FACTORS INFLUENCING THE USE OF ASSISTIVE TECHNOLOGY IN TEACHING MATHEMATICS TO LEARNERS WITH VISUAL IMPAIRMENTS IN SPECIAL PRIMARY SCHOOLS IN KENYA

Chege Mary Wairimu[1], Joel M. Chomba[2], Beatrice Bunyasi Awori[3]

[1-3] Department of Special Needs Education, Kenyatta University, KENYA.

[1]marywai72@gmail.com

ABSTRACT

Learners with visual impairments (VI) in Kenyan primary schools usually perform poorly in Mathematics as compared with the other examinable subjects. With this regard, this study sought to identify factors that influence the use of Assistive Technology (AT) in teaching Mathematics to learners with VI in special primary schools for the Blind in Kenya. The study adopted a descriptive research design targeting 76 learners with VI in classes seven and eight, and 10 teachers of Mathematics from 5 special primary schools. Purposive sampling was used to select 10 teachers, while simple random sampling was used to select 20 learners with VI. Interview guides and observation checklist were used for data collection. The study established that the major factors influencing use of AT devices included: inadequate time for syllabus coverage, high cost of AT devices, inadequate teacher training in the use of AT devices, rigid curriculum and negative attitudes of learners. The study recommends that: the government should allocate more funds for AT devices and conduct regular classroom supervision to ensure efficient use of AT devices.

Keywords: Assistive Technology, Mathematical analysis tools, Learners with VI

INTRODUCTION

According to Ogula (2010), Mathematics is the fundamental that seeks an understanding of a number of disciplines which play a crucial role in socio-economic development. Nowadays we are witnesses to rapid expansion of information and communication technologies that require new technicians all the time whose education is based on Mathematics as well (ICEVI, 2014). With the advancement of technology, computer adapted hardware, software and other assistive devices for the blind and Braille printout can make a greater improvement to the education of these learners. A previous study by Flanagan (2008) established both positive and negative effects on learner's achievement on the use of Technology. The author noted that "a number of new technologies are emerging to support and enhance learning in schools" (Flanagan, 2008, p. 1). At the lessons of Mathematics, learners with VI used Braille books with tactile pictures. To make notes, they used electronic notebooks and for calculations, they used mechanical typewriter (Kohanova, 2006).

In recent years there has been a surge in research and development of technology-based solutions to the teaching of STEM subjects for learners with VI in the developed countries. These include; Mathplayer, Talkmaths, Refreshable Braille displays, advanced scientific talking calculators and other tools which are changing lives every day to learners with VI (Suzuki, Yamaguchi & Gardner, 2011). From audible representation of graphs and charts, to more complex solutions involving the use of Mathematical coding, such innovation software provides a variety of methods of learners who use Braille to access, interact with and create Mathematical content (Rowe, 2014). Technical subjects such as STEM have been particularly challenging for learners with VI. Rapp and Rapp (1992) reported that learners with VI were less likely to participate in advanced Mathematic classes. However, despite this supposed

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difficulty, there was evidence that learners with VI could perform well in STEM subjects and even excel at them (Cryer, 2013).

The national survey in Zambia carried out by Akakandelwa and Munsanje (2012) and ICEVI's (2010) surveyed on the teaching of Mathematics to learners with VI in Kenya's mainstream secondary schools showed that there was a considerable lack of suitable AT resources in the field of Mathematics. These studies concluded that, "Failure to equip these learners, their teachers and education specialists with the appropriate resources means that most children with VI performed below par in their studies and were inevitably required to drop Science and Mathematical subjects" (ICEVI, 2014, p. 19). From this background, the current study sought identify factors that influenced the Assistive Technology used for teaching and learning Mathematics to learners with VI in classes seven (7) and eight (8) in special primary schools for the Blind in Kenya.

Specific objective of the study

The purpose of this study was to find out the factors influencing the use of assistive technology in teaching Mathematics to learners with visual impairments in special primary schools in Kenya.

LITERATURE REVIEW

Factors influencing the use of Assistive Technology in teaching Mathematics

Assistive Technology device is a tool used to unlock teaching or learning and expand the horizons of learners with VI which allows them to lead a productive, independent and healthy life (Jackson, 2009). AT devices usually supplements Braille literacy enhancing communication in teaching or learning and expand the world of persons with VI as their means of communication in many significant ways (Chomba, 2017; Mugo, 2013).

Kohanova (2006) conducted an experimental study in a developed country to investigate on teaching Mathematics to students with VI with specialization in solid geometry. The study noted that some teachers of Mathematics who were not familiar with computers refused their usage as writing devices during examination time for learners with VI, thus students with VI had to pass exam verbally where their schoolmates who were sighted answered the exam questions in writing. Other challenges that the researcher noted included; lack of text books, study materials and limited Braille notation for Mathematics.

Mwakyeja (2013) carried out a case study in one of the secondary schools in Tanzania on the way teachers taught students with VI in inclusive education and the challenges they faced. The study adopted qualitative case study design. Semi-structured interviews and participant observation methods were employed to collect the data from four general teachers who were teaching in classes which had students with visual impairments. The study revealed that: teachers teaching students with VI had little knowledge about inclusive education which included skills of teaching Mathematics. The researcher further noted that: despite teachers' have had some little knowledge of teaching in inclusive settings; they were not using it due to: scarcity of the resources, rigid curriculum, scarcity of both special needs and general teachers and lack of commitment of teachers.

A study carried out by Mugo (2013) interviewed five (5) staff from Kenyatta University and three (3) staff from Syracuse University who provided services of AT to learners with VI. The study pointed out that although the three personnel from Syracuse University had masters degrees, neither of them had trained in the area of AT for the Blind nor the field of Special Needs Education. Moreover, from Kenyatta University out of the five (5) personnel, only one who had been trained in the field of AT for students with VI though for a short

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course certificate. The study concluded that students and the personnel from both Universities lacked training in the area of AT for learners with VI. Lack of knowledge and proper skills prevented the students with VI from using some of the devices and software that were in their possession. Moreover, it was also discovered that the provision of AT to the end user through educational institutions was a major challenge due to the high cost leading to serious scarcity of AT devices.

RESEARCH METHODOLOGY

Research Design

This study adopted a descriptive survey research design to gather the raw data. According to Gay, Mills and Airasian (2006), descriptive surveys are concerned with assessing attitudes, opinions, preferences, demographics, practices and procedures. Thus, the researcher in this study found the descriptive survey design appropriate because it helped her in the collection of raw data based on the attitudes, opinions, preferences and the demographics of the study participants.

Target population

The study targeted 76 learners with VI in classes seven and eight who were without other disabilities and 10 teachers of Mathematics in the 5 special primary schools.

Sample Size and Sampling Technique

Purposive sampling method was used to select 10 teachers, while simple random sampling method was used to select 20 learners with VI and without any other disabilities. This gave a total of 30 respondents.

Data Collection and Data Analysis

Interview guides and observation checklist were used as the tools for data collection. The collected data was qualitative in nature. This data was analysed through identification, examination and interpretation of patterns and themes in textual data. The statistics used involved frequency counts, percentages, means and standard deviations.

STUDY FINDINGS AND DISCUSSIONS

Factors influencing the use of Assistive Technology in teaching Mathematics to learners with VI

The study sought to determine factors influencing the use of Assistive Technology in teaching Mathematics to learners with visual impairments in special primary schools for the Blind in Kenya. To address this objective, Mathematics teachers asked rate their familiarity with the eight factors influencing their use of Assistive technology while teaching mathematics. A 5-point likert scale was used. The scale ranged from 1 to 5 with, 5 denoting very familiar, 4 representing familiar, 3 undecided, 2 unfamiliar and 1 very unfamiliar. The midpoint of the scale was 3. Therefore, mean scores above 3 denoted that teachers were familiar with the item while mean scores below 3 denoted that teachers were unfamiliar with the item. The results of the analysis showed that the mean scores obtained by the teachers on factors that influenced the use of AT ranged from 4.70 to 2.6. The highly scored factors on the scale were high cost of AT and costly maintenance (4.70), inadequate time (4.70), rigid curriculum (4.30), negative attitudes of learners (4.30) and negative attitudes of Mathematics teachers (4.00). On the other hand, the lowest ranked factors were negative attitude of administration (2.60) and lack of training skills (3.50).

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Table 4.1. Teachers' responses on factors influencing the use of Assistive Technology in teaching Mathematics

Factors	Very familiar		Familiar		Undecided		Unfamiliar		Very unfamiliar		Mean	Std. Dev.
	F	%	F	%	F	%	F	%	f	%		
High cost of AT and costly maintenance	7	70.0	3	30.0	0	0.0	0	0.0	0	0.0	4.70	.483
Inadequate time	8	80.0	1	10.0	1	10.0	0	0.0	0	0.0	4.70	.675
Negative attitude of learners	3	30.0	7	70.0	0	0.0	0	0.0	0	0.0	4.30	.483
Rigid curriculum	4	40.0	5	50.0	1	10.0	0	0.0	0	0.0	4.30	.675
Negative attitudes of teachers	2	20.0	6	60.0	2	20.0	0	0.0	0	0.0	4.00	.667
Unavailability of assistive technology	2	20.0	5	50.0	0	0.0	3	30.0	0	0.0	3.60	1.174
Lack of training skills	1	10.0	6	60.0	3	30.0	0	0.0	0	0.0	3.50	1.080
Lack of awareness	3	30.0	2	20.0	2	20.0	3	30.0	0	0.0	3.50	1.269
Negative attitude of administration	2	20.0	1	10.0	0	0.0	5	50.0	2	20.0	2.60	1.506

From the results, the high cost of AT and its costly maintenance emerged as the major factor that had greatly influenced the use of the AT for teaching Mathematics to learners with VI in special primary schools (See table 1). This study finding on high cost of AT devices support Kochung (2003) and Muigai (2017). Kochung (2003) found out that the average cost of educating a learner with VI in a boarding special school was Ksh 32000 per year. Further, Kochung noted that learning and teaching devices was allocated Ksh 6000. Recently, Muigai (2017) revealed that the cost of one Braille machine cost Ksh 75,000 for an individual learner and a thermoform Ksh 300,000. He further found out frequent curriculum reviews of education, shortage of trained personnel to teach learners with VI, negative attitudes and ignorance of parents of children with VI, inadequate instructional materials and facilities for the education of the persons with VI are the major historical challenges that the education for learners with VI had faced between 1945 and 2013. In another research, Wairimu (2013) established that learners with low vision in integrated programmes as well as those in the mainstream in Nairobi City County had negative attitudes towards Mathematics. This study support Bottom (1983) who found out that when the learners' attitudes are negative towards a particular subject, all stakeholders should be examined. Table 4.2 illustrates other factors which influence use of assistive technology influence on the use of assistive technology in teaching Mathematics.

Table 4.2. Other factors reported by study participants that bear influence on the use of assistive technology

Other factors that influenced the use of Assistive Technology by Teachers of Mathematics			
No.	Report regarding factors of Assistive Technology	Categories of participants	F
1	No extra time set to teach AT skills	3, 4, and 8	3
2	Inadequate Braille text books for Mathematics	1	1
3	Late intervention	9	1
4	Lack of motivation to ToM and learners	9	1
5	Shortage of ToM	9	1
6	Teacher-pupil ratio very high	3	1
	Total		8

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Results in Table 2 revealed that only half (5) of the participants mentioned other factors that had influenced the use of AT in teaching Mathematics to learners with VI in special primary schools in Kenya. The other half of the participants i.e. codes 2, 5, 6, 7 and 10 (Appendix I) did not respond to the item regarding the effects of AT on teaching and learning Mathematics. Five (5) participants who did not respond to this item were persons with low vision (2) while the other three (3) were sighted. This was an indication that these participants were not conversant with the challenges learners with VI faced when learning Mathematics with and without AT. Three participants out of the ten reported that their class time table had no extra time that was allocated to teach AT skills.

One participant, code 9 (appendix I), who was a sighted male teacher and a holder of a master's degree and a ten-year experience in teaching Mathematics, reported the highest number of other factors that influenced the use of AT devices to learners with VI in special schools. This was an indication that the participant had desired knowledge and experience about AT for teaching Mathematics. Other five (5) factors that this participant (code 9) reported included: inadequate Braille text books for Mathematics, late intervention, shortage of ToM, lack of motivation of teachers and learners and high teacher-pupil ratio.

Plate 1.A: A pack of broken down thermoform machine (on top) and a perforating machine below it at study site A

Thermoform is a high-tech machine that is used for duplicating Brailled papers for use by learners who read through touch. Plate 1.A represents a pack of broken down thermoform and a perforating machine which had broken down at study site A.

Plate1.B: A broken abacus at study site C

Plate 1.B represents a broken abacus that a learner with VI was using to compute Mathematics skills. The teacher of Mathematics who was teaching a lesson by the time of

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collecting this data was Blind and had no reader. Thus, the teacher was not aware that the learner had a broken down abacus. This study disagree with Kiambati (2016) who found out that most of students with VI used their colleagues who were sighted to read for them.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings presented above, the study concludes that there are numerous factors affecting the use of AT devices in the teaching and learning of Mathematics among learners with VI in special primary schools in Kenya. As such, there is need to work out a formula to remove all learning barriers that can hinder the smooth running of educational programmes initiated for learners with VI to help them to be self-reliant. The study recommends that:-

1. Government through the Ministry of Education should allocate necessary funds for the acquisition and supply of much needed modern AT equipment/devices for teaching Mathematics to learners with VI to special primary schools such as Braille electronic note takers, audio Mathematics text books which will widen access to Science, Technology, Engineering and Mathematics (STEM) to learners with VI.
2. Ministry of Education should prioritize the provision of AT devices that learners with VI require for them to learn effectively in their classrooms.
3. Government through the Ministry of Education to introduce a compulsory AT training course especially in Mathematics in teacher training colleges. For those teachers of Mathematics who are already trained; the Ministry of Education to organize workshops, refresher and in-service courses for them at least twice a year.
4. A study should be carried out with an aim of investigating analysis of AT on teaching and learning Mathematics in other categories in Special Needs Education namely: hearing impaired, physically disabled, learning disabilities and autism.

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APPENDIX-I

Study Participants by Code, Site Code and Gender

Study participants by code, site code, gender, condition of the participants and experience range in years

Participant code	Site code	Level of training	Gender	Condition of the participant	Range in years of experience
1	A	Masters	M	Sighted	6 - 10years
2	A	Masters	F	Low vision	6-10years
3	B	P1 certificate	M	Blind	Less than 5 years
4	B	Diploma	M	Blind	Less than 5years
5	C	Diploma	F	Low vision	11-15years
6	C	Diploma	M	Sighted	5years
7	D	Bachelor	F	Sighted	6-10years
8	D	Diploma	M	Blind	6-10years
9	E	Masters	M	Sighted	6-10years
10	E	Diploma	M	Blind	6 – 10 years
11	B	Diploma	M	Sighted	Less than 2 years
12	C	Bachelor	F	Sighted	Less than 2 years
13	D	Diploma	M	Sighted	Less than 2 years
14	A	Diploma	M	Sighted	Less than 2years

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