Abstract: There has been a problem in Mathematics of learners with Visual Impairments as a result of inadequate Assistive Technology and reluctance of teachers to apply appropriate teaching strategies when teaching Mathematics using Assistive Technology in special primary schools. This regard, this study sought to identify strategies employed by teachers when using Assistive Technology to teach Mathematics to learners with Visual Impairments in special primary schools in Kenya. A descriptive research design was adopted to carry out the study. Purposive sampling technique was applied to sample classes 7 and 8 from the five selected special primary schools in Kenya. Classroom observation schedule was used to gather the information. Study data which was qualitative in nature was analysed manually through identification, examination and interpretation of patterns and themes in textual data. The study established that teachers of Mathematics used inappropriate teaching strategies while teaching Mathematics to learners with Visual Impairments. The study concluded that inappropriate use of teaching methods and instructional strategies is real and this has contributed to lack of interest in working out Mathematics problems leading to a decline of Mathematics performance. The study recommends that the government through Ministry of Education to conduct regular classroom supervisions to ensure efficient use of appropriate teaching strategies in the special primary school in Kenya.

Keywords: Assistive Technology, Learners with Visual Impairments and Strategies

I. INTRODUCTION

Education plays a crucial role in helping a nation achieve its national aspirations (MOE, 2009). It is through education that a country produces and determines the type of human resource that will determine the required development. This is why the educational aspirations of a country are expressed in its National goals which are broad long term statements of intended achievements for all levels of education. Ability to work out Mathmatic problems is a necessary and valuable life skill (Stein, 2013). Whether you are paying bill, shopping for groceries or cooking from a recipe, Mathematics skills are important.

Further, the basics developments in Mathematics such as equations, subtraction, addition, multiplication and division are implicitly used in everyday application like buying and selling, sharing, counting and measuring. However, it is the process of learning which can be affected by different abilities and disabilities (Manchishi, 2015). Visual Impairments is one of the disabilities that can affect learners’ abilities to learn Mathematics and understanding these issues is essential to helping learners overcome them. “Mathematics is the mother science of the abstract world” (Chiu, 2007, p. 64).

Mathematics is considered as the most important science because its development affects the development of other sciences such as physics, biology and technology. This therefore, it may be a hindrance to vocational development (Pau, 2008). The general aim of teaching Mathematics to learners with Visual Impairments is to produce a learner who will be able to use a Mathematical way of thinking and problem solving both in familiar and unfamiliar situations in everyday life. However, the difference comes in when we consider the time taken in acquisition of skills and the highest level of attainment (MOE, 2009). The learner with Visual Impairments will require specialized teaching, compensatory tools, more time and a more effective teaching strategy.

In grading of candidates’ performance at the Kenya Certificate of Secondary Education level, candidates with Visual Impairments can only take one science subject which is Biology, while their sighted peers take two science subjects (Kochung, 2003). This practice was found to disadvantage learners with visual impairments especially when it comes to career choice and admission to the few competitive places in institutions of higher learning (Kochung, 2003). According to National Research Council of Kenya (2012), Mathematics is a subject that has been recognized as the mother of all learning with other subjects deriving their concepts from it in both the sciences and arts. The council further highlighted that Mathematics is also an international language and is essential in almost every field such as measuring in fashion, handling money, and angles in sports, technology and economics;
Assistive Technology is not the teacher, rather it is a tool that is used by the teacher to widen a learner’s reach and should complement and enhance what a teacher does naturally (Young, 2008). Teaching using computer-based instruction enables teachers to take a back seat while learners including those with Visual Impairments workout problems with the help of the computer (Kautz, 2016). Obukowicz (2009) pointed out that there are various Math Toolbars which explain various Mathematics related vocabulary items which also include interactive models that explain Mathematics concepts. MathType is an advanced math toolbar-based program that offers the learner with Visual Impairments symbols they need to use to write equations or solve Mathematics problems on the computer. Other toolbar-based programs are Mathpad and Mathpad Plus which makes Mathematics assignments easier to do for learners with Visual Impairments on the adapted computer.

Despite the crucial role Technology play on teaching and learning of Mathematics for Persons with visual impairments, (Rowe, 2014) further noted that the technologies were usually not available to the developing countries. Rowe (2014) study focused on limitations in teaching STEM subjects to learners with Visual Impairments in developing countries. Moreover, the researcher argued that, due to the changing world of Technology, this area of study was very significant.

Learners with Visual Impairments at primary school level usually miss out an opportunity to get quality instruction when learning Mathematics. These learners usually lag behind their sighted peers in terms of acquiring quality education and in competing for the ever elusive job opportunities in the market. They also require specialized and meaningful utilization of Assistive Technology which is needed in order to benefit from the instruction in the classroom (Gargiulo, 2012). This has led to low access of Science and Technology courses at the university by this group of learners (Wawire et al., 2009).

Improvement in Mathematics performance at primary school level will lead him/her to pursue Science and Technology subjects at secondary level which include Mathematics, Physics, Chemistry and Computer Studies. With positive attitudes towards Mathematics, he or she can perform quite well in these Science subjects in the Kenya Certificate of Secondary Education and be at par with the learner who is sighted. This further will promote this learner with Visual Impairments to pursue Science and Technology courses in the University/College and join good careers. In conclusion, there will be promotion in functional ability for learners with visual impairments with regard to self-reliance, ease to obtain basic life necessities and finally able to compete for life opportunities.

It is important to know the teaching methods and instructional strategies that work best with learners with Visual Impairments. This is because effective techniques can be shared with other teachers (Kautz, 2016). Teachers also need to know how to use Assistive Technology in addressing the different needs of persons with disabilities which include learners with Visual Impairments to learn (UNESCO, 2014).

Studies done in developed and developing countries had mostly focused on strategies employed when using Assistive Technology in higher institutions and also had focused on general subjects. There was no specific study that had focus on strategies employed when using Assistive Technology for teaching Mathematics to learners with Visual Impairments in special primary schools. Mugo (2013) conducted a comparative study of Syracuse University, USA and Kenyatta University, Kenya, to investigate on Assistive Technology and Access to quality instruction for students with visual impairments. The study found out that the instructional strategies and the methodologies applied in higher institutions for students with VI did not meet the needs of the students in general learning.

Kautz (2016) while using descriptive observational study, identified strategies used by effective teacher of developmental Mathematics and to discover the learners’ perceptions they had about these strategies in higher institutions. The qualitative study involved observation of teachers of Mathematics classroom practice and triangulation via students’ questionnaires and interviews. Four study participants were selected through snowball sampling enrolment technique. Students who were eighteen years and above were observed and video recorded in the classes before, during and after the teaching of an algebraic concept. The study focused on three (3) teaching methods and eleven (11) instructional strategies. The three (3) teaching methods were direct instruction, group work and constructivist while instructional strategies included: stating the objective, learner’s engagement, modeling, scaffolding, positive attitudes, use of manipulations, use of Technology, use of graphic organizer, use of humor and fun, real-world relevance and use of games.

The study findings revealed that all the four (4) instructors who were recorded on video used teaching method of direct instruction. Two (2) of the instructors used constructivist and none used group work. A direct instruction is also referred as lecture-based instruction which include tutorials, discussions, recitation, seminars, workshops and observation (Kautz, 2016). Group work is when learners work together as group or in partners. An example of a partner is Think-Pair-Share which involves sharing ideas with a partner enabling him/her to assess new ideas before presenting the ideas to a larger group. The author further stated that in group work, the teacher act as a manager who oversees the project that learners complete. According to Piaget (1967) constructivist teaching requires learners to do experiments and use the findings of those experiments to discover the rules of Mathematics, thus reaching to conclusions. In constructivist teaching the Teachers of Mathematics allows his or her
learner to manipulate blocks and let them come up with their own way of finding area of a circle, as opposed to giving learners the formula.

Regarding the instructional strategies, seven (7) out of eleven (11) were observed in the learning sessions stating the objectives at the beginning. Instructional strategies refers to, “those experiences in teaching that make the attainment of knowledge and skills interesting, effective and appealing to students” (Kautz, 2016, p. 36). The instructional strategies included: stating the objective, learner’s engagement, modeling, scaffolding, positive attitudes, use of manipulations and use of games. Use of manipulates and use of games were not observed on the recorded video at all. Use of technology was observed on three instructors, use of graphics organizer and humor on two instructors while real-world relevance on one instructor.

Wairimu (2013) further observed fourteen (14) classroom sessions in two integrated public primary schools in Nairobi County which enabled that researcher to obtain accurate data on how the Teachers of Mathematics manipulated and used the instructional materials and devices which were actually available and used by learners and their Teachers of Mathematics. The researcher used classroom observation checklists to observe the fourteen (14) sessions in integrated public primary schools in Nairobi County; classes four to eight which had learners with low vision. The qualitative data from the classroom observation checklist was summarized in narrative form. The researcher found out that in six out of the fourteen sessions, the teachers of Mathematics did not use any instructional materials while teaching Mathematics in integrated programmes.

In all the eight out of the fourteen sessions, Teachers of Mathematics were observed employing demonstration method of teaching while teaching learners with Visual Impairments. Other methods that were noted included were: lecture as well as question and answer. Further, the researcher revealed that majority of the sessions (5) observed, learners were not allowed to manipulate the materials while the remaining three sessions, the learners were allowed to manipulate the instructional materials throughout the lesson (Wairimu, 2013). The classroom observations of Wairimu’s study of 2013 revealed that, the majority of the Teachers of Mathematics that were observed typically focused on the content of the task and spent very little time interacting with learners regarding individual attention and showing interest in the learners’ work.

Mugo (2007) investigated instructional methods that were most suitable for the use of instructional media in the facilitation of learning by learners with visual impairments in special primary schools and integrated programmes. The researcher adopted a descriptive survey design. Interview guides, observation schedules, checklists, questionnaires and focused group discussions were used to collect data from twelve (12) Teachers of Mathematics in the six (6) special primary schools and two integrated programmes for learners with Visual Impairments. The study findings were that Teachers of Mathematics used combination of different instructional methods to achieve different types of objectives. Through the questionnaires, all the twelve (12) study participants mentioned the following strategies which they found to be most suitable in the facilitation of learning, assignments, arithmetic calculations, peer tutoring, question and answer, self-exploratory exercise, shape identification and class discussions. Other methods that were noted included: competition games, brainstorming, group discussion, brainstorming and co-operative games. Through observation, the researcher noted that, although the Teacher of Mathematics selected various instructional strategies for teaching learners with Visual Impairments, majority of those Teachers of Mathematics were observed using lecture, class discussion, assignment and they sparingly used the instructional media.

The studies have looked at strategies employed when using Assistive Technology in higher institutions and Assistive Technology in general teaching, but they have not focused specifically at strategies employed when using Assistive Technology to teach Mathematics in lower institutions. A study to find out the teaching strategies employed by Teachers of Mathematics on teaching Mathematics in special primary schools was therefore viable. This study therefore, evaluated on identifying strategies employed by Teachers of Mathematics when using Assistive Technology to teach Mathematics to learners with Visual Impairments in special primary schools in Kenya.

II. PURPOSE OF THE STUDY

The purpose of this study was to identify strategies employed by teachers of Mathematics when using Assistive Technology to teach Mathematics to learners with Visual Impairments in special primary schools in Kenya.

III. RESEARCH METHODOLOGY

This study adopted a descriptive survey research design to identify strategies employed by Teachers of Mathematics to teach Mathematics using Assistive Technology to learners with visual impairments using direct observation. According to Gay, Mills and Airasian (2006), descriptive surveys are concerned with assessing attitudes, opinions, preferences, demographics, practices and procedures. Further, descriptive survey design is concerned with ‘describing behaviours and gathering people’s opinions, attitudes, perceptions and beliefs about a current issue in education’ (Lodico, Spaulding and Voegtle, 2006). Thus in this study, the descriptive survey design was appropriate because it helped in the collection of raw data to identify strategies employed by teachers when using Assistive Technology to teach Mathematics to learners with Visual Impairments in special primary schools in Kenya.

The study targeted five special primary schools for learners with Visual Impairments in Kenya classes seven and eight.
A purposive sampling technique was applied to sampled classes 7 and 8 in the five special primary schools. Purposive sampling allows the researcher to use cases that have the required information with respect to the objectives of the study (Mugenda, 2008). Classroom observation schedule was used to gather the information and the data which was qualitative in nature was analysed manually through identification, examination and interpretation of patterns and themes in textual data.

IV. STUDY FINDINGS AND DISCUSSIONS

This study aimed at finding out strategies that were employed by Teachers of Mathematics when teaching Mathematics to learners with Visual Impairments using Assistive Technology in special primary schools in Kenya. The researcher observed the nine (9) Teachers of Mathematics. Each teacher was observed once while teaching a thirty-five (35) minutes Mathematics lesson in classes seven and eight. Five teachers of Mathematics were observed from class seven while four Teachers of Mathematics in class eight were observed. The findings were analysed in two levels namely; teaching strategies and instructional strategies. The results on teaching strategies are presented on Table 1.1

Table 1.1 Teaching methods for teaching Mathematics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct instructions</td>
<td>9</td>
<td>100.0</td>
</tr>
<tr>
<td>Question and answer</td>
<td>9</td>
<td>100.0</td>
</tr>
<tr>
<td>Discussion</td>
<td>9</td>
<td>100.0</td>
</tr>
<tr>
<td>Tutorials</td>
<td>8</td>
<td>88.8</td>
</tr>
<tr>
<td>Group work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer tutoring</td>
<td>1</td>
<td>11.1</td>
</tr>
<tr>
<td>Cooperative learning</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Collaborating</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Constructivist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demonstration</td>
<td>9</td>
<td>100.0</td>
</tr>
<tr>
<td>Experimental</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 1.1 reveals that all the respondents were observed applying question and answer and discussion, while slightly above four fifth were observed using tutorials. One nineth was observed using peer tutoring and none of the respondents applied cooperative learning and collaborative teaching. All the respondents used demonstration teaching method and none used experimental teaching methods.

This study further investigated on strategies employed by Teachers of Mathematics while teaching learners with Visual Impairments using Assistive Technology throughout the lesson. The results are presented on Table 1.2

Table 1.2 Instructional strategies for teaching Mathematics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency (n)</th>
<th>Percentages (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of technology</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>Stating objectives</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>Use of manipulations</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>Learner’s engagement</td>
<td>4</td>
<td>44.4</td>
</tr>
<tr>
<td>Use of humor and fun</td>
<td>3</td>
<td>33.3</td>
</tr>
<tr>
<td>Real-world relevance</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Games</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Content reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2</td>
<td>22.2</td>
</tr>
<tr>
<td>No</td>
<td>7</td>
<td>77.3</td>
</tr>
</tbody>
</table>

Regarding instructional strategies, all the teachers of Mathematics were observed using technology, stating objectives at the beginning of the lesson and using manipulations. Nearly half of the Teachers of Mathematics were observed engaging learners and a third used humor. Finally, none of the Teachers of Mathematics was observed using Games and real-world relevance. Slightly above three quarter of the classroom observation learners were not allowed to refer to the content, while slightly below a quarter were allowed to refer to the content as the lesson was going on.

Discussion

The findings regarding teaching methods in this study revealed that Teachers of Mathematics combined several teaching methods while teaching Mathematics to learners with Visual Impairments. Teaching methods that were observed were; demonstration, question and answer, tutorials, demonstration and peer tutoring. These findings somehow concurred with Mugo (2007), Mutai (2010) and Wairimu (2013). This is why Alexander (2010) argued that the more teaching methods a Teachers of Mathematics is able to employ, the more likely that they will be successful with the highest percentage of learners. Learners with Visual Impairments need to be exposed to peers through symposiums/bench markings especially those from good performing institutions and learners (Adera, 2004). By so doing, learners with Visual Impairments share new ideas and experiences which in turn develop positive attitudes towards Mathematics hence, improving the performance of the subject. Further, Mutai (2010) noted that students seemed to like Mathematics more when given individual attention by their Teachers of Mathematics as well as in small group discussions to enable them to clearly understand concepts. Some methods of teaching are effective for showing gains in short-term where other methods of teaching are better for increasing and retaining gains in long-term Hiebert and Grouws (2003).
The finding of this study was in line with Kautz (2016) who categorized teaching methods into three groups namely: direct instructions, group work and constructivist. A direct instruction is also referred as lecture-based instruction which include tutorials, discussion, recitation, seminars, workshops and observation (Kautz, 2016). Group work is when learners work together as a group or in partners. Group work involves partner work, cooperative learning and collaborative learning. An example of a partner work is Think-Pair-Share which involves sharing ideas with a partner enabling him/her to assess new ideas before presenting the ideas to a larger group (Azlina and Nik, 2010). In group work, the teacher acts as a manager who oversees the project that learners complete. In cooperative learning learners are grouped into small groups where they work together to accomplish the given task (Slavin, 1987). Cooperative teaching works effectively with computers and had a positive effect on Mathematics anxiety of low achieving learners (Mavarch, Silber & Fine 1991).

This study revealed that none of the teachers was observed using constructivist teaching which requires learners to do experiment and use the findings of those experiments to discover the rules of Mathematics, thus reaching to conclusions (Piaget, 1967). In constructivist teaching the Teachers of Mathematics allows his/her learners to manipulate blocks and let them come up with their own way of finding area of a circle, as opposed to giving learners the formula. Alexander (2010) argued that constructivist teaching has a positive impact on Mathematics anxiety, autonomy and self-efficacy if the right environment and if the teachers are well trained about constructivism.

Regarding instructional strategies, in all the nine (9) classroom lesson observations, Teachers of Mathematics were observed using Assistive Technology while teaching Mathematics. This result concurred with Mugo (2007) who noted that learners with Visual Impairments have no sight and since the eye is the most important gateway to the mind, Assistive Technology is necessary for compensation of their sight. The author further emphasized that, the visual impression is the one that can be easily interpreted and learners with Visual Impairments lack the visual impressions and thus, more attention and efforts ought to be directed towards the provision of appropriate Assistive Technology and availing of qualified personnel in and out of the classrooms. Further, Barghoutti (1973) argued that learners learn and remember more from what they see and they also get much more information about the subject through sight than through our ears, smell, taste and touch.

All the nine (9) teachers were observed introducing the topics by stating the objective and demonstrating to learners with Visual Impairments on how to manipulate the Assistive Technology. This finding concurred with Wairimu (2013) who revealed that majority of Teachers of Mathematics were observed employing demonstration method of teaching while teaching learners with Visual Impairments. Demonstration method of teaching engages multiple senses of the learner with Visual Impairments and can help to ensure learning and understanding while the Teachers of Mathematics emphasizes important points or concepts Tebo (2009). Tebo (2009) further pointed out that demonstrations are good for attracting attention of learners with Visual Impairments.

In four classroom lesson observations, the four Teachers of Mathematics were Visual Impairments and they did not have readers. Thus, once they demonstrated on how to manipulate the Assistive Technology, nobody confirmed that the learners with Visual Impairments manipulated the Assistive Technology correctly. Teachers of Mathematics should state objectives at the beginning of the lesson and not simply describe the upcoming learning activity (Perrott, 2014) as stating the objective at the beginning of a lesson make learners expectations clear Wong and Wong (2001).

In all the nine (9) classroom lesson observations, none of the Technology of Mathematics was observed visiting learners individually to demonstrate on how to manipulate available Assistive Technology and also stating the objectives at the beginning of the lesson. Half of the teachers were observed using question and answer method while teaching learners. This was an indication that slightly above half of the learners with Visual Impairments were engaged throughout the lesson. The findings did not concur with that of Kautz (2016) where all the four (4) instructors recorded on video engaged their students throughout the lesson by calling on students to answer mathematical questions and to work problems at the whiteboard. Hartman of 2001(as cited by Kautzt 2016) advocates on planning what will be taught, demonstrating to the learners and illustrating the techniques for modelling.

A game motivates learners enabling them to perceive a Mathematical task as fun and entertaining which was not observed in this study. Learners with Visual Impairments observe items which are accessible to them through use of their remaining senses namely: by feeling, listening, tasting, smelling and using the remaining vision (Ndurumo, 1993). Use of games can be paper-based, manipulative-based, and technology-based or board games. A game motivates learners thus they perceive a Mathematical task as fun and entertaining (Kautz, 2016).

Teaching with manipulative refers to a technique that teachers of Mathematics use when teaching concepts that are more abstract to their learners (Moyer, 2001). Kautx (2016) stated that “using items such as geometric shapes, graphs and number lines to touch and manipulate helps learners to visualize representations and understand concepts in a more concrete way” (p. 38). Further, the author observed that object concept for a learner with Visual Impairments begins to emerge between three (3) years to five (5) years, while a learner who is sighted develops the concept of objects by two (2) years. This delay causes the learner with Visual Impairments to be delayed in the acquisition of spatial concepts and their causality.
At the stage of manipulating the Assistive Technology as the classroom observation sessions progressed, all the learners with Visual Impairments were observed using the sense of touch while interacting with the Assistive Technology. This is in agreement with Piaget (1967) who argued that learners including those with visual impairments learn best when they are actively interacting with the physical environment and seek solutions for themselves which could increase the rate of development because the opportunity to touch and manipulate objects help them to think in more ways that are complex.

This study also established that slightly above three quarter of the classroom observation sessions, learners with Visual Impairments were not allowed to refer to the content in the Braille Mathematics text books. Instead, the learners with low vision were appointed by Teachers of Mathematics to read Mathematics problems in print as the learners with Visual Impairments listened. These results of learners with low vision reading on behalf of learners with Visual Impairments concurred with that of Mugo (2013). Mugo (2013) carried out a study at Kenyatta University to investigate on how students with Visual Impairments accessed the books and other reading materials in the postmodern library, Mugo’s study of 2013 noted that students with Visual Impairments had to depend on their sighted readers to read the materials for them since it was in print”. In the remaining quarter of the classrooms observation sessions, learners with Visual Impairments were allowed by Teachers of Mathematics to refer to the content themselves through touch. This is why Ndurumo (1993) noted that a learner with Visual Impairments reads with one hand using the fingers to touch and moves from left to right the same as reading by sight. Braille reading refers to reading by touching the raised dots in the cells. This finding was in line with the Theory of Didactical situations which advocates on learning using combination of more than one senses.

V. CONCLUSION

Based on the findings presented above, the study concludes that; inappropriate use of teaching methods and instructional strategies is real in special primary schools in Kenya and this has contributed to lack of interest in working out Mathematics problems leading to a decline of Mathematics performance.

VI. RECOMMENDATIONS

In view of the findings and conclusions that this study has concisely enumerated, the following recommendations was made in order to help improve the teaching and learning of Mathematics using Assistive Technology to learners with Visual Impairments in special primary schools in Kenya.

1. Teachers of Mathematics to improve their teaching performances using combined methods when teaching the subject and the government through Ministry of Education to be supervising teachers of Mathematics regularly while teaching the subject.

2. The government through Ministry of Education to conduct regular classroom supervisions to ensure efficient use of appropriate teaching strategies in the special primary school in Kenya.

3. There is need to investigate strategies of Assistive Technology on teaching and learning Mathematics in other categories in Special Needs Education namely: hearing impaired, physically disabled, learning disabilities and autism.

REFERENCES


