International Journal of Science and Research Archive

eISSN: 2582-8185

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Check for updates

Tactile materials as correlates of performance in mathematics among learners who are blind: The case of Thika high school for the blind, Kiambu County, Kenya

Loise Mumbua Musango *, Margaret Wangui Murugami and Joel Chomba Wamunyi

Department of Early childhood and special Needs Education, Kenyatta University, Kenya.

International Journal of Science and Research Archive, 2024, 12(01), 600–612

Publication history: Received on 01 April 2024; revised on 10 May 2024; accepted on 13 May 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.12.1.0837

Abstract

The purpose of the study was to assess the use of tactile materials as correlates of performance in Mathematics among learners in Thika High School for the Blind. The objectives were to: identify the tactile Mathematics materials used by teachers while teaching learners who are blind, explore the adequacy of the tactile teaching and learning materials, and identify the challenges that teachers face in adapting Mathematic tactile teaching materials. This study adopted social constructivism theory and used a case study research design. Target population was 85 respondents comprising 5 Mathematics teachers and 80 learners who are blind in the school. Purposive sampling technique was used to select Mathematics teachers while stratified random sampling was used to select the learners who are blind according to class and gender. Thereafter, simple random sampling was used to select 24 learners. Questionnaires were used to collect data. Quantitative data was collected, coded and organized. Data analysis was through descriptive summaries and correlational analyses. From the findings, most essential tactile materials for teaching Mathematics were not available in the school. Some teachers were not proficient in Braille Mathematics, thus a major hindrance for them to teach effectively. Many respondents recommended that the government should set aside more funds for Mathematic teaching and learning resources since their use in teaching was of uttermost importance. Therefore, this study recommends a need for the Ministry of Education to introduce AT courses in teacher training colleges. In addition, more time should be allocated in the school timetable for effective use of materials in teaching Mathematics to learners with visual impairment. Also, there is need for proper planning; preparation, presentation, appropriate application and essential follow up make the use tactile Mathematics materials ineffective by the teachers.

Keywords: Tactile Materials; Totally Blind; Mathematics Performance; Learners Perception; Tactual

1. Introduction

Mathematics is important and an indispensable subject in human life. The utility of learning Mathematics is something phenomenal considering the application of Mathematics in one's life. Mathematics is used in all disciplines and one cannot do without it as it opens up career opportunities for learners (Wheeler, 2004). Yet, global trends, especially in developing nations, have shown that learners with Visual Impairment (VI) are hampered from realizing their full potential in careers and disciplines that are mathematically oriented (source). This is due to the nature of mathematical concepts that they acquire during teaching, learning and training (Maher & Martino, 1996).

Brosnan (1997) carried out a study in France on factors contributing to learning of Mathematics among learners with visual impairment. The study identified that a good curriculum for learners with VI must possess carefully chosen objectives that stress a balance among cognitive, affective and psychomotor domain as part of the instructional strategies. It further recommended that key factors such as resources are considered important for effective learning of Mathematics by learners with VI. These factors included selecting and teaching of suitable mathematical Braille code. He also suggested for the adaptation of text materials and teaching on appropriate use of mathematical devices such as

* Corresponding author: Musango Loise Mumbua

an abacus, talking calculators, protractor, compass, and ruler. It provides the right of Mathematics text materials in preparation of appropriate teaching aids, stimulating experiences and creation of stimulating approach (Wheeler, 2004).

The Government of India through the National Institute for Visually Handicapped (NIVH) conducted human resource development program for special educators and resource teachers for schools for the blin. Their study resulted in the development of a Tactile Graphic Tool (TGT) that enabled exploratory progress in making tactile diagrams of graphical and geometrical constructions. The portable digital gadget makes these accessible as digital pictures are interfaced in computer. This benefited people with VI to overcome constraints of accessing graphic information in Mathematics, including graphs, geometry and statistical representations. The case study's result represents a practical manifestation of the potential of Technology assisted learning for VIs (Thamburaj & Nagar, 2010).

Despite the emphasized value of learning and instruction resources in teaching learners who are blind, resource shortages remain a global issue. In Africa, teachers are trained in the reading/writing of Mathematics Braille during their course. A study on education in East, Southern and Central Africa (ESCA) asserted that, despite the training offered in Mathematics subject methods, there is slight to no tailored training relating to Mathematics resources for learners who are totally blind. Hence, there are no emphases on new ideas and innovations to meet their needs which should be cheap and timely. Research that was done in Tanzania, Sierra Leone, Ghana and Nigeria highlighted that teachers had to have good understanding of Mathematics Braille code and provision of relevant Mathematics Braille teaching resources. Such findings highlight the persistence of resource-related issues encountered by learners with VI in the continent.

An earlier study on the factors influencing performance in Mathematics among learners with low vision in integrated public primary schools had clearly indicated that poor provision of materials and resources for Mathematics affected learning of learners with low vision and teaching (Eggleston, 2006). However, the concepts of Mathematics taught in primary school level is far much less complicated to the concepts taught in the secondary level. This is because learning becomes more and more involving and requires more practice. A research conducted by Sight Savers' International as reported by Munsanje (2011) showed that the educators were not all around prepared in the productive utilization of Mathematics material resources and that there was scarce instruction on how to use the resources therefore are unable to operate these devices to their upmost effectiveness. The outcome was that there was no proper use of the materials and resources (Munsanje, 2011).

In Kenya, Thuo (1999), notes most of learners with VI attend secondary schools while they continue to perform poorly in Mathematics due to inadequate resources. Learners with VI depend on mental abilities rather than visual to make calculation easy to solve mathematical problems which comprise use of resource such as graphs, charts and tables. Some learners who are blind may have skills on abacus that help in solving mathematical problem mainly addition, subtraction, multiplication and division (Driscoll, 2005). Abacus does not provide options for mathematical calculations for generating pie charts, graphs and tables. Therefore, a learner who is blind is left with a task that they usually fill through mental calculation in solving such mathematical problem. The mental calculation is prone to errors and forgetting considering the mind and limitation to storing many calculations whereas at secondary school concepts are even more complex to be done mentally (Gachau, 2010). The government of Kenya allows secondary schools to use scientific calculators in mathematical class (KNEC, 2005) which learners with VI cannot use because they are expensive, not readily available and they lack skills to use them thus learners with VI are disadvantaged.

1.1. Statement of the Problem

Mathematic resources are very essential in Mathematics teaching and learning. However, learners with visual impairment continue to perform poorly in Mathematics due to inadequate resources. Schools with scarce resources for learners who are blind can restrict access to gaining knowledge of numeracy, shapes, place value and other Mathematical concepts and hence experience barriers to the entire curriculum. Few studies have investigated the availability of tactile materials for teaching Mathematics in secondary schools in Kenya. Besides, there is limited research on how the availability (or unavailability) of these materials influence learners' academic performance. Therefore, this study sought to address the availability, use of tactile materials as correlates of performance in Mathematics among learners in Thika high school for the blind.

1.2. Purpose of the Study

This study aimed to establish availability, use of tactile materials as correlates of performance in Mathematics among learners in Thika High School for the Blind.

Objectives

- To identify the tactile Mathematics materials used by teachers while teaching learners who are blind in relation to performance in Mathematics.
- To explore the adequacy of the tactile teaching and learning materials in relation to Mathematics performance in Thika High School for the Blind.
- To identify the challenges that teachers face in adopting mathematic tactile teaching and learning materials.

1.3. Hypotheses

- H_{10}: There is no significant relationship between adequacy of tactile materials and performance in Mathematics among learners who are blind.
- H_{11}: There is a significant relationship between adequacy of tactile materials and performance in Mathematics among learners who are blind.

1.4. Theoretical and Conceptual Frameworks

This study adapted the theory of Social Constructivism by Vygotsky (1978) which is concerned with how appraisal should be used to augment both the student's learning and the teacher's understanding of student's progress. Constructivist model encourages the learners to actively participate in their own process of learning Mathematics with adequate Mathematics tactile teaching and learning resources for good performance while inadequate Mathematics tactile teaching and learning materials results to poor performance (Ormrod, 1995).

Constructivist classroom enable both teacher and learners think of knowledge as a dynamic, ever-changing view of the world. The learners therefore should have the ability to successfully stretch and explore, understand the content rather than memorizing (Ormrod, 1995: Owino, 2011). The key assumptions of this theory are that this study adopted that information is not passively accumulated, but rather, is the result of active cognizing by the individual hence this helps learners who are blind to be able to make their calculations in their minds better than their counterparts who are sighted; Cognition is an adaptive process that functions to make an individual's behavior more viable given a particular environment; Cognition organizes and makes sense of one's experience, and is not a process to render an accurate representation of reality and Knowing has roots in both biological/neurological construction, social, cultural, and language based interactions. Constructing a meaning is an active and continuous process therefore learning may involve some conceptual changes (Owino, 2011).

Social constructivism theory emphasizes that, learners who are blind should be provided with adequate tactile Mathematics materials to explore and familiarize, creating way for questions that lead to more questions hence improve their Mathematics concepts. There is a lot of cover in social constructivist study hall, except for the more noteworthy accentuation set on learning through social collaboration, and the worth put on social foundation (Owino, 2011). For Vygotsky, culture gives the kid the psychological instruments required for improvement. This theory also notes that human beings have the ability to perceive real objects that have a sense and meaning beyond shapes that learners who are blind can understand and describe through external and internal speech in our environment (Owino, 2011).

Learners construct a new meaning using Mathematics tactile teaching and learning resources like: Braille Charts and Braille Graphs, Talking Calculators, Abacus, embossers, Measurement tools like rulers, Modified Instruments and equipment like collapsible cube and Tactile diagrams properly. Students use request techniques to pose inquiries, research a subject, and utilize an assortment of materials to discover arrangements and answers. Instructors are relied upon to give an intuitively favorable condition to fruitful learning through direction and backing. Vygotsky argued that there is a moving target when the learners interact with materials to gain new knowledge in Mathematics. Vygotsky argues that teachers have a more elevated level of information than the students along these lines they give basic direction during the learning procedure. In this theory teachers are key who are required to provide initial guidance to learners so that they can develop new ideas in problem solving situation.

Basing on this theory interaction between the visually impaired learners and the teachers, availability and usage of Mathematics materials is pertinent to good performance in Mathematics. Teachers should be well trained to be able to understand how to guide learners who are blind to use the tactile Mathematics materials improve their performance.

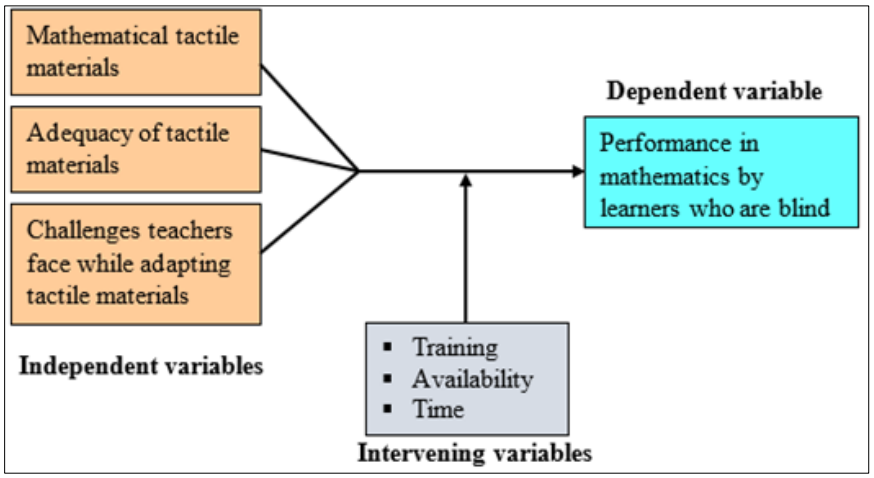

Figure 1 Conceptual Framework

2. Empirical review

2.1. Teaching and Learning Materials Expected for Learners who are blind

Learners who are blind rely on a range of tactile materials to enhance their mathematics experiences. They include Braille charts and graphs, talking calculators, the abacus, Braille embossers, measurement tools, dials, and math windows. Braille charts and graphs involves the first ten letters of the alphabet (a–j) and use the upper four dot positions. The dots stand for the ten digits (0-9) and a, b, c = 1, 2, 3 and to the three vowels in this part of the alphabet (a, e, i), whereas the even digits (4, 6, 8, 0) are corners/right angles. The next ten letters (k-t) are identical a-j respectively; apart from the addition of a dot at position 3.

Talking calculators are intended for visually impaired and low-vision clients, just as second language students. They speak loud as users type a key, bringing about an intelligible voice. Standard makes an increasingly specific model of the talking adding machine which delivers a tape. Add literature.

The abacus is a calculating tool. A bit of delicate texture or elastic is set behind the dots with the goal that they do not move unintentionally. This keeps the globules set up while the clients feel or control them. Students can utilize this device to perform various math functions, including divisions, subtractions, multiplications, additions, square roots, and cubic roots (Nweke, 2004). Braille embossers render texts as Braille on a uniquely thick paper or plastic. Used in conjunction with Braille translation software, embossers can print single-sided or double- sided Braille characters as well as Braille images (Nweke, 2004). Measurement tools are important to gauge and attract edges the geometry homeroom. The most widely recognized gadget for estimating points is a protractor, generally in the state of a half circle. The half circle edge of the protractor is set apart with equitably dispersed divisions from 0º to 180º. Striking enormous print numbers and two Braille dabs are utilized to stamp degrees at 10º increases. Other gear might be named or checked tangibly for the accommodation of a visually impaired individual.

Dials might be set apart by making grooves with a scratch drill or dabs of dried paste or fingernail clean. Decorated chart sheets have Braille dab matrices on manila paper. Decorated diagram sheets and progress outlines have 50-pack. Transcribers, educators, students, and guardians would now be able to stamp anything from maps to machines. They can build geometric and different figures and diagrams identified with math, variable based math, geometry, trigonometry, and analytics which comprise of a stopper board mounted with an elastic tangle embellished with a 34 x 30 lattice of 1/2 inch squares. Included are three level spring wires, 14 push sticks, and elastic groups.

Math Window is a simple to-utilize math training device using attractive tiles on an advantageously measured work surface. It is versatile and accompanies its own conveying case. Math ideas are clearer utilizing this material strategy for building and taking care of math issues. Tiles can be straddled along the border of the board or on our new connectable tile bed (Orton & Frobisher, 1996). It assessed availability of this teaching tool and other related tactile materials used by learners with visual impairment in learning Mathematics.

The literature reviewed is partly in line with the objective on availability of teaching and learning materials expected for learners who are blind. However, this research wishes to address how the tactile Mathematics materials are used to improve on Mathematics performance for leaners who are blind.

2.2. Adequacy of the Tactile Teaching and Learning Materials

The achievement of educating and learning depends to the accessibility of and powerful utilization of instructing materials. Babu (2005) perceives the need to utilize the important gear and ad lib the fundamental learning helps utilizing locally accessible materials. Accessibility of instructing and learning assets are an essential in deciding the exhibition of Mathematics by students with VI. On the off chance that the instructor of Mathematics would like to bestow change and improvement in the presentation, there must be sufficient and suitable assets as far as structures and educating or learning assets. Absence of assets adds to low quality of training (Kimani, 1990).

As per Kimani, (1990), the utilization of instructing and learning materials gives students higher odds of showing improvement over those students who don't utilize them. The insufficiency of the getting the hang of, training materials and gear in the school has a significant commitment towards horrible showing of Mathematics. Students going to inadequately prepared schools have an inclination of performing ineffectively. Instructors ought to have the option to distinguish straightforward showing helps from the earth and ought to likewise have the option to make a portion of the educating helps. Therefore, a few instructors abstain from utilizing training helps in their exercises and this adversely influences the student's exhibition. In order to teach Mathematics to learners who are totally blind, specialized resources such as Brailed textbooks, abacus, graph boards, cubes and cuberithm boards, graphic art for Mathematics, Sewell kit, Brailed geometrical equipment, talking calculators and types with boards should be made available to the learner.

The instructing of Mathematics to students with visual disability ought to be finished by a uniquely prepared educator who is acquainted with the utilization of these particular gadgets (Tinsley, 2007). Flanders (1965) supported by Yunus and Ali (2009) both asserts that learners should be provided by the teachers with appropriate learning resources for example, course readings notwithstanding reasonable Mathematics learning gadgets. According to Cummine (1986), teachers should be innovative in training learners with visual impairment through organizing Mathematics layout in writing and adapting the syllabus in order to suit the learners. Further, the use of models for any 3-dimensional concepts is highly recommended when teaching visual impairment students. When Teaching Mathematics involves a lot of diagrams that need to be specially developed for reading tactually by learners with VI. These tactile diagrams should not use excessive details and should have good contrast in construction materials (Yunus & Ali., 2009).

In Kenya, instructing and learning assets for students with VI has been to a bigger degree gave by NGO's, for example, Christofel Blinden Mission. With the presentation of free essential training in January 2003, the administration began giving assets to the acquisition of educating and learning assets in these schools, however these assets might not have been satisfactory to buy the necessary assets, for example, the course books, Cramer math device, Braille, 3D squares and cuberithm boards. The researcher strongly agrees with the related literature in this section since the adequacy of resources is not yet established, the researcher sought to investigate the extent to which learners who are blind are involved in availability and use of tactile resources in their daily learning processes in relation to their performance in Mathematics.

2.3. Challenges Faced by Teachers and Learners in Adopting Mathematical Teaching and Learning Materials

Challenges reported by teachers who teach learners with VI for example, government employed teachers suggest lack of skills and knowledge on use of resources to teach Braille Mathematics. Hill, (2002) states that there exists limited adopted Braille Mathematics teaching aid that teacher may use like Braille protractor, rule, compass and other adopted equipment which are key component during the learning and teaching and of Mathematics. Instruction time is often short during lesson presentation because learners who are TB need more individualized attention for them to adequately conceptualize a mathematical concept, yet the time provided for mathematical lesson is only 40 minutes. This time limitation makes the teacher not to attend to TB effective and may even rush through the content to finish the syllabus leaving some conceptualization gaps in the content taught (Bansal, 2007). Shortage of Mathematics Braille books makes teaching and learning of Mathematics teacher-centered an approach which is not frequently recommended for large group of learners, hence not suitable for learners who are VI (Martin & Harel, 1999).

Furthermore, Jordan, Carlile, & Stack, (2008) carried out research on the intellectual development through progressive building up of mental images. Images that can be memorized recalled and manipulated. It is in this study whereby they identified that learners with VI encounter difficulties.

This suggests that a stimulating environment and rich experiences need to be provided for learning Mathematics. Descriptions of Mathematical concepts that intrigue to perception might be gotten a handle on quickly by the located students while they require fundamentally progressively subjective preparing for the individuals who are visually impaired (Davis & Mason (1998). Many teachers may find it hard to provide stimulating environment and rich experiences suggested above because they tend to concentrate a lot on visual descriptions.

3. Materials and methods

This study employed the case study design using quantitative methods to assess the relationship between tactile materials and learners' performance in Mathematics. Most case studies select a small geographical area or a very limited number of individuals as the study subjects (Orodho, 2005). In this research, the researcher selected a single school and a sample to represent the target population. This design in its actual quintessence, investigates and explores contemporary genuine marvel through itemized logical examination of a predetermined number of people or conditions, and their connections (Orodho, 2010). The case chosen for the study was Thika High School for the Blind (THSB) in Kiambu County, Kenya. The school was selected because it is the first school for learners with VI to be established in Kenya. Besides, it has a high population of learners who are blind and a long history serving and educating learners with VI in the country, especially in Mathematics. Being a national school, it has a solid foundation and has proved some effort in sourcing Mathematics teaching and learning materials hence an icon in championing education for the visually impaired. The ministry of education usually consults from the school and the school has structures and commendable resources for learners with VI.

The study's target populations included learners who are Totally Blind and mathematics teachers at THSB. The school had 80 learners (36 boys and 44 girls) who are Totally Blind at the time of the study. All the 80 were eligible for inclusion. THSB also had five mathematics teachers. Hence, the total target population comprised 85 learners and teachers (Table 1).

Table 1 Sample Frame

Category	Target Population	Sample Size	Percentage
Mathematics teachers	5	5	100
Learners who are Totally Blind s	80	24	30.0
Learners with RD	85	29	34.1

The researcher included all the five teachers who taught Mathematics in all the classes for purposes of obtaining information on the topic of study. Stratified random sampling was employed to select the learners. The learners were stratified according to class and gender and thereafter simple random sampling was used to select 24 learners, constituting 30% of the target population. The final sample had 29 respondents, as shown in Table 1. The study used both primary and secondary sources to obtain data for analysis.

Two sets of primary variables (one dependent and four independent factors) were included in the analysis, as per the objectives (Figure 1). The dependent variable was performance in Mathematics. The data on this variable was retrieved from school documents. Three independent variables were examined: tactile teaching and learning resources, adequacy of tactile materials, and challenges teachers face while adapting Mathematics tactile materials. Data on these variables were obtained from questionnaires for teachers and learners. The questionnaire for teachers had both closed and open-ended items, which gave them the chance to give their opinion on the performance of the learners in Mathematics. The tool enabled the researcher to gather information on the common tactile materials that teachers used while they are teaching, challenges teachers faced while adapting tactile materials and the adequacy of tactile teaching and learning materials. The questionnaire for learners also included closed and open-ended items. While the structured section was easy to fill and kept the respondent on the subject, the unstructured sections of the questionnaire allowed them to express themselves freely without restriction.

A pilot study was conducted at St Lucy Secondary School for the Blind. The school is located in Igoji, Meru County, and was selected because it has similar characteristics as THSB. The researcher sampled two Mathematics teachers and 12 Mathematics learners who are blind for the pilot. The results of the pilot study were used to evaluate the quality of the research instruments. Reliability was measured and calculated using the test-retest method. The questionnaires were administered to the group members twice with a break interval of two weeks between the first and the second

administrations. After administering the second test instrument, the results were correlated using Pearson's product moment correlation and a correlation co-efficient of 0.75 was obtained and considered high.

Data collection involved administering the questionnaires and examining school records for learners' performances. After notifying the administration on intention of collecting data, teachers who were respondents were assembled and given questionnaires while teachers and learners who were TB were assisted in filling in the questionnaires since the questionnaires were in print. Secondary data was retrieved from school documents. In collecting data, professionalism was adhered to and data collected within two months with the help of two research assistants who were had specialized in Braille and special needs education.

The collected data was organized, coded, and cleaned to ensure it was free of errors. In the case of quantitative data, the researcher numbered the questionnaires appropriately. This was followed by the coding process to mark and categorize information such as gender, age, and education attainment. Statistical Package for Social Sciences (SPSS) program was used to analyze the data. The presentation of the results was through charts, tables, graphs depicting frequencies and percentages.

4. Results and discussion

4.1. Participant's Characteristics

A total of 29 respondents, including 24 learners and five teachers, participated in the study by answering questionnaires. The demographic characteristics of the learners were age, level of study, preferred course of study and confidence in Mathematics. As shown in Table 2, 14 (58.3%) learners were between 18-21 years, while 3 (12.5%) were in the age range of 22-24 years. The other 7 (29.2%) were in the age range of 18-21 years. It is worth noting that all the learners in the sample were older than expected age at this level of education. Specifically, those in 22-24 should have been in postsecondary institutions. A possible explanation is that they either enrolled in school late or repeated several classes, hence, delaying at the lower levels of their education (there are often no repetitions in secondary schools in the country). An exploration of their performance in Mathematics before joining secondary education revealed that 15 (62.5%) attained a grade C in KCPE. Six (25%) obtained between grades A and B, and only 3(12,5%) had a D score. The implication is that learners who are blind perform well in Mathematics at the primary level because none indicated failure or grade E.

Table 2 Characteristics of Learners of Learners in the Sample

Characteristic	***Frequency***	***Percent***
Age		
14-17 years	*7*	*29.2*
18-21 years	*14*	*58.3*
22-24 years	*3*	*12.5*
Level of Study		
Form one	6	25.0
Form two	6	25.0
Form three	6	25.0
Form four	6	25.0
Math grade in Class Eight		
A	1	4.2
B	5	20.8
C	15	62.5
D	3	12.5
Preferred course		

Science	13	54.2
Arts	11	45.8
Level of Confidence in Math		
Very confident	2	8.3
Confident	16	66.7
Not confident at all	6	25.0

When asked what they preferred to pursue at the secondary school level, 13 (54.2%) learners preferred to pursue a science course in the future and Mathematics is often classified as a science course. Furthermore, 18 (75%) indicated being confident or very confident in Mathematics. This affirms Maguvhe's (2015) suggestions that learners who are blind have the same mental capacity to comprehend Mathematics and merely need to be appropriately accommodated to enable them to perform as well as their sighted counterparts in Mathematics.

Teachers' demographic characteristics included gender, highest level of education, professional qualification, training in special needs and teaching experience. Their distribution according to these characteristics is in Table 3.

Table 3 Characteristics of Learners of Learners in the Sample

Characteristic	**Frequency**	**Percent**
Gender		
Male	3	60
Female	2	40
Level of Training in Special Needs		
Certificate	4	80
Degree	1	20
Teaching Experience		
6-10 years	3	60
Over 10 years	2	40

Three (60%) teachers were males, while the other 2 (40%) were females. The findings showed that there are more male teachers teaching Mathematics than their female counterparts. This may have a bearing on Yunus and Ali (2009) study that states that students like being taught by male teacher than female teacher. All respondents indicated having attained the university level of education and consequently attaining Bachelor of Education as their professional qualification. All the respondents also showed that they had been trained in special needs, with majority of them (80%) being trained up to the certificate level. More than half had a teaching experience of between 6-10 years. This findings conquers with Vinner (1991) and Wanjohi, (2003) that level of education, professional qualification and as well as teaching experience of teacher contributes greatly toward performance in Mathematics as they regularly interact with learners and have mastered mathematical skills and how to impact the knowledge to the learner.

4.2. Tactile Mathematics Materials used by Teachers while Teaching Learners who are Blind

The first objective sought to find out the tactile materials that were used by teachers to teach Mathematics to learners who were blind. Teachers were asked to indicate the tactile materials used in their schools when teaching Mathematics to learners who are blind. They responses were as shown in Figure 2.

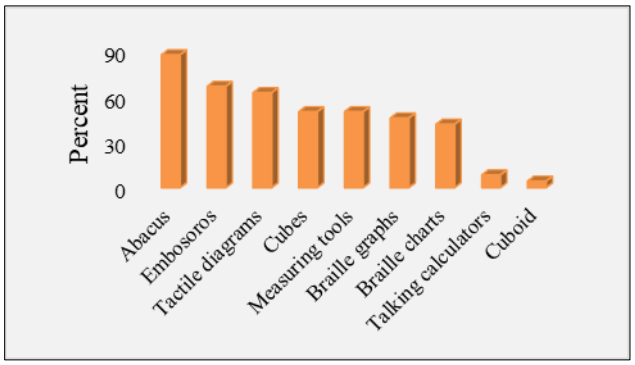

Figure 2 Tactile Materials Used in Teaching Mathematics

The majority (87.5%) indicated that abacus was used to teach Mathematics in their schools. More than a half (66.7%) indicated that embossers was used, while an almost equal number (62.5%) indicated that tactile diagrams were used. However, only a few of the respondents (8.3%) and (4.2%) indicated that talking calculators and cuboid were used respectively. These findings ascertain that Mathematics lesson uses variety of tactile materials during learning and teaching. Therefore, in line with Wheeler (2004), Tinsley (2007) and Thamburaj & Nagar (2010) statements that for better performance, these materials need to be widely adopted to the needs of the learners effectively and efficiently.

To further address this objective, Pearson correlation coefficient was obtained for the association between the tactile materials used in teaching and learners' performance in testing the null hypothesis that there is no statistically significant relationship between the tactile Mathematics materials used in teaching learners who are blind and Mathematics performance. There was a weak positive relationship between tactile materials used in teaching and performance in Mathematics, (r = 0.335, p = 0.11). The relationship that was not statistically significant at the 95% confidence level, hence, the null hypothesis was accepted.

4.3. Adequacy of the Tactile Teaching and Learning Resources on Mathematics Performance

To address this objective, the researcher presented both the learners and teacher respondents with items that enquired on the adequacy of the learning resources. The respondents rated the adequacy on a five point Likert Scale items, including very inadequate (VI), inadequate (I), not sure (NS), adequate (A), and very adequate (VA). The findings are as shown in Table 4. The table shows both frequencies and corresponding percentages (in brackets).

Table 4 Learners' Perception on the Adequacy of Learning Resources

Resource	VA	A	NS	IA	VIA
Library resource	4 (16.7)	17 (70.8)	1 (4.2)	2 (8.3)	0 (0.0)
Mathematics textbook	6 (25.0)	13 (54.2)	1 (4.2)	4 (16.7)	0 (0.0)
Qualified cooperative teachers	9 (37.5)	10 (41.7)	1 (4.2)	2 (8.3)	2 (8.3)
Time to learn mathematics	2 (8.3)	18 (75.0)	0 (0.0)	3 (12.5)	1 (4.2)
Class size (no. of learners)	6 (25.0)	14 (58.3)	0 (0.0)	1 (4.2)	3 (12.5)

From Table 4 above, majority (70.8%) of the respondents indicated that the library materials were adequate, about a half (54.2%) also indicated that the Mathematics textbooks were adequate, with only a few (16.7%) indicating that they were inadequate. Three quarters (75%) of the respondents noted that there was adequate time to learn Mathematics with less than a half (41.7%) indicating that there were adequate qualified and cooperative teachers.

These findings indicate that adequacy of the tactile teaching and learning resources on Mathematics may impact vastly on performance. Hence, there is need to provide them to the learners and teachers to improve performance. Thamburaj, & Nagar, (2010), Munsanje, (2011) and Kenya National Examination Council (2005) indicates that adequacy of the tactile teaching and learning resources on Mathematics should be provided to each and every learner regardless of his or her disability and ability during teaching and learning of Mathematics. For further assessments, teachers were also asked to rate the availability of the above materials. Their responses were as in Table 5.

Table 5 Teachers' Perception on the Adequacy of Learning Resources

Resource	VA	A	NS	IA	VIA
Library resource	1 (20.0)	2 (40.0)	0 (0.0)	2 (40.0)	0 (0.0)
Mathematics textbook	1 (20.0)	2 (40.0)	0 (0.0)	2 (40.0)	0 (0.0)
Qualified cooperative teachers	2 (40.0)	3 (60.0)	0 (0.0)	0 (0.0)	0 (0.0))
Time to learn mathematics	1 (20.0)	1 (20.0)	0 (0.0)	1 (20.0)	2 (40.0)
Class size (no. of learners)	1 (20.0)	1 (20.0)	0 (0.0)	1 (20.0)	2 (40.0)
Measuring tools	1 (20.0)	1 (20.0)	0 (0.0)	0 (0.0)	3 (60.0)

As shown in Table 5 above, more than a half (60%) of the respondents indicated that there were adequate qualified and cooperative teachers, the same number (60%) of the respondents also indicated that there were very inadequate measuring tools. Less than a half (40%) of the respondents indicated that there were both adequate and inadequate library facilities. To further answer this objective, the scale was collapsed into numerical scores and then correlated with the learners' performance in Mathematics to test the null hypothesis that there is no significant relationship between adequacy of learning resources and performance in Mathematics among learners who are blind. There was a weak positive relationship between adequacy of learning materials and performance in Mathematics ($r = 0.14$, $p = 0.513$. This means that availability of adequate learning materials is associated with higher performance in Mathematics. However, the relationship was not statistically significant at the 95% confidence level. From the findings, the null hypothesis was thus accepted.

4.4. Challenges that Teachers Face in Adapting Mathematic Tactile Teaching and Learning Material

This objective sought to find out the common challenges that teachers faced in adapting tactile teaching and learning materials and whether these challenges influenced student performance in Mathematics. To answer this objective, the respondents indicated on how much they agreed with the intensity of the challenges on a five-point Likert's scale items, including strongly disagree (SD), disagree (D), neutral (N), agree (A), and strongly agree (SA). The findings were as shown in Table 6.

From Table 6, the majority (80%) of the respondents strongly disagreed that the nature of mathematical content was a challenge in adopting tactile learning materials, more than a half (60%) disagreed that the syllabus, shortage of mathematical braille books and learning materials gave them challenges respectively. in excess of a half of the respondents (60%) also strongly disagreed that the learners‟ attitude was a challenge. Only a few (20%) of the respondents agreed that inadequate tactile Mathematics teaching and learning materials were posing challenges to them.

Table 6 Challenges Faced by Teachers in Adopting Tactile Learning Materials

Challenge	SA	A	N	D	SD
Lack of skill on tactile Mathematics material	0 (0.0)	0 (0.0)	1 (20.0)	2 (40.0)	2 (40.0)
Inadequate tactile Mathematics teaching and learning materials	0 (0.0)	1 (20.0)	1 (20.0)	0 (0.0)	3 (60.0)
Time shortage during lesson	0 (0.0)	1 (20.0)	2 (40.0)	1 (20.0)	1 (20.0)
Syllabus	0 (0.0)	0 (0.0)	1 (20.0)	3 (60.0)	1 (20.0)
Shortage of Mathematics braille books	0 (0.0)	1 (20.0)	0 (0.0)	3 (60.0)	1 (20.0)
Learning environment	0 (0.0)	0 (0.0)	2 (40.0)	3 (60.0)	0 (0.0)
Mathematics braille code	0 (0.0)	0 (0.0)	0 (0.0)	2 (40.0)	3 (60.0)
Learners' attitude	0 (0.0)	0 (0.0)	1 (20.0)	1 (20.0)	3 (60.0)
Nature of mathematical content	0 (0.0)	0 (0.0)	1 (20.0)	0 (0.0)	4 (80.0)

Teachers face various and varied challenges in adopting tactile teaching and learning materials. Jordan, Carlile, & Stack, (2008) affirms that this adversely affect the performance of Mathematics toward learners as some teachers do not know

how to deal or navigate these challenges and make them learning models or opportunities while teaching learners with VI.

To further answer this objective, Spearman's Rank Order Correlation coefficient was run between the challenges and learners' performance to test the null hypothesis that there is no statistically significant relationship between the challenges that teachers face in adapting tactile materials for Mathematics and performance in Mathematics. There was negative relationship between challenges faced in adopting tactile materials and performance in Mathematics (r = -0.25, p = 0.685). This implies that as the challenges in adopting tactile materials increase, the performance in Mathematics drops. However, the relationship was not statistically significant at 0.05 level. From the findings, the null hypothesis was thus not rejected.

5. Conclusions and recommendations

Learning and teaching resources play vital roles in educational outcomes, especially for learners who are blind. The current study evaluated the availability and use of tactile materials as correlates of performance in Mathematics among learners in THSB. Data on resource availability and students' performance were obtained through questionnaires administered to learners and teachers, as well as from school records. Descriptive summaries and correlation analyses were conducted to address the research objectives.

Most Mathematics teaching and learning resources used were books with audiovisual resources either lacking or used in only one school. Many of the respondents recommended the need for the government to set aside more funds for buying mathematical teaching and learning resources since their use in teaching was of utmost importance. The study found out that abacus was the most frequently used device to teach Mathematics. In excess of a half of the respondents also indicated that embossed tactile diagrams were used. However, only a few of the respondents indicated that talking calculators and cuboid were used respectively. The study observed that the adequacy of tactile teaching and learning resources on mathematic were inadequate for both learners and teachers. This was noted with some of the learners indicating that the library materials were adequate, while others indicated that they were inadequate. The majority of the learners noted that there was adequate time to learn Mathematics and that their teachers were adequately qualified and cooperative. This view was also supported by teachers who also indicated that there were adequately qualified and cooperative teachers. Majority of the teachers indicated that there were very inadequate measuring tools.

The study found out that majority of the teachers did not experience challenges in mathematical content, the syllabus, shortage of mathematical braille books and/or learning materials respectively. The majority of teachers were also not affected by the learners' attitude towards Mathematics as a challenge. Just a few of the respondents agreed that inadequate tactile Mathematics teaching and learning materials were a challenge. Therefore, the researcher concludes that the common challenges that teachers face in adapting mathematic tactile teaching and learning material does negatively affect Mathematics performance for learners with visual impairment. The time allocated for teaching Mathematics was identified as a challenge. The majority of the respondents (both learners and teachers) observed that the time allocated for Mathematics was not adequate. Learners and teachers both observed that brailed Mathematics textbooks were not enough in the school. Most of the time, both learners and teachers sometimes get brailed materials late after a syllabus had been changed.

Training of teachers in Special Needs Education equips them with skills and knowledge that enable them to use effective teaching resources which enable learners with visual impairment to learn effectively in integrated schools. However, findings showed that teachers are not trained in assistive technology. There is therefore a need for the Ministry of Education and Culture to introduce AT courses in Teacher Training Colleges. Government should provide computers and computer software, mathematic kit, radio cassettes and tape recorders which are vital instructional materials in schools to enhance effective teaching and learning Mathematics. More time should be allocated in the school timetable by the school administration for effective use of materials in teaching Mathematics to learners with visual; impairment.

The government should partner with NGOs and International Organizations such as UNICEF and UNESCO to provide resources for instance computers, tape recorders, projectors and film projectors. Learning resource centers manned by qualified personnel should be established to serve as teachers' resource centers. Teachers for learners with visual impairment and other categories of learning disabilities could use such centers to update their skills in the appropriate application and use of resources.

Contribution to knowledge

The study makes a notable contribution to the literature on education for learners who are blind, especially on the state of the availability of teaching and learning resources to meet the needs of this population. Generally, there is limited research on tactile materials for teaching Mathematics to learners who are blind in Kenya, and few studies have examined the influence of the availability of these materials on learners' academic performance. The current findings offer insights into the availability of tactile materials for teaching Mathematics and how they correlate with learners' performance.

Compliance with ethical standards

Acknowledgements

I wish to express my sincere appreciation to all individuals whose contribution made the completion of this thesis possible. First and foremost, my appreciation and gratitude go to my supervisors: Dr. Murugami and Dr. Chomba for the scholarly guidance, assistance tireless devotions and encouragement throughout the course of my studies. My special thanks go to my lecturers in the Department of Special Education at Kenyatta University; particularly to the former chairperson Dr. Nelly Otube for the moral support and encouragement. Furthermore, I wish to appreciate the management of Thika School for the Blind for allowing me to collect data in the school. In addition, my appreciation goes to the learners for giving vital information for the study. Also, I wish to thank my friends who helped me edit and print my work. Finally, I wish to express my personal gratitude to my loving family for their financial assistance.

Conflict of interest

The authors declare no conflict of interest pertaining to the research.

Statement of informed consent

Informed consent was obtained from all participants.

References

[1] Babu K. (2005). *Education in schools*. Retrieved from: www//geocities.com/ednsekara/18 conference.

[2] Bansal, H. (2007). *Modern methods of teacher training*. New Delhi, India: A P H Publishing Corporation.

[3] Brosnan, P. (1997). Visual mathematics using geo boards. *Teaching Exceptional Children*, 19-22.

[4] Davis, P. J. and Mason, J. H. (1998). Notes on a radical constructivist epistomethodology applied to didactic situations. *Journal of Structured Learning, 10*(10), 157-176.

[5] Driscoll, M. (2005). *Psychology of learning for instruction*. Boston, MA: Allyn & Bacon.

[6] Eggleston, L.E. (2006). Teaching algebra. In M. E. Frampton (ed.), *Education of the blind: A Study of methods of teaching blind*. New Delhi, India: Cosmo Publications.

[7] Gachau (2010). Educational aspects of Mathematics disabilities. *Journal of Learning Disabilities, 30*(1), 47-56.

[8] Hill, W. F. (2002). *Learning: A survey of psychological interpretation* (7th ed). Boston, MA: Allyn and Bacon.

[9] Jordan, A., Carlile, O., & Stack, A. (2008). *Approaches to learning: A guide for teachers.* Berkshire, United Kingdom: Open University Press.

[10] Kimani, P. (1990). *Effects of low vision in teaching mathematic to learners with low vision.* Nairobi, Kenya: Kenya Institute of Special Education.

[11] KNEC. (2005). *Kenya certificate of primary education.: Regulations and syllabus*. Nairobi, Kenya.

[12] Maguvhe (2015). The teaching of Mathematics and science to students with visual impairment. Cambridge, United Kingdom: Cambridge University Press.

[13] Maher, C., & Martino, A. (1996). The development of the idea of mathematical proof: A 5-year case study. *Journal for Research in Mathematics Education, 27*(2), 194–214.

[14] Martin, W. G., & Harel, G. (1999). Proof frames of pre-service elementary teachers. *Journal of Research in Mathematics Education, 20*(1), 41–51.

[15] Munsanje, J. (2011). *Provision of learning and teaching materials for pupils with visual impairment: Results from a national survey in Zambia*. Lusaka, Zambia: ICEVI Press.

[16] Nweke (2004). *A brief historical overview of tactile and auditory aids for visually impaired mathematics educators and learners*. Unpublished Masters Project.

[17] Ormrod, J. E. (1995). *Human Learning* (2nd ed.). Hoboken, NJ: Prentice Hall.

[18] Orodho J.A. (2005). *Elements of education and social science research methods*. Nairobi, Kenya: Kanezja Publishers.

[19] Orodho, A. J. (2010). *Techniques of writing research proposal and reports.* Nairobi, Kenya: Kanezja Publishers.

[20] Orton, A. (1994). Learning mathematics: implications for teaching. In A. Orton & G. Wain (Eds.), *Issues in teaching mathematics* (pp. 35 – 57). London, United Kingdom: Cassell.

[21] Owino (2011). *Studies in cognitive growth*. New York, NY: John Wiley & Sons Publishers.

[22] State Board of Education. (1997). *Psychological implications. visual impairment and blindness*. Washington, DC: Department of Veterans Affairs employee Education System.

[23] Thamburaj, R. and Nagar, A. (2010). *Tactile graphic tool for portable digital pad*. Proceedings of the 12th international conference on Computers Helping People with Special Needs. Lecture Notes in Computer Science (LNCS), vol. 6180. Berlin, Germany: Springer Verlag.

[24] Tinsley, T. (2007). The use of origami in the mathematics education of visually impaired learners. *Education of the Visually Handicapped, IV,* 8-11.

[25] Vinner, S. (1991). The role of definitions in the teaching and learning of Mathematics. In D. Tall (Ed.), *Advanced mathematical thinking, mathematics education library* (pp. 65–81). Dordrecht, The Netherlands: Kluwer Academic Publishers.

[26] Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

[27] Wanjohi, K., (2003). *Attitudes towards visually impaired children by sighted peers and teachers in integrated schools*. Unpublished M.Ed Thesis. Egerton University.

[28] Wheeler, D. (2004). *Mathematics academic content standards*. Sacramento, California: State Board of Education.

[29] Yunus, A. S. and Ali, W. Z. (2009). Motivation in the learning of mathematics. *European Journal of Social Sciences, 7*(4), 93-101