University of Education, Winneba http://ir.uew.edu.gh

University of Education, Winneba http://ir.uew.edu.gh

LIST OF TABLES

University of Education, Winneba http://ir.uew.edu.gh

ABSTRACT

This case study was to find out the approaches teachers' use in teaching mathematics to students with visual impairment at Adidome Senior High School in the Volta Region of Ghana. Sixteen students with visual impairment were purposively sampled from a population of 19 students. Data were gathered using a semi-structured interview guide. Data were coded and analyzed using the thematic approach. Results of the study indicated that the teachers employed strategies such as peer tutoring, co-operative teaching and explicit instruction in teaching mathematics to students with visual impairment. Also, the results revealed that teachers did have access to varieties of teaching and learning materials for use in teaching mathematics to students with visual impairment that enabled them to better understand mathematical concepts. It was recommended that teachers should make intensive use of explicit instruction, guide peer tutors, cooperative teaching and manipulatives as strategies in teaching mathematics to students with visual impairment. Again, it was recommended that the head-teacher should make sure students with visual impairment are provided with teaching and learning materials such as scientific talking calculators, abacus and others for the learning of mathematics. Finally, it was recommended that the school should periodically train teachers who teach mathematics to students with visual impairment.

University of Education, Winneba http://ir.uew.edu.gh

University of Education, Winneba http://ir.uew.edu.gh

UNIVERSITY OF EDUCATION, WINNEBA

TEACHERS' APPROACHES TO TEACHING MATHEMATICS TO STUDENTS WITH VISUAL IMPAIRMENT AT ADIDOME SENIOR HIGH SCHOOL IN VOLTA REGION OF GHANA

MAVIS SAFORO

8160150006

A Thesis in the Department of SPECIAL EDUCATION, Faculty of EDUCATIONAL STUDIES, submitted to the School of Graduate Studies, University of Education, Winneba, in partial fulfillment of the requirements for award of the Master of Philosophy (Special Education) degree.

OCTOBER, 2018

University of Education, Winneba http://ir.uew.edu.gh

CHAPTER ONE

INTRODUCTION

1.0 Background to the study

Mathematics is one of the core subjects in the curriculum from basic school level to senior high school in Ghana. A credit in mathematics is a crucial consideration in the admission process of institutions of higher learning, and content in mathematics cuts across other school subjects such as science, social studies, and even music and art (Appiahene, Opoku, Akweittey, Adoba, & Kwarteng, 2014). In every aspect of human lives, mathematics is needed in one way or the other. For example, mathematical knowledge is used at school, marketplaces, work places, in the home and hospitals. For instance, Bayram (2014) stated that mathematics can be used in calculating grocery shopping costs, making comparisons between quantities or describing the shapes that are touched.

According to Bruce, Flynn, Moss, and the Mathematics for Young Children Research Team (2012), every child should have access to high quality mathematics instructions and experiences at a tender age. This, according to Duncan, Claessens, Huston, Pagani, Engel, Sexton, and Japel (2007), mathematics instruction would help children to get themselves ready for academic achievement. According to the Ministry of Education (2013), mathematics is one of the compulsory subjects to be studied at all levels of education in Ghana. Therefore, mathematics is very important to the extent that it is one of the required subjects to be passed before one gains admission into any higher institution. However, results from mathematics examinations at all levels of the educational system in Ghana shows that many students are failing in the subject (Anku, 2014). Statistics from the West African Examination Council (WAEC) indicated that in Ghana, the performance of students in mathematics in the West African Senior

University of Education, Winneba http://ir.uew.edu.gh

Secondary Schools Certificate Examination (WASSSCE) has continued to decline over the years (Appiahene, et al., 2014). For example, in 2013, the WAEC reported that students' performance in core mathematics for the year 2012 dropped from 49.9% to 36.8%, and the decline in students' performance in the subject keeps getting worse as the years go by.

Csocsan, Klingenberg, Koskinen and Sjostadt (2002), stated that the main goal of mathematics education is to help students improve on their awareness of numbers and coping with different relations and dimensions. The understanding of mathematics improves educational and occupational opportunities for every individual (Brawand & Johnson, 2016). Mathematics helps students to acquire more knowledge in technologies that help them in their work places. However, most people who do not have adequate mathematical knowledge do not have the opportunity in most of the jobs they want (Kapperman & Sticken, 2003).

All students, including those with disabilities, especially those with visual impairment, are to be taught mathematics throughout all their educational levels. However, students with visual impairment have peculiar problems so far as the learning of mathematics is concerned. An inability to learn incidentally affects the learning of mathematical concepts of students with visual impairment (Zhang, 2016).

Students with visual impairment have the potential in doing mathematics and can be at comparable level with their sighted peers if taught appropriately, and to their understanding (Kapperman & Sticken, 2003). The use of appropriate approaches by teachers in teaching mathematics to students with visual impairment could help to improve on their lives. Many approaches can be used in the regular classroom to facilitate the inclusion of students with visual impairment in the regular classroom. For

University of Education, Winneba http://ir.uew.edu.gh

example, Igun (2009) mentioned co-operative learning, peer tutoring, peer support and team teaching as some of the approaches used in teaching students with visual impairment.

The use of teaching and learning materials such as talking calculators, abacus, tactile graphics and concrete materials may benefit students with visual impairment in learning mathematics (Brawand & Johnson, 2016), and the materials, if properly presented to students, may help the students to improve on their knowledge and understanding of the subject. However, several challenges account for the poor performance of students with visual impairment in learning mathematics in Ghana. According to Ocloo (2011), the study of mathematics is difficult for most persons who have no sight or very little useful sight. Kumar, RaGsamy, and Greg (2001) also noted that students with visual impairment have the same range of cognitive abilities as their sighted peers. However, Kumar and colleagues observed that mathematics requires considerably more effort using vision on than does subjects which are more verbal in nature. Consequently, students with visual impairment are often at a disadvantage when the teaching of learning is done only using strategies that require learners to use vision.

Various adaptations are made in the teaching of mathematics to students with visual impairment to improve on their learning. These adaptations may include instructional adaptation and teaching and learning materials adaptation. Mathematics instructional adaptations may include breaking down of instructional process into bits or step by step (task analysis) and verbalizing all instructions. Adaptations are made to teaching and learning materials, such as concrete materials (e.g., talking calculators), and abacus. Mathematics cannot be taught to students with visual impairment to their understanding without these appropriate adaptations. Though many adaptations are

University of Education, Winneba http://ir.uew.edu.gh

available for teaching students with visual impairment in general education classrooms, they face many challenges when studying mathematics. These challenges may include lack of trained tutors and resources that can be used to arouse the interest of students with visual impairments in the subject.

Studies have been conducted on teachers' approaches to teaching mathematics to students with visual impairment in regular classrooms (Maguvhe, 2016). However, it appears only a few have been done concerning the approaches teachers use in teaching mathematics to students with visual impairment in senior high schools in Ghana, whether in regular schools or special schools, though just a few have been done concerning students with other disabilities. In this study, however, approaches to teaching mathematics to students with visual impairment is conceptualized under the following: (a) strategies teachers use to teach mathematics to students with visual impairment, (b) teaching and learning materials used in teaching mathematics to students with visual impairment,(c) challenges students with visual impairment face when learning the subject, and (d) adaptations for teaching the subject in the schools.

1.1 Statement of the Problem

Teaching mathematics requires the use of different approaches in order to enhance performance of students. Different approaches are used in teaching subjects such as mathematics to sighted students (Asamoah, 2009). Students with visual impairment, however, need a well-planned approach in the teaching of mathematics for a better understanding and performance. Examination results of students with visual impairment at Adidome Senior High School for two academic years; namely, 2015/16 and 2016/17 indicate that out of 15 students with visually impairment who took part in the WASSCE at the school, only one obtained Credit in mathematics. This abysmal

University of Education, Winneba http://ir.uew.edu.gh

performance prompted the researcher to interact with some past students of the school who were pursuing studies in the University of Education, Winneba. This interaction, which occurred on October 10, 2017 revealed that teachers seemed not to use appropriate strategies in teaching mathematics to students with visual impairment. Furthermore, it appeared that teachers did not adapt their teaching of mathematics to suit the needs of students with visual impairment in the school. Again, it seemed students with visual impairment faced some challenges when they were taught mathematics in the school. Finally, a conversation with a teacher at the Adidome Senior High School revealed that teachers did not use appropriate teaching and learning materials in teaching mathematics to students with visual impairment. All these problems, coupled with the fact that many students with visual impairment get denied admission to universities because of their poor performance in mathematics, compelled the researcher to investigate the approaches used in teaching mathematics to students with visual impairment in Adidome Senior High School.

1.2 Purpose of the study

The purpose this study was to find out the approaches teachers use in teaching mathematics to students with visual impairment at Adidome Senior High School in the Volta Region of Ghana.

1.3 Objectives

The objectives of the study were to:

- Find out the strategies teachers use in teaching mathematics to students with visual impairment at Adidome Senior High School.

University of Education, Winneba http://ir.uew.edu.gh

- Find out what teaching and learning materials are available in teaching mathematics to students with visual impairment at Adidome Senior High School. l
- Find out what challenges students with visual impairment face in the learning of mathematics.
- Examine the adaptations that teachers make in teaching mathematics to the learning needs of students with visual impairment at Adidome Senior High School.

1.4 Research Questions

The following research questions were raised to guide the study:

1. What strategies do teachers use in teaching mathematics to students with visual impairment at Adidome Senior High School?
2. What teaching and learning materials are available in teaching mathematics to students with visual impairment at Adidome Senior High School?
3. What challenges do students with visual impairment face in the learning of mathematics at Adidome Senior High School?
4. What adaptations do teachers make in teaching mathematics to students with visual impairment at Adidome Senior High School?

1.5 Significance of the study

The findings of this study would reveal the strategies teachers use in teaching mathematics to students with visual impairment in Adidome Senior High School. This would enable the school authorities to find out means of improving on their teaching strategies of instructing students with visual impairment in mathematics lessons in the

University of Education, Winneba http://ir.uew.edu.gh

school. The results of this study would also help in finding out what teaching and learning materials are available for teaching mathematics to the students. This would also enable the school authorities to find means of providing the needed materials for the students with visual impairment. Additionally, the results of the study would help in finding out what challenges students with visual impairment face in learning mathematics. This would enable the teachers to factor in the challenges when teaching mathematics. The findings, of the study would also help in revealing the kinds of adaptations that are made by teachers to mathematics to suit the needs of students with visual impairment in the school. This would enable teachers to re-examine the mathematics lessons in order to make the relevant adaptations that would suit the needs of those with visual impairment.

The results of the study would further help in finding out inherent challenges students with visual impairment face in learning mathematics in the School. This would further allow teachers to find ways of addressing the challenges in order to improve upon the performance of the students in learning mathematics. Again, the findings of the study would again help in finding out the teaching and learning materials available to assist students with visual impairment during mathematics lessons. This would help the school authorities to find different ways of assisting teachers with the necessary teaching and learning materials that can arouse the interests of students with visual impairment in mathematics. Finally, the results of the study would add to the existing literature for researchers interested in similar studies in the future.

1.6 Delimitation

University of Education, Winneba http://ir.uew.edu.gh

There are many inclusive senior high schools in Ghana which admit students with visual impairment. This study focused on Adidome Senior High School. because the Adidome Senior High School appeared to be the only inclusive senior high school in Ghana where students with visual impairment offer mathematics as major concentration. Furthermore, the study was delimited to students with visual impairment in only forms two and three as they had spent more than one year in the school with two mathematics teachers and a resource teacher, who supported the students with visual impairment in their learning. Furthermore, the study delimited to the following areas: (a) the strategies teachers use to teach mathematics to students with visual impairment, (b) teaching and learning materials used in teaching mathematics to students with visual impairment, (c) the challenges students with visual impairment face when learning the subject, and (d) the adaptations for teaching the subject in the school.

1.7 Limitation

In the course of writing this thesis, I found it difficult accessing literature on works relating to the topic. This was because most of the information in the university's library e-resources was not related to this work. Again, one of the major challenges the researcher encountered during the study was that, the researcher should have used observation as an additional tool for the data collection to confirmed what the participants' said. As a result, the findings cannot be generalized to reflect the situation in other schools. Though these challenges were considered as limitations, it did not affect the results of the study.

1.8 Operational definition of terms

University of Education, Winneba http://ir.uew.edu.gh

Visual impairment: It is the term used to describe any kind of vision loss whether total or partial sightedness.

blindness: One who can learn through tactile or auditory cannel without the use of residual vision.

Teaching: An act of instructing someone to acquire knowledge

Learning: It a process of acquiring knowledge or skills through instructions or studying

Challenging: A task that require the use of one's full ability

Approaches: Different ways of tackling things to make them easier

Strategies: Skills and methods of giving an instruction or teaching.

Mathematics: It the science that deals with logic of space, quantity and arrangement.

Peer tutor: A student who acts as a tutor or teacher to teach his or her other colleagues after the instructor have finish teaching for better understanding

Explicit instruction: It is a step by step detailed instruction or giving an instruction bit by bit for easy understanding.

Adaptations: A modification made to an original to suit a purpose

Cooperative learning: Learning in groups with mix abilities**.**

Manipulative: Concrete material with three dimensions for learning.

Talking calculator: It is a special calculator with speech for students with visual impairment

University of Education, Winneba http://ir.uew.edu.gh

Abacus: It is a rectangular object with beads and rod use for calculations of additions, subtractions, divisions and multiplications in mathematics

Nemeth Code: These are Braille notations for representing mathematical expressions.

Differentiated instruction: Teaching one concept using many approaches.

Teaching and learning Materials: They are teaching aids that facilitates teaching and learning for easier demonstration of a concept and understanding

Credit: It has been used to refer to a grading system by the West African Examination council, where a student obtains a mark of 60-65 in a subject. This is usually the least mark required in a subject for a consideration into higher or tertiary institution.

1.9 Organization of the study

The study is presented in six chapters. Chapter one discusses the background to the study, statement of the problem, aim and objectives of the study, research questions, significant of the study, delimitations of the study, limitations, operational definition of terms and general layout of the study.

Chapter two, deals with the review of related literature. It presents an overview of the theoretical perspectives of the study. It also outlines what other authors or writers have written about the topic of the study. Chapter three focuses on the general methodology adopted for the study. It describes the research approach and design, the population, sample and sampling techniques, data gathering instruments, validity and reliability, pre-testing and data collection procedures of the study. Also covered in the chapter are procedures adopted for data analysis.

Further, chapter four also presented the results of the study, and in chapter five, the discussion of the findings is presented. Finally, the summary of findings,

University of Education, Winneba http://ir.uew.edu.gh

conclusions, recommendations and suggestions for further research form the concluding chapter of the study.

University of Education, Winneba http://ir.uew.edu.gh

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents the literature reviewed for the study. The literature reviewed covered the following sub- headings:

- Theoretical framework
- Strategies teachers use in teaching mathematics to students with visual impairment.
- Teaching and learning materials available for teaching mathematics.
- Challenges students with visual impairment face in learning mathematics
- Adaptations teachers make in teaching mathematics to students with visual impairment.

2.1 Theoretical Framework

The normalization process theory propounded by Wolf (1980) was used to guide this study. Wolf (1980) stated that, the normalization process theory attempts to explain the process of supporting people to attain as "normal" life as possible. This means that the theory deals with accepting people, especially those with disabilities, in a system by providing them the same opportunities as their peers without disabilities (Mugambi, 2011). Furthermore, Wolf asserted that the normalization process theory describes ways by which new technologies, acting and working, become routinely embedded in people's everyday practice. According to Finch, Rapley, Girling, Mair, Murray, Treweek, et al. (2013), the normalization theory provides a framework for understanding how new approaches can be used in every aspect of life to become part

University of Education, Winneba http://ir.uew.edu.gh

of a normal practice. May (2010) made it clear that, this theory presents different or adjust existing patterns of collective actions in some formal organization setting in order to make things an everyday process.

The use of appropriate strategies, in teaching students with visual impairment mathematics helps them to take part fully in the lesson without many challenges. The implication of the theory to this study is that with the appropriate strategies in teaching mathematics to students with visual impairment, they can have a normal lesson just like their sighted colleagues. Secondly, with appropriate teaching and learning materials during mathematics lessons, students experience normal system whereby the students can study in the same classroom with their sighted peers. In addition, these strategies, when used appropriately, enable teaching and learning to become a normal routine, and can further enable students to improve on their performance in mathematics.

More so, when mathematics lessons are well adapted to suit students with visual impairment, they can enjoy the lesson to the extent that they see the study of mathematics as an ordinary lesson therefore do not get so worried about the lesson. Lastly, the normalization theory suggests that, as long as appropriate strategies are used in teaching mathematics to students with visual impairment, adaptations are made to the lesson and appropriate teaching and learning materials are used in teaching mathematics to students, the students are able to have a normal school system and forget about all the challenges they might be facing.

University of Education, Winneba http://ir.uew.edu.gh

2.2 Strategies teachers use in teaching mathematics to students with visual impairment

AlbertaLearning (2002) noted that instructional strategies are methods used by teachers to assist students become independent and strategic learners. According to AlbertaLearning, instructional strategies become learning strategies when students independently select the suitable ones and use them effectively to accomplish tasks or meet goals. General education teachers change their instructional methods slightly when students with disabilities are placed in their classrooms (Vaughn & Schumm, 1995). A study conducted by Spindler (2006) on teaching mathematics to a student who is blind revealed that, teachers use simple manipulatives and teaching strategies, such as proper verbal wording of formulas, and repetition in teaching students. This study was a case with one student with visual impairment in a general class in the University of Vermont. One-on-one tutoring was used in teaching this student. The study recommended that instructors should be more careful when teaching mathematics to students with visual impairments in the general classroom.

Dauda, Jambo, and Umar (2016) conducted a study on students' perception of factors influencing teaching and learning of mathematics in senior secondary schools in Maiduguri Metropolis of Borno State, Nigeria. The objectives of the study were to determine the extent to which students perceived, qualification, methods of teaching, instructional materials and how attitude of both teachers and students influence the teaching and learning of mathematics in senior secondary schools. The study involved a sample of 1,500 male students and 1100 female students from six selected senior secondary schools in Maiduguri Metropolis in Borno State, Nigeria. The instrument used for data collection was a self-developed questionnaire measuring students' perception of factors influencing teaching and learning of mathematics. The findings

University of Education, Winneba http://ir.uew.edu.gh

revealed that, teaching strategies were highly perceived by students as important determinants of their success in learning. The researchers recommended that mathematics teachers must try and understand the perceptions of their students and adopt instructional strategies that whatever student perceived as easy would really turn out to be easy, and whatever they perceived to be difficult may be properly addressed to motivate and encourage students to see the need in learning mathematics and improve their performance.

Peterson (2011) stated that many researchers have exclusively investigated the most suitable instructional strategies for students with disabilities in inclusive classrooms. Hamann, Reeves, Baurain, and Valenciano (2008) also mentioned that instructional strategies for including students with disabilities, specifically those with visual impairment into inclusive classrooms include, personal interactions such as cooperative learning, feedback, reinforcement, differentiation of instructions, and high expectations. However, in teaching mathematics to students, specific instructional strategies such as explicit instruction, peer tutoring, cooperative learning are some of the instructional strategies teachers use to teach mathematics (The IRIS Centre, 2017).

Peterson (2011) further conducted a study on a qualitative study of instructional strategies used by elementary general education teachers in inclusive classrooms. The study made use of the phenomenological design through fifteen in-depth interviews with elementary general education teachers from across Michigan's Upper Peninsula to understand general education teachers' perception, thoughts, feelings, and beliefs about the instructional strategies they use to teach the students. It was revealed that the effective instructional strategies used by teachers for including students with disabilities include small group instruction, peer tutoring, and strategy instruction. The study recommended that, instructional strategies for inclusion, as described by the

University of Education, Winneba http://ir.uew.edu.gh

participants using a quantitative approach, would also be beneficial to both the teachers and students. In the literature, some of the strategies teachers use in teaching mathematics includes the following:

2.2.1 *Use of explicit instruction*

As stated earlier, the IRIS Centre (2017) mentioned explicit instruction as one of the main instructional strategies for teaching mathematics to students with visual impairment. Teaching mathematics to learners who are blind entails exactness, definiteness, totality and comprehensibility of presentation (Kohanová, 2007). Akdeniz (2016) mentioned explicit teaching as one of the instructional strategies for teaching students. According to Mercer and Mercer (2001), explicit teaching is when the teacher explains or models a skill or concept and further assists students through the learning process and gives them more opportunities to independently practice the skills in order to have mastery over the skills needed, Explicit instruction is very necessary in teaching students with disabilities including those with visual impairment; however, some professionals believe that this strategy is very complex and difficult in the general education classroom (Zigmond, 1997). Furthermore, a study conducted by Partanen (1993) revealed that special education classes were slower in pace when it comes to the use of explicit instruction in the regular schools Among all the strategies used for teaching, the explicit instruction strategy is the most researched strategy, s and it is the most widely used for classroom intervention (Rosenberg, Westling, & McLesky, 2008).

Karshmer, Guptab and Pontellic (nd) stated that explicit strategies are used for making mathematics simple and understanding for students with visual impairment. According to Gersten, Baker, Pugach, Scanlon and Chard (2001), the combination of explicit instruction with guided problem solving and discussion, in order to ensure

University of Education, Winneba http://ir.uew.edu.gh

transfer and generalization of learning in subjects like mathematics and science for children identified as having disability, such as visual impairment, is very important.

2.2.2 *Use of peer tutors*

Peer tutoring is the practice when peers act as their fellow students' tutors (Schloss, Schloss, & Schloss, 2007). Peer tutoring is one of the instructional approaches that may be used to help students with visual impairment during mathematic lessons. Romano and Walker (2010) noted that "peer-tutoring is an instructional strategy which provides small group, intense, focused instructions that allows students an opportunity for active responding and immediate student feedback" (p. 7). Peer tutoring can be a very good technique for providing modifying instructions to many students, including those with visual impairment, concurrently (Britt, 2014). Greenwood, Maheady, and Delquadri (2002 & 2008) also noted that the use of class wide peer tutoring approach by teachers helps improve student achievement during mathematics lesson. Again, one of the most useful instructional strategies for including students with disabilities into the inclusive classroom during mathematics lesson is the use of peer tutors (Louie, Brodesky, Brett, Yan, & Tan 2008)

Britt (2014) further added that, students could improve their classroom behavior and relationships with their peers when their peers act as peer tutors. On this note, Romano and Walker (2010) conducted a study entitled "Bio Buddies: Peer Tutoring as an Instructional Strategy". This study used both the qualitative and quantitative approaches with observation and questionnaire as the main instruments for data collection. High school biology students participated in this study. The findings revealed that when peer-tutoring was used as an instructional strategy, off-task behavior in class was reduced. Also; majority of the students in the study agreed strongly that

University of Education, Winneba http://ir.uew.edu.gh

working with peers led to greater understanding, better focus on task, and more enjoyment in studying biology.

Bloyd (2015) stated that in teaching mathematics to students with visual impairment, many types of student tutoring may be used. For example, students with disabilities serving as peer tutors to other students with disabilities (Utley, Reddy, Delquadri, Greenwood, Mortweet, & Bowman, 2001), students without disabilities serving as peer tutors to students with disabilities (Godsey, Schuster, Lingo, Collins, & Kleinert, 2008), and students with disabilities serving as peer tutors to students without disabilities in a general classroom setting (Hudson, Browder & Jimenez, 2014).

A study was carried out by Bloyd (2015) on the effects of peer-mediated approach to teaching mathematics skills to middle school students. The experimental and descriptive designs were adapted for this study. Four participants with mild to severe disabilities participated in this study. Woodcock-Johnson Tests of Achievement WJ-III Ach., 3 ed.), Wechsler Intelligence Scale for Children (WISC-IV), Vineland Adaptive Behavior Scales – (2nd ed.), and Gilliam Autism Rating Scale (GARS) were the tools used to test the students. One of the findings from this study was that students were able to make progress when learning academic mathematics skills when taught by peer tutors.

Ansuategui and Miravet (2017) carried out a study on emotional and cognitive effects of peer tutoring among secondary school mathematics student. The findings revealed that peer tutoring was a dynamic, enjoyable strategy that encourages participation in mathematics and offers an alternative way to learn. This study made use of both the qualitative and quantitative approaches with the quasi-experimental design as the design used for this study. Out of 27 students with visual impairment, 18

University of Education, Winneba http://ir.uew.edu.gh

were selected for the study. The instruments used for the data collection included, questionnaire, interview, and observation. The researcher however recommended that peer tutoring should be adopted when teaching mathematics to secondary school students with disability because it is an appropriate cooperative learning method for working with mathematics. However, the results should be interpreted with caution. Kunsch, Jitendra, and Sood (2007) noted that during mathematics lessons, the use of peer tutoring as a strategy for involving students is effective in improving mathematics performance in students at risk for or experiencing mathematics disabilities, elementary aged participants, and mathematics computation content.

In another study, Parkinson (2009) investigated the effects of peer-assisted learning support on students' performance in mathematics and chemistry. Data were collected from 63 participants with the use of both the qualitative and quantitative approach through interview and questionnaire. The study revealed that, peer assisted learning was highly effective in improving student performance in the tutored subjects such as mathematics and in improving progression.

Similarly, Campit, Cayabyab, and Galas (2015) carried out a study on the effects of peer tutoring on achievement of students in discrete structures. The post-test control group experimental design was used in the study. Two intact classes were randomly assigned to experimental and control group and were subjected to a six-week treatment period. Valid and reliable researcher-made achievement test was used as the data gathering instrument. The findings from this study revealed that students who were taught with the help of peer tutors significantly performed better than those who were not. The researcher recommended that peer tutoring strategy should be used by mathematics teachers in order to improve the performance of their students in the subject.

University of Education, Winneba http://ir.uew.edu.gh

2.2.3 *Cooperative learning approach*

Aziz and Hossain (2010) defined cooperative learning as a teaching technique that assists students to learn together in groups to increase their level of learning with a lot of interest and motivation. Siegel (2005) also define cooperative learning as a learning situation where by two or more students learn together to complete a given task. In cooperative learning students learn to build rapport with other students (Sturz, Kleiner & Fernandez, 2005). Mwakyeja (2013) also added that cooperative group learning involves learners working together in small learning groups. This helps students to assist each other to carry out different tasks. It is a good strategy of teaching students with visual impairment, particularly in the mixed ability groups, (p.g. 26).

Also, cooperative learning provides opportunities for students with learning disabilities to practice various skills and concepts in mathematics in order to solve mathematical problems with their peers, use mathematical language to discuss concepts, and make connections to other skills and corrections (LDonline, 2014). According to Hooker (2011), collaborative learning in mathematics is a strategy that helps students to learn effectively during mathematics lessons. Gökmen (2009) carried out a study on the effects of cooperative learning on learning outcomes and reactions to training in an in-service training course. The study made use of the experimental research design. The data were gathered from 92 participants who were randomly selected from a government bank. The study revealed that cooperative learning appeared to be a method of instruction that is well suited to the needs of adult learners. Also, the participants learned better through cooperative learning method than individualistic learning method. Cooperative learning in mathematics, helps students to work together to achieve a common goal in a mathematical lesson (Nevin & Renne,

University of Education, Winneba http://ir.uew.edu.gh

2001). A study carried out by Pawattanaa, Prasarnpanicha, and Attanawong (2013) revealed that, with the use of cooperative learning as a strategy in teaching mathematics, all students worked together to achieve a common aim. The study made use of the qualitative approach and a case study as a design. Thirty-six participants were used from whom data were obtained using a questionnaire, 10 lesson plans under cooperative learning on the topic of weight measurement, a test of learning achievement and observation and action evaluation. Johnson and Johnson (1986), cited in Mwakyeja (2013) noted that cooperative learning amongst students with special needs, including those with visual impairment in inclusive classrooms, has been seen to be very effective in promoting academic achievement, positive attitude towards the students with special needs, and improving social interaction among the students.

Furthermore, a study conducted on the use of cooperative learning in a sixth-grade mathematics classroom by Andersen (2009), revealed that, students became more engaged and excited, less disruptive, and more willing to participate when cooperative learning groups were used in mathematic classes. This study was an action research study in which the data were obtained from 19 students through questionnaire and interview. Again, the study revealed that, using cooperative learning groups in mathematics classes helped the students to think more deeply. Gezahegn (2007) stated that in learning mathematics, the use of cooperative learning is advisable because it helps students to better understand concepts and skills, and also helps students to be more active by participating in mathematics problem-solving activities with classmates, which helps them to understand how to solve the problem correctly.

Another study conducted by Kodisang (2015) revealed that teachers use strategies such as cooperation, discussion and problem-based approach to teach probability to students with visual impairment. Data were obtained from 3 teachers

University of Education, Winneba http://ir.uew.edu.gh

from 3 different schools through the use observation and semi-structure interview. The main purpose for this study was to find out the approaches teachers use to teach mathematics to grade six primary pupils. The study made use of a qualitative research with a case study as the main design.

2.2.4 *Use of manipulatives*

Another strategy for teaching mathematics is the use of manipulatives (Moore, 2012). Moyer-Packenham (2001) defined manipulatives as objects which are designed to represent clearly and concretely mathematical ideas that are intangible. Also, Bouck (2010) added that mathematics manipulatives are physical objects that students can work with in order to explore and build on the understanding of mathematical concepts. Moyer-Packenham noted that, manipulative materials, which are both in the visual and tactile forms, can be manipulated by learners through hands-on experiences. Moore added that, the use of manipulatives is very effective in teaching mathematics since it allows children to have hands-on learning experiences.

Sullivan (2005) conducted a study on teaching mathematics to three participants and found that students understood mathematical concepts better when the concepts were presented through demonstration combined with manipulatives and pictorial representations.

The main reason for allowing children who are blind to explore tactile objects is to help them have identified objects in a fast and reliable manner (Argyropoulos, 2002). Leuder (2016) stated that the use of mathematical manipulatives, which often require processing of the exact spatial structure, in contrast to the perception of outstanding features needed for identification, help children who are blind in identifying mathematical concepts quickly. Leuder further noted that, tactile materials,

University of Education, Winneba http://ir.uew.edu.gh

such as raised-line drawings and manipulatives, must be used with acoustic material for children who are blind. Bryant, Bryant, Kethley, Kim, Pool, and You-Jin (2008) added that in teaching mathematics to students with disabilities, the use of mathematical manipulatives is very necessary.

According to Bouck, Satsangi, Doughty and Courtney (2013), the use of concrete manipulatives is one of the best strategies for teaching subjects such as mathematics to secondary students with disabilities. On this note Satsangi, Bouck, Taber-Doughty, Bofferding, and Roberts (2016) conducted a study on comparing the effectiveness of virtual and concrete manipulatives to teach algebra to three secondary school students with learning disabilities identified as having a learning disability in mathematics. An experimental design was used to guide this study. The study revealed that, with the use of concrete manipulatives students performed better. It was however recommended that special educators should take into consideration the best forms of manipulatives to use in teaching mathematics to secondary students, which is either the use of concrete or virtual manipulatives.

Finally, a study conducted by Goracke (2009) to investigate the use of manipulatives and its impact on students' attitude and understanding, with data obtained through survey and interviews, revealed that students enjoyed mathematics class more as a result of using manipulatives. Some of the joy came from the socialization with their peers, while more importantly, some enjoyment came from understanding.

2.3 Teaching and Learning Materials available for Teaching Mathematics to Students with Visual Impairment

University of Education, Winneba http://ir.uew.edu.gh

Some of the compensatory skills for students who read **B**raille are their knowledge in the use of an area of mathematics which includes their knowledge of literary Braille and, use of a Cranmer abacus, braillewriter, or talking calculators (Robinson, 2004). According to Simalalo (2006), students with visual impairment are more able if they are provided with appropriate tools during teaching and learning, especially during mathematics. Simalalo (2006) further mentioned graphing calculators, Taylor frames, Bennan slate, Cranmer Abacus, and scale drawing tools as some of the instructional materials used in teaching students with visual impairment.

2.3.1 *The use of talking calculators*

Calculators simplify students' interactions and understanding of mathematics and provide them feedback that can enhance the quick development of the concept of numbers (Bing & Redish, n.d.). One of the standard equipment used in teaching students with visual impairment is the talking calculator (Fraser & Maguvhe, 2008). The talking calculator view is a simple "talking" integer calculator with 4-operations, which is used for testing on approach by users who are visually impaired and who need audio feedback (Erenel & Bingol, 2016). Highly advanced listening skills may assist learners to access computers, electronic reading devices and talking calculators that can produce speech (Westwood, 2008), which mostly suggest numeric calculators help students develop algorithmic computation and problem-solving skills (Dunham, 2000). According to Supaloet al. (2007), students with visual impairment face many challenges in practical courses such as science. This, according to the authors, is because the courses need observation and manipulations where vision is mostly used. These practical courses may also include mathematics.

University of Education, Winneba http://ir.uew.edu.gh

Simalato (2006) conducted a study on the challenges of teaching and learning by pupils who were visually impaired in Zambia. The researcher used both the qualitative approach and the quantitative approach and a survey design. With the convenient sampling technique, 60 participants, made up of 4 trainers of special education teachers, 40 pupils with visual impairment, and 16 mathematics teachers were selected from four schools for the study. Questionnaire, observation and focuses group discussions were used as the instruments for collecting data from the participants. The findings revealed that tools such as talking calculator were not available in teaching mathematics to students with visual impairment in the school. The researcher recommended that the teachers should learn to use teaching aids such as talking calculators in teaching mathematics to students who are blind.

Moreland (2015) also conducted a study on science for students with visual impairments and accessible technologies. The purpose of the study was to investigate the attitudes, perceptions, and knowledge of assistive technology used by science teachers of visually impaired students and how they were incorporated in the classroom. The study was a quantitative study where questionnaire was used to collect data from 81 teachers teaching science to students with visual impairment in Atlantic State. It was revealed that teachers were not trained in using talking calculator for teaching science to students with visual impairment.

2.3.2 *The use of Abacus*

According to Csocsán and Sjöstedt (n.d.), an abacus is a rectangular-shaped device with varied columns and number of beads that can be used for calculations, and can be used for addition, subtraction, division and multiplication of numbers. Csocsán

University of Education, Winneba http://ir.uew.edu.gh

and Sjöstedt further added that, an abacus is not only a computation aid but a learning assistant that shows many mathematical contents and relationships. Csocsán and Sjöstedt explained that the abacus is specifically made for learners with blindness and has a layer under the beads for easy movement on the rods. This type of abacus is called the Cranmer abacus (Willing, 2017). The Cranmer abacus performs calculations that involve arithmetic that enables students to manipulate beads to represent numbers in base 10. According to fisher and Hartman (2005), beads on the Cranmer abacus can be used to represent quantities in problems involving whole numbers, decimals and fractions. Eltinger and Ogleree (1980) cited in Ibrahim (2015) stated that, the use of abacus by the blind in solving mathematics is easier than using paper and pencil. One of the advantages of the Cranmer abacus may be that it is spaced and does not move rapidly, and as such they can be easily manipulated.

Willing (2017), noted that the Cranmer abacus is just like using paper and pencil to solve mathematics. Further, the Cranmer abacus teaches skills in mathematics that the talking calculator cannot teach because it teaches students processes that are best understood than the talking calculator. According to a study by Igun (2009), one of the support services students with visual impairment lacked in a school was the Abacus. Steinbrenner and Becker (1982) citing Robinson (2004) stated that there is insufficient training of teachers in the use of the abacus that helps in the development of more than minimal skill.

Robinson (2004) conducted a study on the perceptions and efficacy of training in compensatory mathematics skills among teachers of students with visual impairment. This study used a quantitative approach whereby data were obtained from 392 respondents, made up of certified teachers of students with visual impairment in Texas. The result of the study revealed that the teachers have been taught in the use of abacus

University of Education, Winneba http://ir.uew.edu.gh

for them to effectively teach students with visual impairment. However, Cranmer abacus was mostly not used in teaching mathematics to students with visual impairment. The researcher recommended that more programs should be organized to educate teachers

Again, a study conducted by Fox (2012) revealed that Cranmer abacus was one of the least tools used for teaching mathematics to students with visual impairment in the school where the study was conducted. Erin (2003) recommended that the Cranmer abacus should be used by teachers in teaching mathematics to students with visual impairment.

2.3.3 *The use of Braille Nemeth Codes*

The California State Board of Education (2006) stated that the teaching and learning of mathematics in a tactile mode is very important to children who are blind just like how teaching and learning of print mathematics is important to children who are sighted. Yet, students find it very difficult to learn to use the Nemeth Code at their lower level of education. This might be due to one of the findings of the study conducted by Simalato (2006) on the challenges of teaching and learning by pupils with visual impairments in Zambia that most teachers found it challenging to teach mathematics to students with visual impairment because most of them did not have knowledge in the use of Nemeth code and Braille mathematics. Yet, The California State Board of Education (2006) noted that students with visual impairment mostly pick up the use of the Nemeth code in solving mathematics problem in their higher level of education.

A study conducted by McDermott-Wells (2015) revealed that all four students with visual impairment who were assessed on how they used the Nemeth Braille code made a lot of errors.

University of Education, Winneba http://ir.uew.edu.gh

2.4 Challenges Students with Visual Impairment face in Learning Mathematics

Students with visual impairment in regular secondary schools and classrooms go through many challenges, which affect their academic pursuit (Okonkwo, Fajonyomi, Omotosho, Esere, & Olawuyi, 2017). Making mathematics accessible to learners who are blind is a challenging and difficult process (Karshmer, & Bledsoe, 2002). Cowan (2011) found that students with visual impairments struggled in various areas of their mathematics education. Although there are challenges in mathematics for students with visual impairment, there are also areas of mathematics in which students with visual impairment have been shown to outperform their sighted peers. According to Karshmer and Bledsoe (2002), one of the challenges students with visual impairment face when engaging in mathematics is lack of teachers' knowledge in teaching Braille mathematics notations.

2.4.1. *Inadequate teaching and learning materials*

Teaching materials mostly help support students learning and increase their success (Rights, 2017). The author added that learning materials are very necessary because they significantly increase students' attainment by supporting students learning. The use of appropriate teaching and learning materials during mathematics lessons helps improve on students understanding. According to Sahin and Yorek (2009), students with visual impairment can perform just like their sighted colleagues when equipment are modified, and they are able to have access to information easily. Yet, Mwakyeja (2013) noted that, the findings from a study conducted by Kisanji (1995) in Tanzania revealed that, suitable materials for teaching students with disabilities were limited in regular school.

University of Education, Winneba http://ir.uew.edu.gh

Again, a study conducted by Grönlund, Lim, and Larsson (2010) on the effective use of assistive technologies for inclusive education in developing countries: revealed that teaching and learning materials for students with special needs were lacking. A case study approach was adopted for the study. Observation and interviews were used as the main instruments for collecting the data from 44 participants from two countries in Africa.

Furthermore, Mugambi (2011) conducted a study, which sought to find out whether teachers were adequately trained to teach students with visual impairment. The researcher adopted the exploratory approach with the use of the descriptive survey design. The study sampled 47 teachers out of 63 teachers at Moi by asking them to complete a questionnaire for the study. The findings revealed that; special materials used for teaching students with visual impairment in the school were limited.

2.4.2 *Poor teachers' knowledge in teaching mathematics to the blind*

For an effective education of students, teachers need to be highly trained in order to obtain the necessary knowledge and skills. That is, they need to gain academic qualification, professional training, be committed and dedicated (Mugambi, 2011). Zheng (2014) noted that, most teachers in regular schools lacked the necessary knowledge and skills for teaching students with visual impairment. Kovács (2000) added that, this might lead to negative attitudes towards students with visual impairment, which mostly make it difficult for students with visual impairments to stay in regular schools.

Maguvhe (2015) conducted a study on teaching science and mathematics to students with visual impairment. The purpose of the study was to find out the factors that limit the participation of learners who are blind and partially sighted in mathematics

University of Education, Winneba http://ir.uew.edu.gh

and science education. A qualitative approach with a case study was used for the study. The study made use of one student with visual impairment in one of the schools in Kenya. A semi-structured interview was used to gather the data from the student. The study revealed that, teachers lacked the necessary skills that were needed in teaching mathematics and science to the student with visual impairment in the school.

Zheng (2014) conducted a study on the experiences that students with visual impairments had regarding availability and nature of support in schools. Three students with visual impairments, who were participants in this study responded to items on a semi-structured interview. The findings of this study revealed that, teachers in the school lacked training and therefore had little knowledge and skills in order to support students with visual impairment in the school. In another study, Sansrisna (2017) investigated teachers' beliefs in practicing inclusive education in elementary schools in Banda Aceh. The researcher used qualitative approach and case study design and a semi-structured in-depth interview to collect data from six teachers. The findings revealed that most teachers were trained in special education to teach all subjects and therefore the schools did not lack trained teachers.

2.5 Adaptations in Teaching Mathematics to Students with Visual Impairment

Mani (1998) pointed out that, for students with visual impairment to perform well in the general classroom, resource teachers and regular classroom teachers, can make changes in the presentation of materials to suit the needs of their students. Accommodations, in the form of adaptations, occur when teachers differentiate instruction assessment and materials in order to create a flexible learning environment (British Columbia Teacher's Federation, 2009). Various adaptations can be made to

University of Education, Winneba http://ir.uew.edu.gh

mathematics to effectively include students with visual impairment in mathematics lessons (Willing, 2017).

2.5.1 *Use of differentiated instructional methods in mathematics*

Instructional adaptation deals with how teaching is done and how learning is demonstrated (Janney & Snell, 2000). Differentiation has a process of lesson design where the teacher varies approaches to content, process, and product in anticipation of and response to student differences in readiness, interest, and learning needs. One way of adapting an instruction is by differentiated instructions. In a differentiated classroom, more different ways can be used to complete a lesson that exists under any given topic (Koeze, 2007). According to Mulder (2014), differentiated instructions emphasize the use of instructional adaptations and academic progress of teachers in general education classrooms. Roy, Guay, and Valois (2013) pointed out that, differentiated instruction has great impact on students' achievement., Specifically, it helps teachers to vary teaching and learning routines that can address readiness levels of learners in practical classes such as mathematics and science (Tomlinson, 2001).

Mulder (2014) conducted a study on the effect of differentiated instruction on student mathematics achievement in primary school classrooms in the Netherlands. Twenty-four four primary school teachers who were randomly selected and observed regarding how they taught mathematics to students with visual impairments. The results revealed that differentiated instruction had no statistically significant effect on students' mathematics achievement, which was against expectations before the beginning of the study. In another study, Lawrence-Brown (2004) found that differentiated instruction has a positive impact on students' level of understanding

University of Education, Winneba http://ir.uew.edu.gh

because students who struggle to master the curriculum at their grade turn to perform well when differentiated instruction is used.

Koeze (2007) also conducted a study on the effect of differentiated instruction on students' achievement in an elementary school in Michigan. The main purpose of this study was to determine if differentiated instruction or any component thereof, has a positive effect on student achievement. Both qualitative and quantitative research methods were used for this study. The study involved 7 teachers and 160 students. Results from this study revealed that, the use of differentiated instruments during mathematics challenged students to study harder, which further enabled them to improve on their achievement level.

Amadio (2014) also conducted a study on differentiated instructions in secondary mathematics. The researcher used a mixed methods approach with surveys and interviews as the primary tools for collecting the data. The survey consisted of questions with a rating scale. The study revealed that most secondary mathematics teachers in the schools believed that the use of differentiated instructions could have been effective, if it has not be the limited time and the structure of the curriculum. The researcher recommended that the school should give teachers time and additional professional development that can assist them in implementing effective and successful differentiated instruction.

2.5.2 *Adaptation made to instructional materials in teaching mathematics*

Edenfield (2010) noted that instructional materials are all the resources available in a school that teachers use for teaching. These materials are mostly found in the curriculum. These have to do with what the teacher is expected to teach, and the resources provided to achieve that goal. To help students with visual impairment in the regular classroom, teaching materials need to be adapted (Mwakyeja, 2013). The author

University of Education, Winneba http://ir.uew.edu.gh

added that adaptations of teaching materials becomes imperative, if they must learn all the things other students without visual impairment learn in the class. According to Igun (2009), suitable materials for teaching students with visual impairment provide them with tactile skills that help them to explore and describe activities being learnt and provide meaning to new knowledge.

Good performance by students in mathematics depends on teacher's knowledge and understanding of mathematics (Gwendolyn, 2008). Remillard and Bryans (2004) cited in Gwendolyn (2008) noted that when teachers adapt materials in mathematics, they mostly adopted mathematical tasks from the curriculum guides, but build on their own strategies and approaches to support them. Edenfield (2010) conducted a qualitative case study on mathematics teachers' use of instructional materials while implementing a new curriculum. The researcher randomly selected 21 high school teachers working together in writing lessons for teaching the Georgia Performance Standards (GPS) courses. Data were collected through interview, observation and field notes. The findings revealed that most teachers try to adapt the materials to suit students' needs during mathematics lessons through their own knowledge and approaches. In addition, Edenfield found that experienced teachers paired the tasks and the materials with their own approaches and teaching strategies.

Asempa (2013) conducted a study on adaptations for enhancing inclusion of pupils with disabilities in some schools in Ghana. The random sampling techniques were used to sample 90 teachers from the schools. The main instrument used for collecting data was questionnaire. It was revealed from the study that most of the instructional materials available for teaching students with disabilities in the schools were not adapted to meet the needs of students with disabilities.

University of Education, Winneba http://ir.uew.edu.gh

2.6 Summary of Literature Review

Chapter two reviewed related literature on approaches to teaching mathematics to students with visual impairment. The related literature was reviewed on instructional strategies for teaching mathematics to students with disabilities, especially those with visual impairment. the main issues reviewed include: (a) the use of explicit instructions; use of peer tutors, (b) cooperative learning, and (c) the use of manipulatives. The literature also revealed the various adaptations made to mathematics lessons to suit students with visual impairment in the regular classroom. These adaptations include the use of differentiated instructions and adaptations made to teaching and learning materials, and the use of Braille Nemeth Codes.

The literature further identified and described some challenges students with visual impairment face during mathematics lesson in the regular classroom. These include lack of teaching and learning materials and lack of teachers' knowledge in teaching mathematics to students with visual impairment. Finally, the issue of teaching and learning materials in teaching mathematics to teaching students with visual impairment was addressed. The literature, however, did not specifically highlight the approaches teachers use in teaching mathematics to students with visual impairment during mathematics lesson in senior high schools in Ghana, and Adidome Senior High School. This study was therefore set out to address this gap.

University of Education, Winneba http://ir.uew.edu.gh

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the methodology for the study. The areas covered are the research approach, research design, population, sample size, sampling techniques, instrumentation, validity and reliability, procedure for data collection, data analysis, and ethical considerations.

3.1 Research Approach

The study employed the qualitative research approach to explore the approaches teachers use in teaching mathematics to students with visual impairment at Adidome Senior High School. Shank (2002) defined qualitative research as a form of systematic experimental inquiry into a phenomenon. According to Denzin and Lincoln (2005), qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, a phenomenon in terms of the meanings people bring to them. Again, qualitative researchers investigate in-depth small distinct groups (McMillan & Schumacher, 2001).

Furthermore, qualitative researchers stress the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry. Such researchers emphasize the value-laden nature of inquiry. Denzin and Lincoln (2000) claim that qualitative research involves an interpretive and naturalistic approach. “This means that qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them” (p. 3).

University of Education, Winneba http://ir.uew.edu.gh

The qualitative approach was adopted for this study because it was the most appropriate approach that could provide comprehensive and orderly information concerning the problem identified by the researcher.

3.2 Research Design

The researcher adopted the case study design for this study. Robson (2002) defined case study as a strategy for doing research which involves an empirical investigation of a contemporary phenomenon within its real-life context. Cresswell (2003) also regards case study as that in which the researcher explores in-depth a program, an event, activity, a process, or one or more individuals. This study employed case study as a research strategy to explore the approaches teachers use in teaching mathematics to students with visual impairment within its real-life context using semi-structured interview guide. The researcher`s choice of this study design is informed by the fact that case study is the approach that will easily help her arrive at the answers to the research questions posed.

The distinctive advantage case study has over other research approaches is that it helps find answers to how and why questions that are posed to discover a current phenomenon especially when the researcher has no control over events (Yin, 2003), and this has been found suitable by the researcher. Also, the researcher anticipated that, in the course of collecting data, certain unexpected findings may occur. This is because the researcher used semi-structured interview, which called for more unexpected answers. Case study is the best approach that can help explain the outcomes of the study (Denscombe, 2003), because it allows for an additional research question and explanation in the course of the study.

University of Education, Winneba http://ir.uew.edu.gh

In addition, the researcher found case study design appropriate because of its flexibility by allowing for further explanations from the original plan of study as compared to other qualitative approaches, such as grounded theory or phenomenology (Hyett, Kennedy, & Dickson-Swift, 2014). Stake (1995) posited that a case study is the study of the particularity and complexity of a single case. Hyett and colleagues again noted that cases are primarily people, but programs, communities, institutions and organizations can also be explored. The researcher again found case study suitable because it specifically explores in depth a program, an event and activity. It involves a collection of detailed information using a variety of data collection procedures over a sustained period as opined by (Stake, 1995). Case study researchers usually combine a variety of data collection methods such as interviews, observations and document archives to find answers to research questions as this ensures validation of data through triangulation (Denscombe, 2003). The researcher did a critical and an in-depth study of the case, particularly considering the challenges teachers face in the teaching of mathematics to students with visual impairment.

Although the objectivity of this design is questioned (Thomas 2003) because critics feel its generality to a larger population is difficult. The researcher clearly defined the boundaries around the phenomenon in relation to what to include and what not to include in accordance with the views of Stark and Torrenance (2005). With this, the researcher studied only one case of Adidome Senior High School in the Volta Region of Ghana on the approaches teachers use in teaching mathematics to the students with visual impairment in the school. This study focused on the investigation of the available teaching and learning materials used in teaching the students.

University of Education, Winneba http://ir.uew.edu.gh

3.3 Population

Research population is any field of inquiry which involves a complete enumeration of all items in the inquiry, and this is also known as a census inquiry (Kothari, 2004). The population for the study was 29 comprising 21 students with visual impairment, 5 mathematics teachers, and 3 resource teachers. Table 1 shows the distribution of the population.

Table 1: Distribution of Population

Participants	Number
SHS 1 students	5
SHS 2 students	6
SHS 3 students	10
Mathematics teachers	5
Resource teacher	3
TOTAL	**29**

3.4 Sample size

The sample size for the study was 19 respondents comprising 16 students with visual impairment, 2 mathematics teachers and 1 resource teacher at Adidome Senior High School. The 16 students with visual impairment were sampled because they had been in the school for over a year and had experienced the teaching and learning of mathematics in the school. Two teachers were also selected because they were in charge of teaching mathematics in the class that included students with visual impairment. Again, one resource teacher was selected because only one resource teacher was in

University of Education, Winneba http://ir.uew.edu.gh

charge of assisting students with visual impairment in mathematics lessons. Table 2 shows the sample distribution for the study.

Table 2: The Sample Size the study

Participants	**No.**
SHS Two students	6
SHS Three students	10
Mathematics teachers	2
Resource Teacher	1
Total	**19**

3.5 Sampling Technique

The researcher used the purposive sampling technique to select the participants for the study. The mathematics teachers and the resource teacher were purposefully chosen because they were taught students with visual impairment in the school. Again, the students were also chosen purposefully because they were the focus of the study. Avoke (2005) contended that in a purposive sampling technique the researcher handpicks the cases to be included in the sample based on their judgment of typicality. Fraenkel and Wallen (2009) also explained that purposive sampling technique is a technique in which researchers use their judgment to select a sample that they believe, is based on prior information. To draw a purposive sample, a researcher begins with specific perspectives in mind that he or she wishes to examine and then seeks out research participants who cover that full range of perspectives. Some scholars argue that purposive sampling techniques are more suitable for studies located within the

University of Education, Winneba http://ir.uew.edu.gh

qualitative framework than studies that fall within the quantitative framework (Creswell, 2005, 2012; Gall, Gall, & Borg, 2007; Kusi, 2012).

3.6 Instrumentation

The instruments were a semi-structured interview guide in the form of face-to-face and focus group interview to collect the data.

3.6.1 Semi-structured interview guide

The interview questions were prepared based on the key themes raised in the questions. According to Avoke (2005), interviews can be described as a form of conversation between two people. A semi-structured interview guide was used because it allows for deeper probing of issues from respondents on the research questions.

3.6.2 One-On-One interview.

The researcher used one-on-one interview to gather information from the teachers and the resource person for students with visual impairment. According to Creswell (2005) one–on-one interview is perfect for gathering information from participants who are willing to express themselves and can share ideas comfortably without disruptions from any other person. Furthermore, due to the limited number of teachers and resource persons teaching mathematics in the school, the researcher thought it wise to interview them on one-on-one basis to obtain accurate information.

3.6.3 Focus group interview

University of Education, Winneba http://ir.uew.edu.gh

A focus group interview was used as one of the instruments for collecting the data. The focus group interview was used to generate the information from the respondents on the approaches teachers' use in teaching mathematics to students with visual impairment, and to obtain general background information about the topic under study. This instrument enabled the researcher to gather data from different sources, which enhanced the investigation. Fraenkel and Wallen (2009) noted that an interview is one of the main techniques used to collect data in qualitative research. In the interviews, the researcher included probes and prompts to aid further exploration of his own line of questioning. The probes and prompts helped to explore and develop views of respondents and to prevent respondents from going off the main line of questioning (Rodgers, 1999).

The interview questions were guided by the themes raised in the research questions such as (a) strategies that teachers use in teaching mathematics to students with visual impairment at the Adidome Senior High School, (b) teaching and learning materials used in teaching mathematics to students with visual impairment in the school, (c) challenges teachers face when teaching mathematics to students with visual impairment, and (d) adaptations that teachers make in teaching mathematics to students with visual impairment in the school.

3.7 Trustworthiness

Vanderstoep and Johnston (2009) explained an instrument is trustworthy if it has the ability of measure what it is intended to measure. Content validity was adopted to ensure the validity of the interview items. In this regard, the semi-structured interview items were developed to cover the key themes raised in the research questions. Macmillan and Schumacher (2012) indicated that participants' in-depth

University of Education, Winneba http://ir.uew.edu.gh

interviews need to be conducted in natural settings to reflect the reality of life experiences more accurately than do laboratory settings. In this study, therefore, the focused group interviews were conducted in the natural setting of the participants, which is the resource centre for students with special needs in the Adidome Senior High School.

3.8 Dependability

According to Creswell (2012), dependability means that scores from an instrument are stable and consistent. Creswell further indicated that scores should be nearly the same when researchers administer the instrument multiple times at different times. To ensure reliability of the interview items, the researcher asked three peers to review the entire data collection instrument, to detect ambiguities and weaknesses in the items for corrections and modifications. The researcher then gave the peer-reviewed instrument to the researcher's supervisor for judgment, suggestions, and approval, after which the final instrument was prepared.

3.9 Transferability

This relates to the extent in which study findings can be applied in a wider context (Shenton, 2004) or used in different situations (Yin 2014). I will provide adequate and relevant information on the context in which this study is conducted so that any interested researcher or reader can determine the areas which relate to their context and whether these apply to situations that they have or intend to research.

3.10 Confirmability

It focuses on the subject of researchers' objectivity. I will reduce biases as much as possible by employing a reflexive approach to data interpretations. I will present

University of Education, Winneba http://ir.uew.edu.gh

transparent views of data collection and analysis procedures. Undoubtedly, the in-depth research design of my study will also help to achieve confirmability.

3.11 Procedure for Data Collection

As a characteristic feature of a case study, the data collection process in the study employed a multiple data collection, which further helped in developing and enhancing a clear understanding of the case (Stake, 1995). Data for the current study were collected through the following procedures:

As part of protocol and ethical considerations, the researcher first visited the school of the participants. This visit was to explain the purpose of the study to the participants. Participants were also assured of the necessary confidentiality of information to be gathered and booked appointments with them.

According to Creswell (2012), the site where a research takes place is important and must be respected. The researcher sent an introductory letter from the Department of Special Education, UEW to the school for permission to collect the data. Two sets of data were collected; one set from student participants and the other set from the resource teacher and the mathematics teachers. Students were grouped according to their grade level to gain the cooperation of the focus groups. The focus group interview was held at the Resource Centre in the school. The Resource Center is a place where the students are familiar with since that is where they receive assistance from their resource teachers. The interview was held after school hours and did not interfere with students' academic work. Additionally, two sets of focus group interviews were conducted. In each of the groups, the interview guide was used to direct the interviewer.

The interview guides were made up of questions based on effective strategies reported in the literature that teachers use in teaching mathematics to students with

University of Education, Winneba http://ir.uew.edu.gh

visual impairment, the teaching and learning materials used in teaching mathematics to students with visual impairment, challenges teachers face in teaching mathematics to the students with visual impairment, and the adaptations that teachers make in teaching mathematics to students with visual impairment. Each interview session lasted between 45 minutes to 60 minutes. Responses were audio recorded by a trained colleague of the researcher. This was done to help the researcher remember details of the information collected during the interviews. Responses from focus groups were audio taped, in order to remember each group, numbers were assigned to them to avoid difficulty in discriminating among the voices of individuals in the group.

The researcher requested that each participant mentioned his or her number before responding to a question to enable the researcher to differentiate among the students. The interview was based on the four research questions. The recorded interviews were played back to the students to confirm whether what they said were exactly what has been audio recorded. The resource teacher and the mathematics teachers were interviewed in the resource room of the school. Permission was sought from other teachers in the school in order to conduct the interview in the room.

3.12 Data Analysis

Analyzing qualitative data requires understanding of how to make sense out of text and images so that one could form answers to research questions (Creswell, 2005). The data were analyzed qualitatively using narrative themes from the interview data recorded and transcribed. Transcripts of the focus group interview data were given codes such as Group 1, Group 2, Group 3, Group 4 and Group 5 for identification of responses from the various groups. Fraenkel and Wallen (2009) noted that the first step in coding data is to assign identity numbers to every group from whom data has been

University of Education, Winneba http://ir.uew.edu.gh

collected. According to Bogdan and Biklen (2007), coding allows for the categories and patterns emerging from data to be decided in advance and facilitates the interpretation of smaller units since the analysis begins with the researcher reading all of the data to gain the sense of the whole.

3.13 Ethical Considerations

Ethical considerations are very essential in conducting any type of research with human subjects to protect the wellbeing and rights of research participants (Kimmel, 1996). To ensure that participants' health, safety, respect, and fidelity is sustained, the researcher sought for verbal consent of participants; that is, students with visual impairment in Adidome Senior High School, and their mathematics teachers and resource teacher to participate in the study. The researcher explained to the participants that their names will not be needed in the course of data collection to assure them of confidentiality. Prior to the interview sessions, the researcher explained the purpose of the study to the participants and assured them of their rights as voluntary participants who could withdraw from the study whenever they deemed it necessary. In addition, the researcher sought the permission of participants to tape record the interview session in order to capture detailed data while concentrating on listening and prompting participants.

University of Education, Winneba http://ir.uew.edu.gh

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF FINDINGS

4.0 Introduction

This chapter presents the results and analysis of findings. The chapter presented and analyzed data generated from the one-on-one interview conducted with the mathematics teachers and the resource teacher and focused group interviews conducted with the students with visual impairment. The analysis reflects themes that emerged from the data under the main variables of the research questions.

4.1 Result

4.1.1 Research Question One: What strategies do teachers use in teaching mathematics to students with visual impairment at Adidome Senior High School?

Four themes emerged from the analysis of data collection. These included the use of explicit instructions, use of peer tutors, cooperative learning and use of manipulatives as strategies in teaching mathematics to students with visual impairment.

Use of explicit instructions

The interviews conducted by the researcher with the teachers and students revealed their thoughts on the use of explicit instruction by teachers in the teaching of mathematical concepts to students with visual impairment. Explicit instruction is making a concept simpler for the learner to be able to understand it easier. It could be breaking down of the instruction into bits, step-by-step instruction, and it goes beyond just verbalizing it but explaining the concept over and over.

University of Education, Winneba http://ir.uew.edu.gh

Teacher A commented this way:

> *Actually, I do so, as I start the lesson, if I realized that when I say it they will actually hear. So, I say it verbally loudly for them to hear. Except those that involve diagrams. But those that involve numbers, I mention the numbers for them to hear it. But because they can't see I find it difficult to break the steps down for them to understand.* (A verbatim expression by one teacher).

Teacher B noted this:

> *What I normally do is that, I give little more details for the students to understand since they can't see from the board. When I'm teaching say indices, if you want to use a word like division which you use "over" inter changeably, So you may have something like division and over in the same question so you need to be able to mention them separately, so let's say 2 over 3 is different from 2 divided by 3.* (A verbatim expression by another teacher)

From the comments, above it clear that the teachers used this strategy to some extent and were doing their best for the students with visual impairment to carry along in the teaching and learning process. In reverse, the students seemed not benefiting from this type of strategy. The students were bitter about scanty instructions received from their mathematics teachers,

A student commented this way:

> *They teach us anyhow. They teach us as normal students. Like students who are sighted. Sometimes they forget that they have students with*

University of Education, Winneba http://ir.uew.edu.gh

visual impairment in the class. There is nothing like detailed explanations. We don't receive any special teaching in mathematics. (A verbatim expression by a student in group A)

Another student expressed this:

One thing concerning the mathematics is that, our way of learning is different. The visually impaired here are taught like the way sighted students are taught. (A verbatim expression by a student in group B

Another student added the following:

Mathematics is supposed to be taught systematically. I mean step-by-step. But we are not taught that way. They only verbalize everything making me so confused sometimes. Some of the teachers do not teach us to understand there is nothing like step by step teaching. (A verbatim expression by a student in group C)

From the data it was clear that explicit instructions were not used much during mathematics lessons. Though one of the teachers stated he uses it, most of the students and the second teacher stated it was not used. The students with visual impairment were taught just like the sighted students. They were not taught systematically for easy understanding. Making the student feeling they are not part of the class.

Use of peer tutors

Another theme that emerged during the interview was the use of peers as tutors during mathematics lessons: Peer tutoring is guiding a student who understands a

University of Education, Winneba http://ir.uew.edu.gh

concept better to teach his or her colleagues with guidance from the teacher. With this, his colleagues feel more comfortable and understand the concept better.

Teacher A stated that:

> *I sometimes use peers to assist the blind when I am teaching. Sometimes I do the arrangement such that every visually impaired will sit beside those who can see. When I give a question and I realized that they do not get it I ask the students who can see to assist them.* (A verbatim expression by one teacher)

Teacher B also added:

> *I mostly ask the students with visual impairment to contact their sighted friends for more explanations after my lesson.* (A verbatim expression by another teacher)

A student also noted:

> *Yes, they help in all other subjects except mathematics because they themselves find it very difficult to understand the mathematics, so they find it very difficult to help.* (A verbatim expression by a student in group A)

Another student added:

> *The only thing they do in assisting us in class is reading what is on the board. Sometimes I become very confused when they read to me. When*

University of Education, Winneba http://ir.uew.edu.gh

> *I came in the beginning there was a friend who was helping me in the mathematics, but she has also stopped because she also doesn't understand what the teachers have been teaching.* (A verbatim expression by a student in group B)

Another student added:

> *Sometimes when the teachers are teaching and there is a sighted student sitting beside you the sighted students will be explaining everything to you but apart from that the teachers do not break the instructions into bit. I think the friends can also be trained to assist us in mathematics as well. Sometimes when they explain things to us we understand it better than the teachers so I think it will be very helpful they are also trained*. (A verbatim expression by a student in group C)

According to the statements made by both the teachers and the students it was revealed that sighted peers sometimes assist the students with visual impairment. It was again revealed that the students understand the mathematics concept better when they are taught by their sighted peers.

Cooperative learning

Cooperative learning during mathematics lessons was another theme that was raised during the interview. This was where the students come together to learn on their own.

University of Education, Winneba http://ir.uew.edu.gh

With this the students were given a problem to solve within a stipulated time. During this section, they share their problems and learn to understand well. The teacher often grouped them according to their abilities and strength, it could be mis-ability or same ability.

For instance, teacher A noted this:

> *I have divided the class. I have grouped them and every in group there is a visually impaired in the group and some even get to understand the work I give them better and it is sometimes interesting. The assumption is that, go and be part of this group and work with them. So when I am judging, I judge everybody together so I think that is what I do* (A verbatim expression by a teacher).

Teacher B also remarked is way:

> *Hmm! ok, the group aspect, that one I don't do it. Why? The reason is that, you know when you put them in group, you know they have to see and read but because they cannot see, when you put them in group like that, they are not able to detect or follow what you are doing* (A verbatim expression by another teacher).

A student commented this way:

University of Education, Winneba http://ir.uew.edu.gh

> *We mostly learn in groups during mathematics lessons. One of our teachers even has given all of us a permanent group where we do a lot* (A verbatim expression by a student in group A).

Another student emphasized the following:

> *When the teachers are teaching they sometimes put us in groups for easy understanding* (A verbatim expression by a student in group B).

In the view of another student, this emerged

> *One thing I enjoy most is when we are asked to solve mathematics in group. I get the opportunity to ask my friends questions. This helps me to understand some of the concepts better* (A verbatim expression by a student in group C).

From the above comments, it was clear that teachers made use of cooperative learning as a strategy during mathematics lessons for students with visual impairment. Almost all the students commented that some of the teachers put them in groups during mathematics lessons. This helps them get the opportunity to ask the questions that are bothering them. It also helps them understand concept better and students seem to prefer this type of teaching strategy.

Use of manipulatives

University of Education, Winneba http://ir.uew.edu.gh

Concerning the use of manipulatives, the results of the interview data analyzed revealed that manipulatives were not used in teaching mathematics to the visually impaired in the classroom. This is a strategy whereby the teacher gives a variety of materials for the students to manipulate to come out with his or her own ideas and understanding concerning a topic under discussion.

Teacher A made this comment:

> *Oooh! we don't have things here, so we also don't use them in teaching. What we have are for only the students who can see.* (A verbatim expression by a teacher)

Teacher B also remarked:

> *The government has not provided us with the things to help in teaching mathematics to the blind, students who can see have a lot of materials, but the blind don't have*. (A verbatim expression by another teacher)

A student said:

> *There are no materials for us. We go to the classroom empty handed and come back empty handed.* (A verbatim expression by a student in group A)

Another student added:

> *We don't use those manipulatives in class. This makes it very difficult for us to understand some of the concepts. Because we don't have these*

University of Education, Winneba http://ir.uew.edu.gh

materials, I don't enjoy the class at all. I even wish I will stop the mathematics class. (A verbatim expression by a student in group B)

Another student commented this way

I for instant some of the things they use to mention I have I don't know. I always feel rejected in class, if you want to ask a question the teacher will tell you wait but will never attend to you. (a verbatim expression by a student in group c)

The comments from both the teachers and students indicated that, there is nothing like using manipulatives during mathematics lesson as an approach. This makes it difficult to grab the understanding and making the study of mathematics boring. The students don't even enjoy the classroom.

4.1.2 Research Question Two: What teaching and learning materials are used in teaching mathematics to students with visual impairment in the school?

The research question two, elicited information from students with visual impairment, their teachers and a resource person regarding the use of teaching and learning materials, in teaching mathematics to students with visual impairment. Some of the themes that emerged from the findings were; the use of teaching and learning materials such as talking calculators, abacus and Nemeth codes in making the learning of mathematics easier.

University of Education, Winneba http://ir.uew.edu.gh

The use of talking calculators

This is a specially made calculator for students with visual impairment. It has a speech for easy manipulation.

Teacher A said:

> *I never knew there is something like talking calculators for students with visual impairment. When they are solving mathematics, they use any calculator. It is a very big challenge when it comes to solving mathematics during exams. So, as I have said I don't use anything like talking calculators in teaching them.* (A verbatim expression by a teacher)

Teacher B commented:

> *Talking calculator? I have not heard or seen it before. When I am teaching, I don't teach them with calculators. It is only the sighted students who bring calculators to the class. But I think it is the student's responsible to bring a calculator to the class. It is not the responsibility of the teacher to tell them to bring calculators to the class. Well I think maybe we don't have such calculators in the school, maybe that is why they don't have them.* (A verbatim expression by a mathematics teacher)

The resource teacher added:

University of Education, Winneba http://ir.uew.edu.gh

No, at time the talking calculator is only for addition. But they are not enough. The calculators available are just market calculators. It is there I can even give you one to see. It is also not all that strong. When I give it to them, and they are not able to use it then I take it back. (A verbatim expression by a resource teacher)

One student also stated:

Teaching and learning materials are not used during mathematics lessons. We have a talking calculator, but they are not the advanced or the scientific ones. It cannot be used in solving mathematics at the senior high school level. So, I will say we don't have talking calculators. (A verbatim expression by a student in group A)

Another student also stated:

We don't have scientific talking calculators, so we don't use them during mathematics lessons not even during exams. (A verbatim expression by a student in group B)

A third student emphasized:

The calculators that we use that are in the system are not for the blind. The kind of calculators, students with visual impairment use are mostly not in Ghana. They mostly are found in the developed countries not here. Can you imagine doing mathematics without calculators in the senior high school level? It's not easy at all. Sometimes, some of us just go to the class room just listen to what the teachers are saying because

University of Education, Winneba http://ir.uew.edu.gh

whether we like it or not, we will write mathematics exam during WASSCE. (A verbatim expression by a student in group C)

It is evident from the remarks made by the respondent that, there are no scientific or talking calculators for helping students with visual impairment to solve mathematics questions. From the responses made by the teachers it was clear that the teachers do not have any idea what talking calculators are. This makes the solving of mathematical problem very difficult for the students with visual impairment in the school.

The use of Abacus

Questions were asked on the use of Abacus as a teaching and learning materials, for teaching students with visual impairment.

Teacher A noted:

Is it used for calculations in mathematics? I have never heard of that one too before. Hmm you see, all these are even new to me if not today I have never heard that the blind use something like that for calculations. We don't have it, so I don't use it during mathematics lessons. (A verbatim expression by a teacher)

Teacher B stated:

I don't use abacus during teaching. The school lacks all these materials. (A verbatim expression by another teacher)

The resource teacher also added:

University of Education, Winneba http://ir.uew.edu.gh

We don't have the abacus here at the center. I think abacus is used at the basic level. I don't think it will be useful or if I should say helpful here. (A verbatim expression by the resource teacher)

A student remarked:

There are no abacuses. More so if there should be abacus we cannot use it to solve most of the questions at this level. I don't know why we are even doing mathematics here. Not even a single teaching and learning materials for us. (A verbatim expression by a student in group A)

Another student noted:

We don't have abacus in this school. So we don't even use them during mathematics lessons. (A verbatim expression by a student in group B)

A student again stated:

*We don't use any Abacus in solving mathematics questions. There are no abacuses at the resource center. I don't even think the teachers are aware of that***.** (A verbatim expression by a student in group C)

From the above comment, it is very clear that Abacus was not used during mathematics lessons. Because this material is not available at the resource centre they don't have access to it. The comments made by the teachers prove that, they are not even aware of such a material being used by students during mathematics lessons. The students further argued that the abacus cannot be used in solving all the questions.

University of Education, Winneba http://ir.uew.edu.gh

The use of Nemeth code

Another theme that emerged under the kind of TLM used for teaching mathematics has to do with the use of Nemeth codes in mathematics.

Teacher A emphasized:

> *I don't use anything of that in teaching mathematics to the students with visual impairment. As I said earlier, I don't use any TLM in teaching the students. and most of the things you are mentioning, I have never seen them before.* (A verbatim expression by a teacher)

Teacher B also noted:

> *I have not received any training in teaching with things like that. Even if not today I never knew of anything of that sort. But I don't think those Nemeth are common here in Ghana.* (A verbatim expression by another teacher)

The resource teacher also added:

> *We don't teach the students how to solve the mathematics with Nemeth codes. First of all, we don't have any idea about it and secondly, I don't think we have it here in Ghana.* (A verbatim expression by the resource teacher)

A student said:

University of Education, Winneba http://ir.uew.edu.gh

Oooh we don't use them during mathematic lessons. We don't even have it, so we don't use it. I heard about it before, but I don't know how it looks like. I have never seen it before. (*I don't know how to use Nemeth codes in solving maths. We have not been taught how to use it. We don't even have it at the resource centre.* (A verbatim expression by a student in group A)

Another student also added:

We don't have such materials in this school. I have heard of Nemeth code before, but I have never had the chance to feel it. I learnt it makes the solving of mathematics very easy for the blind. (A verbatim expression by a student in group B)

Another student again noted:

I have never heard of it and we don't have it. I think the teachers don't use these materials to teach us because they are not available. If they were to be available, the teachers would have been using them to teach us. (A verbatim expression by a student in group C)

It is clear from the analysis of comments of the students and teachers that the students were not taught how to use Nemeth codes for solving Maths. Some of the students and all the teachers do not have any idea about the Nemeth codes. Though some of the students admit they have heard of the Nemeth code before, they have never had the opportunity see or feel it. One of the students who have heard of it even noted

University of Education, Winneba http://ir.uew.edu.gh

that it would have been very useful since it makes the solving of Mathematics very easy among students with visual impairment.

4.1.3 Research Question Three: What Challenges do students with visual impairment face when learning mathematics in the school?

Mathematics teachers, resource teacher and students with visual impairment indicated that students with visual impairment faced the following challenges during mathematics lessons:

Teacher A stated that:

> *We face a lot of challenges in terms of teaching on our part and learning on the part of the students. First of all, we don't have any teaching and learning materials for the students with visual impairment. The sighted students have mathematics books, calculators and other learning materials that help them during mathematics lessons. But the students with visual impairment don't have all those things. Teaching and learning materials for the students are one of main challenges. Again, I have not been trained to teach such students, so I find it difficult to explain some of the concepts to them. Finally, most of the students are not serious at all. They are not ready to learn the mathematics.* (A verbatim expression by a teacher).

Teacher B added

> *Some of the challenges students face during mathematics lessons are the lack of teaching and learning materials and we not having much*

University of Education, Winneba http://ir.uew.edu.gh

idea about teaching students with visual impairment. The introduction to special education we had during our first degree is not enough. I think teachers should be specially trained in mathematics to teach the blind. (A verbatim expression by another teacher)

A student added:

One of my main challenges is that our teachers don't pay attention to us during mathematics lesson sometimes we just go and sit in the classroom without learning anything. (A verbatim expression by a student in group B)

From the comments of the teachers and one of the students, it was very clear that, some of the challenges students face, during mathematics lessons are lack of teaching and learning materials and teachers' inability to teach mathematics to students with visual impairment. Due to this, the teachers mostly end up paying little attention to students with visual impairment.

Lack of teaching and learning materials

In terms of lack of teaching and learning materials as a challenge below are the responds of the teachers and students

Teacher A said:

Erm…., actually like as you are teaching the whole class you have them in mind, so when you are explaining a concept and you say it verbally. And then when it comes to sketch or diagram then how to let them get that one is the problem and challenge because they have to see it and

University of Education, Winneba http://ir.uew.edu.gh

they cannot and you have to get the materials but it not there. (A verbatim expression by a teacher)

Teacher B stated:

The unavailability of the teaching aids, and readily availability of textbooks in braille is a very big challenge here. So, I think the school needs more resource teachers, we have only one resource teacher helping them in mathematics. The materials for teaching are very few. (A verbatim expression by another teacher)

The resource teacher also added:

The material that will help us with teaching mathematics is also not there. But we as the resource teachers are ready to support them to learn them. As I said earlier, we have some calculators but they are not advanced calculators for calculating mathematics at the senior high school level. (A verbatim expression by the resource teacher)

The resource teacher further noted that:

Our major challenges are lack of teaching and learning materials. Like they are going to do geometry, to produce those diagrams for them to also be part of the class is a problem. When we tell those at the headquarters to provide us with machines they claim the machines are too expensive but we try to produce it. To me they are not helping the system. (A verbatim expression by the resource teacher)

University of Education, Winneba http://ir.uew.edu.gh

A student added:

> *There are no teaching and learning materials to make the teaching understandable. So I have lost interest in the subject. Teaching and learning materials are very necessary for learning or solving mathematics*. (A verbatim expression by a student in group A)

Another student said

> *The main problem I have is the unavailability of the teaching and learning materials in the school to make learning easier. The unavailability of these materials, such as books and scientific calculators to make mathematics easy for us. Teachers teach verbally. There are absolutely, no teaching and learning materials in this school for us during mathematics lesson. No calculators, no books, there are no teaching learning materials.* (A verbatim expression by another student in group B)

A student again added:

> *One of our challenges is that math's without materials at this level is very challenging even those without visual impairment find it difficult to do mathematics how much more us. No, Madam, how do you expect us to solve mathematics without a calculator. Because of all these challenges all the inclusive senior high schools in Ghana don't do mathematics, I don't know why we are even doing mathematics. I think the tools necessary for teaching mathematics are not available. We don't have any teaching and learning materials. The ones available are*

University of Education, Winneba http://ir.uew.edu.gh

for the sighted they have calculators, books, maps, graph boards and so many other materials making them have more advantage over us. The learning of mathematics in this school is like wasting your time. The resources are not available and they expect us to learn and write the same exams with the sighted students. The school is not ready for teaching mathematics to the blind. Because of all these challenges, we don't even write the terminal examinations. (A verbatim expression by another student in group C)

From these comments it could be noted that there are no teaching and learning materials for students with visual impairment. This pose a very big challenge to both the teachers and the students. Because of these challenges the student didn't see why they should be allowed to take part in mathematics. After all by the end of the day the teachers end up concentrating on only the sighted students.

Lack of teachers' knowledge in teaching mathematics to students with visual impairment

Lack of teachers' knowledge in teaching mathematics to the blind emerged as one of the challenges the students face during mathematics lessons.

Teacher A said:

Oh we had some training but as you are with them you might face some challenges. You actually be thinking what other things you could do for them to also get as you are teaching the lesson. When I was in the

University of Education, Winneba http://ir.uew.edu.gh

university I did introduction to special education so I was taught how to handle students with disabilities. But that was not enough. I don't have much idea about teaching mathematics to blind students. I never knew I would even come and teach students with visual impairment. (A verbatim expression by a teacher)

Teacher B stated:

I have never been trained in teaching mathematics to students with visual impairment. I use my own skills in teaching them but it is not easy at all. When it comes to teaching them mathematics there is the need for highly qualified special mathematics teachers to teach students with visual impairment. I don't have much knowledge in teaching them. (A verbatim expression by another teacher)

One of the students stated:

The teachers teach us anyhow. They don't know how to teach to suit our understanding. The teachers teach the sighted students well but for us they don't teach well. I think the teachers are not trained. There should be teachers who are purposively trained in teaching mathematics to the blind. The teachers don't have any knowledge in teaching we the blind students. They were also trained to teach only the sighted students not us (A verbatim expression by a student in group A)

University of Education, Winneba http://ir.uew.edu.gh

Another student added:

> *Sometimes when the teachers are teaching they forget that they have such students in their classroom. They don't know how to teach us. They always talk to the board. There are no trained teachers to teach us mathematics***.** (A verbatim expression by another student in group B)

Another student added:

> *Some of the teachers are not trained in special education so they don't know how to treat us especially during mathematics lessons which make some of us go to the class without learning anything. They are not skilled at all in teaching us. They only concentrate on the sighted students. The teachers don't have any knowledge in teaching us mathematics.* (A verbatim expression by another student in group C)

The comments above shows that, the teachers are not trained in teaching students with visual impairment. Though one of the teachers has a little knowledge in special education (Introduction to Special Education). That knowledge gained was not enough to teach mathematics to the students with visual impairment. The students also stated that because the teachers do not have much idea in teaching the students with visual impairment, they end up not teaching the students well. Further due to the lack of knowledge and skills, the students find it difficult to follow whatever is being taught in class.

4.1.4 Research Question Four: What adaptations do teachers make in teaching mathematics to students with visual impairment in the school?

University of Education, Winneba http://ir.uew.edu.gh

The objective four dealt with the adaptations teachers make during mathematics lessons to suit students with visual impairment at Adidome Senior high school. Below are some of the responses the respondent gave to retrieve general information on the adaptation teachers during mathematic lessons.

Teacher A noted:

> *Ooh sometimes when I am teaching, I speak loud for the students to hear. I also teach step by step so that the students can follow. But apart from this, I don't do much because the materials are not available.* (A verbatim expression by a teacher)

A student added

> *No adaptations are made during mathematics lessons. We are taught anyhow. There is no special teaching for us. They don't use any different ways of teaching us.* (A verbatim expression by a student in Group A)

The themes identified from interactions with both the teachers and students regarding the adaptations made to the environment include, adaptations in terms of differentiated instructions in mathematics classes and adaptations made to the teaching and learning materials.

Use of differentiated instructions in Mathematics

Regarding the use of differentiated instructions as an adaptation to suit students with visual impairment during mathematics lesson,

University of Education, Winneba http://ir.uew.edu.gh

Teacher A said:

> *Yes, as I told you earlier, when I am teaching the mathematics, because I know I have such students in class, I teach step by step so that they can also understand. That is one of the things I do. So that they can also benefit.* (A verbatim expression by a teacher)

Teacher B also emphasized:

> *Teaching these students is sometimes very difficult. Sometimes I wish I was in the position to use different, different ways to make them understand but I don't have any option because the time for teaching mathematics is very limited.* (A verbatim expression by another teacher)

A student mentioned that:

> *There is no different way our teachers teach us. We are taught like sighted students. When we were at the basic school, our teachers had time for us but for here it is only the sighted students whom much attention is given when it comes to mathematics.* (A verbatim expression by a student in group A)

Another student stated:

> *Oooh there are no special ways teachers in this school teach us. We are taught just like the sighted. This makes the learning of mathematics so boring and not understandable. The teachers don't use any different*

University of Education, Winneba http://ir.uew.edu.gh

ways of teaching us mathematics. Me specifically because of this I don't perform well in mathematics. (A verbatim expression by another student in Group B)

From the comments above, it is clear that differentiated instructions were not used in teaching students with visual impairment. Apart from the teacher who stated that he task analyzed the instructions during teaching almost all the other respondents stated differentiated instructions were not used during mathematics lesson. According to one of the respondents this is because the time for teaching mathematics is very limited.

Adaptations made to instructional material in mathematics

This theme emerged as a challenge during the interview with the respondents. For example a teacher stated.

Teacher A noted:

Those topics that need adaptations it like I said I don't have teaching and learning materials so personally I exempt them from such topics like those that involve diagrams so that they will be in the class alright but I will tell them I will go through with them an example is plain geometry 2 such us cylinder, volume. (A verbatim expression by a teacher)

Teacher B noted:

University of Education, Winneba http://ir.uew.edu.gh

There are no materials to adapt so I don't do any adaptations to the teaching and learning materials. More so the teaching and learning for the sighted students cannot be adapted to suit the blind students. (A verbatim expression by the second teacher)

The resource teacher said:

Sometimes we modify their questions, we also replace some of the questions with other questions they easily answer. Those who completed here did very well in mathematics. Most of the students are from various backgrounds. So some too don't have the zeal to do the mathematics. And those who have the zeal are discouraged by their friends. (A verbatim expression by the resource teacher)

A student added:

There are no modification to suit us in mathematics. The teachers don't make any adaptations to suit us. (A verbatim expression by a student in group A).

A second student stated:

As we already said, there are no materials in the school for us. Those available are also for only the sighted which cannot be adapted. I don't

University of Education, Winneba http://ir.uew.edu.gh

think our teachers know how to do all these things. (A verbatim expression by another student in group B).

Another student again noted:

No, adaptation are made to the materials available during mathematics lessons. (A verbatim expression by a student in group C)

The comments from mathematics teachers, resource teacher and the students show that no adaptations were made to the teaching learning materials to suit students with visual impairment during s lessons. This is because the materials available are only for the sighted and cannot be adapted to suit the students. More so, the teachers do not have any knowledge in adapting materials to suit students with visual impairment in the class.

University of Education, Winneba http://ir.uew.edu.gh

4.2 Findings and discussions of results

The findings are discussed in line with the key themes raised in the interview guide and inferences made from the research question in view of findings from related previous studies.

4.2.1 What strategies do teachers use in teaching mathematics to students with visual impairment at Adidome Senior High School?

The data analyzed responses from mathematics teachers, a resource teacher and students with visual impairment concerning the strategies teachers used in teaching mathematics to students with visual impairment in Adidome Senior High School. Findings of the study revealed that teachers sometimes made use of approaches such as peer tutoring and cooperative learning when teaching mathematics to the students with visual impairment but did not make use of explicit instructions and manipulatives in teaching mathematics. This finding was in line with the findings from a study conducted by Peterson (2011), which found that effective instructional strategies used by teachers for students with disabilities included small group instruction, peer tutoring, and strategic instructions.

Regarding the use of explicit instructions as an instructional strategy used by teachers in teaching mathematics to students with visual impairment, it was shown that most of the teachers did not use this strategy in teaching the students, and this was because the teachers found it very difficult to explain the lessons into detail for the students to follow. This finding was in line with a statement made by (Zigmond, 1997, cited in Peterson, 2011), which stated that explicit instruction is very necessary in teaching students with disabilities including those with visual impairment; however,

University of Education, Winneba http://ir.uew.edu.gh

some professionals believe that this strategy is very complex and difficult in the general education classroom. Again, it was revealed that teachers did not use any specific steps in teaching mathematics to the students with visual impairment in the general classroom though Vaugh and Schumm (1995) stated clearly that general education teachers change their instructional methods slightly when students with disabilities are placed in their classrooms. It was further revealed that teachers only verbalized everything being taught in class making students very confused therefore preventing them from understanding whatever is being taught. This was contrary to Karshmer, et al. (n.d.) who stated that explicit strategies are used for making mathematics simple and understanding for students with visual impairment.

The use of peer tutors in teaching mathematics to students with visual impairment was one of the strategies used by teachers during mathematics lessons. It was revealed that sometimes sighted friends were asked to assist students with visual impairment during mathematics class. It was further revealed that if sighted peers are trained to assist their non-sighted peers, the latter finds it easier to understand the subjects. This was also in line with the findings by Bloyd (2015) which concluded that students were able to make progress academically when learning mathematics skills were being taught by peer tutors.

Cooperative learning was revealed to be used by teachers when teaching students with visual impairment mathematics in the school. Both teachers and students made it clear from their comments that students were sometimes put in groups during mathematics lessons for easy understanding of some concepts. This was also in line with a study conducted by Kodisang (2015) which revealed that teachers use strategies such as cooperation, discussion and problem-based approach to teach probability to students with visual impairment.

University of Education, Winneba http://ir.uew.edu.gh

With the use of manipulatives for teaching mathematics to the students, both students and teachers stated that manipulatives were not used in teaching them during mathematic lessons. The lack of these manipulatives made the teaching and learning of mathematics very boring and unenjoyable. This finding was contrary to a study conducted by Goracke (2009), which suggested that students enjoyed mathematics class more as a result of using manipulatives. Some of the joy came from the socialization with their peers, while more importantly some enjoyment came from the understanding of the concept**.** With this understanding the students with visual impairment can have a normal lesson just like their sighted as said by Wolf (1980).

Generally, the findings indicated that teachers made use of peer tutors and cooperative learning as strategies in teaching mathematics to students with visual impairment. And did not make use of explicit instructions and manipulatives as strategies in teaching mathematics to the blind.

Summary

In terms of the strategies teachers use in teaching mathematics to students with visual impairment, the findings from this study show that teachers at Adidome Senior High School did not use explicit instruction to explain mathematics lessons to the students with visual impairments. For example, the teachers did not task analyze their instruction to make mathematical concepts easier for the students; rather, they verbalized every step, which confused the students.

On the use of peer tutors in teaching, it was found that teachers made use of this approach when teaching mathematics to students with visual impairment. Though the sighted students were not trained, their colleagues with visual impairment understood them better when they taught them.

University of Education, Winneba http://ir.uew.edu.gh

Cooperative learning was another approach that teachers used for making mathematics lessons students with visual impairments understand mathematical concepts easily. This was mostly done in small groups where sighted students and students with visual impairment solved mathematics questions together. Regarding the use of manipulatives, it was found that teachers did not use manipulatives during mathematics lessons. This really could have negative effects on the students' understanding of mathematical concepts since they would not enjoy mathematics lesson as they should.

4.2.2 What teaching and learning materials are available in teaching mathematics to students with visual impairment in the school?

Data from both the teachers' and students' responses from the research question regarding the teaching and learning materials used in teaching mathematics to students with visual impairment in the school indicated that most teaching and learning materials such as talking calculators, abacus were not available for the teaching and learning of mathematics in the school.

Results of the interview by both teachers and students concerning the use of talking calculators as a teaching and learning material revealed that, though there were some talking calculators in the school, they were not the scientific ones that could be used to calculate the advanced mathematics. This finding was in line with Simalato (2006) who found that talking calculators were not available for teaching mathematics to students with visual impairment in the school where the study was carried out. Again, it was revealed that due to the lack of the talking calculators, students were not able to participate in end of term exams which further affected them during West African

University of Education, Winneba http://ir.uew.edu.gh

Senior School Certificate Examination (WASSCE), because even during WASSCE they do not use calculators.

Another finding was the lack of abacus in the school during mathematics lessons. From the comments of the respondents it was revealed that abacus was not available in the school. The outcome supports the findings of Fox (2012) that, Cranmer abacus was one of the least tools used for teaching mathematics to students with visual impairment in the school where the study was carried out. Again, the finding agrees with a study by Igun (2009) which revealed that it is one of the support services students with visual impairment lack in the school, the study was carried on abacus. Further, all the teachers did not even have any idea about what abacus for the visually impaired was all about which disagrees with a finding from a study carried out by Robinson (2004) which revealed that teachers have been taught in the use of abacus to teach students with visual impairment which improved on students understanding in learning mathematics.

From the findings, if these basic materials, such as talking calculators and abacus were used the students would have had the chance to take part in their end of term exams and West African Secondary Schools Certificate Examinations (WASSCE) without much challenge. This is what the normalization process theory is all about and has to do with ways by which new technologies, acting and working become routine embedded in people's everyday practice (Wolf, 1980).

Summary

In expressing their views on the teaching and learning materials used in teaching mathematics, it was confirmed that though there was a talking calculator in the school, it was not scientific calculator that could be used for computing advanced mathematical problems. This further affected the students during end of term examination and WASSCE since they do not use calculators during these examinations.

University of Education, Winneba http://ir.uew.edu.gh

It was also confirmed that a material such abacus was not available during mathematic lessons. Furthermore, teachers did not have any idea about abacus and, therefore, could not have used it to teach the students even if it was available in the school.

4.2.3 What challenges do students with visual impairment face when learning mathematics in the school?

In terms of the challenges students with visual impairment face when learning mathematics, it was revealed that there were limited teaching and learning materials for teaching students with visual impairment and lack of teachers knowledge in teaching mathematics to the students.

With the lack of teaching and learning materials, it was revealed that the school did not have enough teaching and learning materials such as, mathematics books, calculators and other teaching and learning materials used in drawing or during geometry lessons. Supporting these findings, a study conducted by Kisanji (1995) in Tanzania revealed that, suitable materials for teaching students with disabilities were limited in regular schools. Again, a study conducted by Grönlund, Lim and Larsson (2010) revealed that teaching and learning materials for students with special needs were lacking. Furthermore, Mugambi (2011) conduct a study which revealed that, special materials used for teaching the students with visual impairment in the school were limited. Due to the lack of these materials students wish they could stop the reading of mathematics in the school since they are even the only inclusive school in Ghana offering mathematics.

Lack of teachers' knowledge in teaching mathematics to students with visual impairment was also revealed to be one of the challenges the students face. From the

University of Education, Winneba http://ir.uew.edu.gh

comments made by the students, it was revealed that all the teachers who teach them mathematics did not have enough knowledge in teaching mathematics to students with visual impairment. One of teachers revealed that he had some knowledge in special education, but the knowledge was not enough in teaching students with visual impairment since he was not trained in teaching mathematics to students with visual impairment. This comment disagrees with the findings from a study conducted by Sansrisna (2017) which revealed that most teachers were trained in special education to teach all subjects and therefore the schools the study was conducted did not lack trained teachers. Again, the second teacher on the other hand did not go through any training which in turn affected the students with visual impairment since much attention was rather given to the sighted students. Also, due to the lack of knowledge and skills, the students find it difficult to follow whatever is being taught in class. These findings corroborate the findings of Zheng (2014) which found that, teachers in the school where the study was carried out lacked training and therefore had little knowledge and skills to support students with visual impairment in the school. Again, a study by Maguvhe (2015) showed that, teachers lacked the necessary skills that were needed in teaching mathematics and science to the student with visual impairment.

Summary

The findings regarding the challenges students with visual impairment face when learning mathematics indicated that there was limited teaching and learning materials. Materials such as talking calculators, mathematic books and drawing materials were not available for the students with visual impairment, thus making learning difficult. Furthermore, lack of knowledge on the part of teachers about effective strategies for teaching mathematics to students with visual impairments was also shown to be a challenge to students with visual impairment during mathematics

University of Education, Winneba http://ir.uew.edu.gh

lesson. None of the mathematics teachers in the school had any training in teaching mathematics to students with visual impairment, and therefore found it difficult to teach both students with visual impairment and sighted students at the same time in the same classroom. Furthermore, the results suggested that teachers did not use any differentiated instruction in teaching mathematics to the students. This was as a result of limited time allocated to the teaching of mathematics in the school.

4.2.4 What adaptations do teacher make in teaching mathematics to students with visual impairment?

The analysis of the data concerning the adaptations teachers make in teaching mathematics to students with visual impairment revealed that little adaptations are made to the teaching and learning materials and differentiated instructions were also not used in teaching mathematics.

In terms of the use of differentiated instructions during mathematics lessons, it was revealed from most of the respondents' that teachers did not use differentiated instructions for making the study of mathematics easy to students with visual impairment. Though one of the teachers stated that he task-analyzed his instructions, almost all the students said otherwise. The inability of teachers to use differentiated instructions was as a result of the teachers not having enough time for the lesson. That is the time allocation for the lesson was very limited. This finding agrees with the findings of a study conducted by Amadio (2014) which revealed that most secondary mathematics teachers believed that the use of differentiated instructions could have been effective if it has not been the limited time and curriculum. It was further revealed that students found the learning of mathematics boring since most of them did not even perform well during mathematics lessons. This finding is contrary to the findings from

University of Education, Winneba http://ir.uew.edu.gh

a study conducted by Koeze (2007), which concluded that, the use of differentiated instruments during mathematics challenged students to study harder, and further helped them to build on their achievement level.

Adaptation made to materials for teaching mathematics to students with visual impairment was one of the themes that were looked at. Comments from, teachers, the resource teacher, and the students revealed that no adaptations were made to the teaching and learning materials to suit students with visual impairment. This is inconsistent with Edenfield (2010), whose findings suggested that most teachers try to adapt teaching and learning materials to suit students' needs during mathematics lessons through their own knowledge and approaches. It was also found that most of the materials available were for sighted students and could not be adapted to suit the needs of students with visual impairment. This is contrary to the statement made by Mwakyeja, 2013) that to help students with visual impairment in the regular classroom, teaching materials need to be adapted. Another major finding of the study was that the students were taught how to use Nemeth codes in the school. From the analysis of the comments of the students and teachers, it could be concluded that teachers or resource teachers taught the students how to present their mathematical symbols or solutions in Braille notations. Therefore, students with visual impairment in the school could use the Nemeth codes. The outcome is contrary to the findings from Simalato (2006) that most teachers found it challenging to teach mathematics to students with visual impairment because most of them did not have knowledge in the use of Nemeth code and Braille mathematics.

Summary

University of Education, Winneba http://ir.uew.edu.gh

Again, no adaptations were made to the teaching materials available to suit the students with visual impairment. Most of the materials available were for the sighted students, which could not be adapted to suit students with visual impairment during mathematics lessons. Finally, Nemeth Code was used by both the resource teacher and students during mathematic lessons. This is because they were taught how to use Nemeth codes or Braille notations.

University of Education, Winneba http://ir.uew.edu.gh

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the summary, conclusions and recommendations made on the findings from the study conducted to examine the approaches teachers use in teaching mathematics to students with visual impairment at Adidome Senior High School in the Volta Region of Ghana. Focus group interviews and one-on-one interviews were used as the main instrument to gather information from the students with visual impairment, mathematics teachers and resource teachers. Data from the interviews were analyzed using themes that emerged from the responses of the participants.

5.1 Summary

In terms of the strategies teachers use in teaching mathematics to students with visual impairment, the findings from this study show that teachers at Adidome Senior High School did not use explicit instruction to explain mathematics lessons to the students with visual impairments. For example, the teachers did not task analyze their instruction to make mathematical concepts easier for the students; rather, they verbalized every step, which confused the students.

On the use of peer tutors in teaching, it was found that teachers made use of this approach when teaching mathematics to students with visual impairment. Though the sighted students were not trained, their colleagues with visual impairment understood them better when they taught them.

Cooperative learning was another approach that teachers used for making mathematics lessons students with visual impairments understand mathematical

University of Education, Winneba http://ir.uew.edu.gh

concepts easily. This was mostly done in small groups where sighted students and students with visual impairment solved mathematics questions together. Regarding the use of manipulatives, it was found that teachers did not use manipulatives during mathematics lessons. This really could have negative effects on the students' understanding of mathematical concepts since they would not enjoy mathematics lesson as they should.

In expressing their views on the teaching and learning materials used in teaching mathematics, it was confirmed that though there was a talking calculator in the school, it was not scientific calculator that could be used for computing advanced mathematical problems. This further affected the students during end of term examination and WASSCE since they do not use calculators during these examinations.

It was also confirmed that a material such abacus was not available during mathematic lessons. Furthermore, teachers did not have any idea about abacus and, therefore, could not have used it to teach the students even if it was available in the school.

The findings regarding the challenges students with visual impairment face when learning mathematics indicated that there was limited teaching and learning materials. Materials such as talking calculators, mathematic books and drawing materials were not available for the students with visual impairment, thus making learning difficult. Furthermore, lack of knowledge on the part of teachers about effective strategies for teaching mathematics to students with visual impairments was also shown to be a challenge to students with visual impairment during mathematics lesson. None of the mathematics teachers in the school had any training in teaching mathematics to students with visual impairment, and therefore found it difficult to teach both students with visual impairment and sighted students at the same time in the same

University of Education, Winneba http://ir.uew.edu.gh

classroom. Furthermore, the results suggested that teachers did not use any differentiated instruction in teaching mathematics to the students. This was as a result of limited time allocated to the teaching of mathematics in the school.

Again, no adaptations were made to the teaching materials available to suit the students with visual impairment. Most of the materials available were for the sighted students, which could not be adapted to suit students with visual impairment during mathematics lessons. Finally, Nemeth Code was used by both the resource teacher and students during mathematic lessons. This is because they were taught how to use Nemeth codes or Braille notations.

5.2 Conclusion

The study concluded that teachers sometimes made use of approaches such as peer tutoring and cooperative learning when teaching mathematics to the students with visual impairment, but not a lot of explicit instruction and manipulatives in teaching mathematics. Again, results from the study confirmed that teaching and learning materials such as talking calculators, abacus were not available for the teaching and learning of mathematics in the school. It was further found that there were limited teaching and learning materials for teaching students with visual impairment. Also, teachers had limited knowledge in teaching mathematics to the students with visual impairment, which was found to be a challenge. Finally, in terms of adaptations made in teaching mathematics to students with visual impairment, it was confirmed that teachers did little when teaching mathematics to students with visual impairment. Differentiated instruction strategies were not used during mathematics lessons, and teachers made a few adaptations to the teaching and learning materials to suit the needs of the students with visual impairment.

University of Education, Winneba http://ir.uew.edu.gh

5.3 Recommendations

These recommendations were made based on the findings of this study:

- Teachers should make intensive use of explicit instructions, trained peer tutors, cooperative teaching and learning and manipulatives as approaches in teaching mathematics to students with visual impairment.
- The head teacher should make sure students with visual impairment are provided with teaching and learning materials such as scientific talking calculators, Abacus and others. In order for students to fully participate in end of term examinations and WASSCE without much difficulties.
- The school should give training to teachers who teach mathematics to students with visual impairment frequently.
- Teachers should make use of differentiated instructions and adapting teaching and learning materials such as mathematics books and drawing materials for teaching a topic such as geometry in mathematics to students with visual impairment.

5.4 Suggestions for Future Research

The current research was based on the approaches teachers use in teaching mathematics to students with visual impairment at Adidome Senior High School in the Volta Region of Ghana. It is suggested that future studies should be conducted on the performance of students with visual impairment in mathematics at Adidome Senior High School in the Volta Region of Ghana.

University of Education, Winneba http://ir.uew.edu.gh

REFERENCES

Akdeniz, C. (2016). *Instructional process and concepts in theory and practice.* Springer: Turkey

Alberta Learning. (2002). *Instructional strategies: health and life skills guide to implementation (K-9).* Retrieved, 10th October, 2016 from https:lleducation.alberta.calmedial482311/is.pdf

Andersen, T. (2009). *Using cooperative learning in a sixth grade Math classroom. Action Research Projects.* University of Nebraska - Lincoln DigitalCommons@University of Nebraska – Lincoln.

Anku, S. E. (2014). *What is wrong with mathematics? Asks Ghana Mathematics Society.* Retrieved from http://www.graphic.com.gh/news/education/what-is-wrong-with- mathematics-asks-ghana-mathematics-society.html on Friday 25th November, 2016.

Ansuategui, F. J. A., & Miravet, L. M. (2017). Emotional and cognitive effects of peer tutoring among secondary school mathematics students. *International Journal of Mathematical Education in Science and Technology. 23*(1), 1-21.

Appiahene, P., Opoku, M., Akweittey, E., Adoba, E., & Kwarteng, R. (2014). Assessing the challenges of learning and teaching of mathematics in second cycle institutions in Ghana. *International Journal of Innovation and Applied Studies, 6(*3), 362-368

Argyropoulos, V. S. (2002). Tactual shape perception in relation to the understanding of geometrical concepts by blind students. *British Journal of Visual Impairment, 20*(1), 7- 16.

University of Education, Winneba http://ir.uew.edu.gh

Asamoah, K. A. (2009). *Teaching strategies for students with special needs in early grades in Ghana.* Master's thesis: University of Education, Winneba.

Asempa, Y. E. (2013). *Adaptations for enhancing inclusion of pupils with disabilities in selected regular schools in Ghana.* Master's thesis: University of Education, Winneba, Ghana

Avoke, M. (2005). *Special educational needs in Ghana: Policy, practice and research.* Winneba: Special Educational Books

Aziz, Z., & Hossain, M. A. (2010). A comparison of cooperative learning and conventional teaching on students' achievement in secondary mathematics. *Procedia - Social and Behavioral Sciences, 9*(1), 53-62.

Bayram, G. 1. (2014). *Exploring the academic and social challenges of visually impaired students in learning high school mathematics.* Master's thesis: Bilkent University

Bing, T., 1., & Redish, E. F. (2009). Symbolic manipulators affect mathematical mindsets. Department of Physics. *American Journal of Physics*, 76(2), 418-424.

Bloyd, E. S. (2015). *The effects of peer mediated instruction to teach math skills to middle school students.* Theses and Dissertations--Early Childhood, Special Education, and Rehabilitation Counseling. Retrieved from http://uknowledge.uky.edu/edsrc_etdsI17

Bogdan, C. R., & Biklen, S. K. (2007). *Qualitative research for education: an introduction to theories and methods Boston.* MA: Pearson Education, Inc

University of Education, Winneba http://ir.uew.edu.gh

Bouck, E. C., Satsangi, R., Doughty, T. T., & Courtney, W. T. (2013). Virtual and concrete manipulatives: A comparison of approaches for solving mathematics problems for students with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 44*(1), 1-14.

Bouck, E., & Flanagan, S. (2010). Virtual manipulatives: What they are and how teachers can use them. *Intervention in School and Clinic, 45*(3), 186-191.

Brawand, A., & Johnson, N. (2016). Effective methods for delivering mathematics instruction to students with visual impairment. *Journal of Blindness Innovation and Research*, *6*(1), 2-21.

British Columbia Ministry of Education. (2009). *A guide to adaptations and modifications.* Retrieved on 22lld April, 2007 from www.bced.gov.bc.cals pecialed/docs/adaptations_and_modifications_guide.pdf

Britt, A. K. (2014). *The effects of visual stimulation on the mathematics performance of children in second grade with attention deficit hyperactivity disorder (ADHD).* Master's Thesis: State University of New York at Fredonia

Bruce, C., Flynn, T., & Moss, J. (2016). *Early mathematics: Challenges, possibilities and new directions in the research (Mathematics for Young Children: Literature Review, 2nd Ed.).* Comprehensive literature review submitted to the Literacy and Numeracy Secretariat, Ontario Ministry of Education. Toronto, Ontario, Canada.

Bryant, B. R., Bryant, D. P., Kethley, C., Kim, S. A., Pool, C., & You-Jin, S. (2008). Preventing mathematics difficulties in the primary grades: The critical features of instruction in textbooks as part of the equation. *Learning Disability*

University of Education, Winneba http://ir.uew.edu.gh

Quarterly, 31, 21-35.

Campit, J. B., Cayabyab, J., & Galas, E. (2015). The effect of peer tutoring on achievement of students in discrete structures the effect of peer tutoring on achievement of students in discrete structures. *Asia Pacific Journal of Multidisciplinary Research, 3*(5), 8-12.

Chew, Y. C. (2014). *Assessing the use of auditory graphs for middle school mathematics.* Doctorate thesis: Georgia Institute of Technology

Cowan, H. (2011). *Knowledge and understanding of function held by students with visual impairment.* PhD thesis: The Ohio State University. Retrieved from *https:lletd.ohiolink.edulrws_etd/document/ get/osu* 1316530569/inline

Creswell, J. W. (2003). *Research design, qualitative, quantitative and mixed methods approaches* (2nd Ed.). Thousand Oaks: CA: Sage publication Inc.

Creswell, J. W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Upper Saddle River, NJ: Pearson Education, Inc.

Creswell, J. W. (2012). *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (41h Ed). Boston: Pearson Education.

Csocsan, E., & Sjostedt, S. (n.d.). *Abacus, the most genius calculation aids in the world.* Retrieved from http://isar-internationaI.com on 26th August, 2017.

Csocsan, E., Klingenberg, 0., Koskinen, K. L., & Sjostadt, S. (2002). *MATHS "seen" with other eyes: A blind child in the classroom: Teacher's guide to mathematics.* Ekenas Tryckeri: Aktiebolag

University of Education, Winneba http://ir.uew.edu.gh

Dauda, B., Jambo, H. E., & Umar, M. A. (2016). Students' perception of factors influencing teaching and learning of mathematics in senior secondary schools: Maiduguri Metropolis in Borno State, Nigeria. *Journal of Education and Practice*, *17*(20), 114-122.

Denscombe, M. (2003). *The good research guide for small-scale social research projects.* (2nd Ed.) Maiden head, PA: Open University Press.

Denzin, N. K., & Lincoln, Y. S. (2005). *Handbook of qualitative research* (2nd Ed.). Thousand Oaks: SAGE.

Duncan, G. J, Claessens, A., Huston, A. C., Pagani, L.S., Engel, M., Sexton, H., et al. (2007). School readiness and later achievement. *Developmental Psychology*, *4*(3), 1428- 1446.

Dunham, P. H. (2000). Hand-held calculators in mathematics education: A research perspective. In E. Laughbaum (Ed.), *Hand-held technology in mathematics and science education: A collection of papers* (pp. 39-47). Columbus, OH:

Erenel, D., & Bingol, H. O. (2016). *An accelerometer-based calculator for visually impaired people using mobile devices*. Bogazici University, Istanbul: The Department of Computer Engineering,

Erin, I. N. (2003). *Educating students with visual impairment. Eric Clearing House on Disabilities and Gifted Education.* (ERIC EC), Digest.

Fisher, S. P., & Hartmann, C. (2005). Math through the mind's eye. *Mathematics Teacher, 99*(4), 34-56.

Fox, L. A. (2012). *Performance of students with visual impairment on high-stakes*

University of Education, Winneba http://ir.uew.edu.gh

tests: a Pennsylvania report card. Doctorate thesis: University of Pittsburgh.

Fraenkel, J. R., & Wallen, N. E. (2009). *How to design and evaluate research in education* (5th Ed). New York: McGraw-Hill Publishing Co.

Fraser, W. 1., & Maguvhe, M. O. (2008). Teaching life sciences to blind and visually impaired learners. *Journal of Biological Education*, *42*(2), 84-89.

Gersten, R., Baker, S., Pugach, M., Scanlon, D., & Chard, D. (2001). Contemporary research on special education teaching. In V. Richardson (Ed.) *Handbook of Research on Teaching,* (4th Ed.), (pp. 695-722). Washington DC: AERA

Gezahegn, Y. B. (2007). *Barriers to teaching and learning mathematics in grade four: A study in one primary school in Addis Ababa city, Ethiopia.* Masters theses: University of Oslo

Godsey, J. R., Schuster, 1. W., Lingo, A. S., Collins, B. C., & Kleinert, H. L. (2008). Peer- implemented time delay procedures on the acquisition of chained tasks by students with moderate and severe disabilities. *Education and Training in Developmental Disabilities, 43*(1), 111-122.

Gokmen., S. (2009). *The effects of cooperative learning on learning outcomes and reactions to training in an in-service training course.* PhD Theses: Middle East Technical University.

Goracke, M. A, (2009). *The role of manipulatives in the eighth-grade mathematics classroom. Action Research Projects 7l.* Retrieved from http://digitalcommons.unl.edulmathmidaction researchl71.

Gronlund, A, Lim, N., & Larson, H. (2010). Effective use of assistive technologies

University of Education, Winneba http://ir.uew.edu.gh

for inclusive education in developing countries: issues and challenges from two case studies. *International Journal of Education and Development using Information and Communication and Technology (IJEDICT), 6*(4), 5-26.

Gwendolyn M. L. (2008). Curriculum use while learning to teach: one student teacher's appropriation of mathematics curriculum materials. *Journal for Research in Mathematics Education, 39*(1), 63-94.

Hamann, E. T., Reeves, J., Baurain, B., & Valenciano, G. (2008). *Accessing high-quality instructional strategies/acuity publications*: *Department of teaching, learning and teacher education.* Retrieved from http://digitalcommons.unl .edu/teachlearnfacpub/l1.

Hooker, D. (2011). Small peer-led collaborative learning groups in developmental math classes at a tribal community college. *Multicultural Perspectives, 13*(4), 220-226.

Hudson, M. E., Browder, D. M., & Jimenez, B. A., (2014). Effects of a peer-delivered system of least prompts intervention and adapted science read-alouds on listening comprehension for participants with moderate intellectual disability. *Education and Training in Autism and Developmental Disabilities, 49*(1), 60-77.

Hyett, N., Kenny, A., & Dickson-Swift, V. (2014). Methodology or method?: A critical review of qualitative case study reports. *International Journal of Qualitative Studies on Health and Well-being, 9*(1), 23-60

Ibrahim, A. I. (2015). Effects of modelling on the teaching of pre-primary children with visual impairment. *National Journal of Inclusive Education, 3*(1), 261-267.

University of Education, Winneba http://ir.uew.edu.gh

Igun, G. W. (2009). *Inclusion of blind children in primary schools: A case study of teachers' opinions in Moro district-Uganda.* Master's thesis: University of Oslo, Norway.

Janney, R., & Snell, M. (2000). *Modifying schoolwork.* Baltimore, MD; Paul H. Brooks Publishing Co.

Kapperman, G., & Sticken.J. (2003) Practice report: A case for increased training in the nemeth code of Braille mathematics for teachers of students who are visually impaired. *Journal for the Visually Impaired*, *97*(4), 110-112.

Karshmer, A. I., & Bledsoe, C. (2002). Access to mathematics by blind students. In K. Miesenberger, J. Klaus, & W. Zagler (Eds.) *Computers helping people with special needs* (pp. 471-476). Berlin Heidelberg: Springer.

Karshmer, A., Gupta, G., & Pontelli, E. (2007). *Mathematics and accessibility: A survey.* 9th International Conference on Computers Helping People with Special Needs, 3118, 664- 669.

Kimmel, A. J. (1996). *Ethical issues in behavioral research.* Cambridge, MA: Blackwell.

Kisanji, J. (1995). Attitudes and beliefs about disability in Tanzania. In B. O' Toole, & R. Me. Conkey (Eds.), *Innovations in developing countries for people with disabilities* (pp. 227-241). Chorley, Lancashire: Lisieu Hall.

Kodisang, S. M. (2015). *Teaching strategies used by mathematics teachers to teach grade six probability in Nkangala district.* Master's thesis: University of Pretoria

University of Education, Winneba http://ir.uew.edu.gh

Koeze, P. A., (2007). *Differentiated instruction: The effect on student achievement in an elementary school.* Master's Theses and Doctoral Dissertations.

Kohanova, I. (2007). *The ways of teaching mathematics 10 visually impaired students.* Master's theses: Comenius University Bratislava, Slovakia

Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd Ed.); New Delhi: New Age International (P) Limited, Publishers.

Kovacs, K. (2000). Hungary: Changing attitudes in the education of children and youth with a visual impairment. *British Journal of' Visual Impairment. 18*(2), 61-66.

Kumar, D. D., Ramasamy, R., & Stefanich, G. P. (2001). Science for students with visual impairment: Teaching suggestions and policy implications for secondary educators. *Electronic Journal of Science Education, 5*(3), 30-36.

Kunsch, C. A., Jitendra, A. K., & Sood, S. (2007). *The effects of peer mediated instruction in mathematics for students with learning problems: A research synthesis. Learning Disabilities Research & Practice, 22*, 1-12

Lawrence-Brown, D. (2004). Differentiated instruction: inclusive strategies for standard based learning that benefit the whole class. *American Secondary Education*, *32*(3), 34-62.

LD Online (2014). *Using cooperative learning to teach mathematics to students with learning disabilities.* Retrieved from http://www.ldonline.org/article/5932

Leuders, J. (2016). Tactile and acoustic teaching material in inclusive mathematics classrooms. *British Journal of Visual Impairment, 34*(1), 42-53,

University of Education, Winneba http://ir.uew.edu.gh

Louie, L, Brodesky, A., Brett, J., Yang, L.-M., &. Tan, Y. (2008). *Math education practices for students with disabilities and other struggling learners: case studies of six schools in two Northeast and Islands Region states.* Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Northeast and Islands

Maguvhe, M. (2015). Teaching science and mathematics to students with visual impairment: Reflections of a visually impaired technician. *African Journal of Disability, 4*(1), 1-6.

Mani, M. N. G. (1998). The role of integrated education for blind children. *Community Eye Health, 11*(27) 41-42.

May, C. (2010). *Thinking through" implementation". Using normalization process theory to understand the dynamics of complex interventions in health services research. S*ummer Institute on Health Service Research. University of Victoria, British Columbia.

McDermott-Wells, P. M. (2015). *Math in the Dark: Tools for: Expressing mathematical content by visually impaired students.* PhD Theses: Nova Southeastern University. Retrieved from http://nsuworks.nova.edu/gscis_ ctd/61

McMillan, J. H., & Schumacher, S. (2006). *Research in Education: Evidence-Based Inquiry.* (6th Ed.). USA: Pearson.

Mercer, C. D., & Mercer, A. R. (2004). *Teaching students with learning problems* (7th ed.) Upper Saddle River, NJ: Merrill/Pearson Education.

University of Education, Winneba http://ir.uew.edu.gh

Ministry of Education. (20l3). *Education sector performance report.* Accra: Ministry of Education.

Moore, N.D. (2012). *Alternative strategies for teaching mathematics.* Retrieved from http://digitalcommons.brockport.edu/ehdthescs.

Moreland, L. M. (2015). *Science for visually impaired students and accessible technology.* Theses, Dissertations and Capstones. Paper 978.

Moyer-Packenh, P. S. (2001). Are we having fun yet?: How teachers use manipulatives to teach mathematics. *Educational Studies in Mathematics. 47*(2), 175-197.

Mugambi, M. K. (2011). *Challenges facing teachers in teaching students with visual impairment in an integrated school:* A study of Moi *Girls' School, Nairobi.* Master's thesis: Kenyatta University.

Mulder, Q. (2014). The effect of differentiated instruction on student mathematics achievement in primary school classrooms. Master's thesis: University of Twente

Mwakyeja, B. M. (2013). *Teaching students with visual impairment in inclusive classrooms: A case study of one secondary school in Tanzania*. Unpublished Master's Thesis: University of Oslo.

Nevin, A., & Renne, D. (2001). *Cooperative group learning: K-12 mathematics lesson plans.* Arizona State University: West, Phoenix.

Ocloo, M. A. (2011). *Effective education for persons with visual impairment in Ghana.* Tema: Distinctive Publishing Limited.

University of Education, Winneba http://ir.uew.edu.gh

Okonkwo, H. C., Fajonyomi, M. G. Omotosho, J. A., Esere, M.O. & Olawuyi, B. O. (2017). Challenges, counselling needs, and coping strategies of students with visual impairment in regular secondary schools in Nigeria. Journal *of Education and Practice, 6*(13), 111-137.

Parkinson, M. (2009). The effect of peer assisted learning support (PAL) on performance in mathematics and chemistry. *Innovations in Education and Teaching International*, *46*(4), 381-392.

Pawattanaa, A., Prasarnpanicha, S., & Attanawong, R. (2013). Enhancing primary school students' social skills using cooperative learning in mathematics. *Procedia - Social and Behavioral Sciences, 112*, 656–661.

Peterson, K. (2011). *A qualitative study of instructional strategies used by elementary general education teachers in inclusive classrooms*. Dissertation 448. Retrieved from https://sholarworks. Wmich.edu/dissertations/448 on 17th May, 2018.

Right, J. (2017). *The importance of learning materials in teaching*. Retrieved from http://classroom.Synonym.Com/importance-learning-materials-teaching-6628852.html on 3rd March, 2017.

Robbison, D. M. (2009). *A new way to set a teaching program for deaf blind students*. Washington: NFB Organization.

Robson, C. (2002). *Real world research: A resource* for *social scientists and practitioner researchers* (2nd Ed.). Oxford: Blackwell Publishing.

Rodgers, E. M. (1999). *Diffusion of innovations* (4th Ed.). Boston: McGraw-Hill.

University of Education, Winneba http://ir.uew.edu.gh

Romano, P., & Walker, J. (2010). *"Bio buddies": Peer tutoring as an instructional strategy. NERA Conference Proceedings.* Retrieved from htt://digitacommons.uconn.edu/near_2010/3

Rosenberg, M., Westling, D., & McLeskey, J. (2008). *Special education for today's teachers*. Upper Saddle River, NJ: Prentice Hall.

Roy, A., Guay, F., & Valois P. (2013). Teaching to address divers learning needs: development and validation of a differentiated instruction skill. *International Journal of Inclusive Education, 17*(11), 1186-1204

Sahin, M., & Yorek, N. (2009). Teaching science to visually impaired students: A small-scale qualitative study. *Online Submission, 6*(4), 19-26.

Sansrisna, N. S. (2017). *Teachers' beliefs in practicing inclusive education case study of elementary schools in Banda Aceh*. Master's theses: University of Tampare.

Satsangi, R., Bouck, E., C., Taber-Doughty, T., Buffering, L., & Roberts, C. A. (2016). Comparing the effectiveness of virtual and concrete manipulatives to teach algebra to secondary students with learning disabilities. *Learning Disabilities Quarterly, 39*(4), 240-253.

Schloss, P. J., Schloss, N. A., & Schloss, C. N., (2007). *Instructional methods for secondary students with learning and behavior problems*. Boston, MA: Person Education, Inc.

Shank, G. (2002). *Qualitative research. A personal skill approach*. Upper Saddle River, NJ: Merril Prentice Hall.

University of Education, Winneba http://ir.uew.edu.gh

Siegel, C. (2005). Implementing a research-based model of cooperative learning. *The Journal of Educational Research, 98*(6), 1-15.

Simalalo, M. M. (2006). *Challenges in teaching and learning mathematics by visually impaired pupils*. Master's thesis: University of Zambia

Spindler, R. (2006). Teaching mathematics to a student who is blind. *Teaching, Mathematics and Its Applications, 25*(3), 120-126.

Stake, R. E. (1995). *The art of case study research*. London: SAGE.

Stark, S., & Torrance, H. (2005). Case study. In B. Somekh & C. Lewin (Eds.), *Research methods in the social sciences* (pp. 33-40). London: SAGE.

Sturz, D., Kleiner, B., & Fernandex, A. (2005). Effective management of cultural diversity in setting. *Equal Opportunities International, 24*, 57-64.

Sulivan, M. M. (2005). Teaching mathematics to college students with mathematics–related learning disabilities: Report from the classroom. *Learning Disabilities Quarterly, 28,* 205-220.

Supalo, C. A., Mallock, T. E., Amorosi, C., Rankel, L. A., Wolhers, H. D., Roth, A., et al. (2007). Talking tool to assist student who are blind in laboratory courses. *Journal of Science Education for Student with Disabilities*, *12*(1), 4.

The California State Board of Education. (2006). *Braille mathematics standards*. Los Angeles, CA: California Department of Education.

The IRIS Centre. (2017). *What evidence-based mathematics instructional strategies can teachers employ?* Retrieved from

University of Education, Winneba http://ir.uew.edu.gh

https://iris.peabody.vanderbilt.edu/module/math/cresource/q3/p07/#content.

The Ohio State University. Edenfield, K. W. (2010). *Mathematics teachers' use of instructional materials while implementing a new curriculum.* Doctorate thesis: University of Georgia Education.

Tomlinson, C. A. (2001). *How to differentiate instruction in mixed-ability classrooms* (2nd Ed.). Alexandria, VA: ASCD.

Utley, C. A., Reddy. S. S., Delquadri, J. C., Greenwood, C. R., Mortweet, S. L., & Bowman, V. (2001). Class wide peer tutoring: An effective teaching procedure for facilitating the acquisition of health education and safety facts with students with developmental disabilities. *Education and Training of Children, 24*(1), 1-24

Vandersteop, S. W., & Johnston, D. D. J. (2009). *Research methods for everyday life: Blending qualitative and quantitative approaches.* New York: Wiley & Sons, Inc.

Vaughn, S., & Schumm, J. S. (1995). Responsible inclusion for students with learning disabilities. *Journal of Learning Disabilities,* 28, 264-270.

Westwood, P. (2008). *What teachers need to know about teaching methods.* Camberwell, Vix: Australia P.

Willing, C. (2007). *Math adaptation.* Retrieved from http//www.teaching visuallyimpaired.com/math-adaptations.html.

Wolf, W (1980). *Social integration and human service*. Baltmore: University Park Press.

University of Education, Winneba http://ir.uew.edu.gh

Yin, R. K. (2003). *Case study research design and methods*. London: Sage Publishers.

Zhang, D. (2016). A review of literature: Mathematics instruction for student with visual impairment. *Journal of Child Development and Disorder, 2(*1), 1-4.

Zheng, X. (2014) *A study on blind students' experience of provision and support in schools.* Unpublished Masters theses: University of Oslo.

University of Education, Winneba http://ir.uew.edu.gh

APPENDIX A

DEPARTMENT OF SPECIAL EDUCATION

UNIVERSITY OF EDUCATION, WINNEBA (UEW)
OFFICE OF THE HEAD OF DEPARTMENT

Our Ref: November 22, 2017

…….

……

…….

…….

Dear Sir/Madam,

LETTER OF INTRODUCTION

I write to introduce to you, Mavis Saforo an M.Phil student of Department of Special Education of the University of Education, Winneba, with registration number 8160150006.

He is currently working on his thesis on the topic *"Teachers' approaches to teaching Mathematics to students with visual impairment at Adidome Senior High School in the Volta Region of Ghana".*

I should be grateful if you could give him with the needed assistance to enable him to collect data from you school. This forms part of the requirements to complete the programme.

Counting on your cooperation.

Thank you.

Yours faithfully,

ESAU YAO YEKPLE (PHD)
AG. HEAD OF DEPARTMENT

University of Education, Winneba http://ir.uew.edu.gh

APPENDIX B

INTERVIEW GUIDE FOR STUDENTS WITH VISUAL IMPAIRMENT

Strategies Teachers use in teaching Mathematics to Students with Visual impairments.

1. What activities do your teachers engage you in during mathematics lesson? Describe them.

Prompt

a) How do your teachers teach you mathematics? In a step by step order?

b) How often do your teachers allow you or your colleague to go to the board to solve problems for the class?

c) How do your colleagues solve the questions or give explanations in class?

d) How do you seek assistance from friends after class?

e) How are peer tutors used in teaching mathematics to you?

f) Explain how your teachers group you to solve mathematics problem?

g) In what ways do you receive assistance from your colleagues during mathematics lessons?

Teaching and learning materials for teaching mathematics to students with visual impairment

1. What teaching and learning materials does your teacher use in teaching mathematics to you?

Prompt

b) Mention them.

c) How do your teachers used talking calculators in teaching you mathematics concepts?

University of Education, Winneba http://ir.uew.edu.gh

d) What about the use of abacus?

e) How does the resource teacher support you in learning mathematics?

Adaptations in Teaching Mathematics to Students with Visual Impairment

1. What adaptations do teachers make in teaching you mathematics?

Prompt

a) Describe them.

b) What about the use of different methods to teach one topic in mathematics?

c) How do your teachers present charts, graphs and other image to you during mathematics lessons?

d) Are there any other ways do your teachers present their lessons to you?

Challenges Students face in Learning Mathematics

1. What challenges do you face during Mathematics lessons?

Prompt

a) Mention them

b) What about the use of teaching and learning materials?

c) How would you describe teachers' ability to teach you Mathematics?

University of Education, Winneba http://ir.uew.edu.gh

APPENDIX C

Strategies Teachers use in teaching Mathematics to Students with Visual impairments.

1. What strategies do you use in teaching Mathematics to students with visual impairment

   in your class?

Prompt

a. Describe them

b. How do you break down instructions for students during Mathematics lessons?

c. Do you normally allow their colleagues to teach themselves during lessons in place of you?

d. How often do you group the students to solve mathematical problem?

e. Do your students receive assistant from their colleagues during Mathematics lessons?

Teaching and Learning materials for teaching Mathematics to students with visual impairment

2. What teaching and learning materials do you use in teaching Mathematics to students with visual impairment?

Prompt

a. Mention them

b. How do you use talking calculators in teaching Mathematics concept?

c. What about the use of abacus?

d. How do you use Braille Mathematics in teaching the students?

University of Education, Winneba http://ir.uew.edu.gh

Adaptations in Teaching Mathematics to Students with Visual Impairment

3. What modifications do you make when teaching Mathematics to the students with visual impairment?

Prompt

a. Describe them.

b. How do you normally do to explain a concept that seems more challenging t the students?

c. What other modifications do you do to instructional materials for the students to grasp the idea or the concepts?

Challenges Students Face in Learning Mathematics

4. What challenges do students with visual impairment face during Mathematics lessons?

Prompts

a) Mention them.

b) What about lack of teaching and learning materials?

c) How knowledgeable are you in teaching Mathematics to the students with visual impairment?