VOL. 07 NO. 2,
FEBRUARY, 2025
E-ISSN 3027-1533
P-ISSN 3026-8648

African Scholar Publications & Research International
www.africanscholarpub.com

Journal of African Innovation & Advanced Studies (JAIAS)

Effects of Computer Assistive Technology on the Mathematics Achievement of Pupils qith Visual Impairment in Otana Integrated School Jos, Plateau State

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DOI: https://doi.org/10.70382/ajaias.v7i2.008

Abstract

This research study was conducted to investigate the effects of computer assistive technology on mathematics achievement of pupils with visual impairment in Otana Integrated School Jos, Plateau State. This researcher study adopts the pre-test post-test experimental research design. The population of this study is all the pupils with visual impairment in Primary three. The sample for this research is made up of eight (8) pupils who are visually impaired: 4 sample in experimental and 4 in control groups. Convenience sampling technique was used in the study. Two aims and objectives, two research questions and two hypotheses were formulated to guide the study. The instrument for data collection was teacher-made-achievement test in mathematics developed by the researcher. The choice of the instrument was necessary in order to determine the effect of independent variable on the dependent variable. The data collected were analyzed using t – test for independent samples and was tested at 0.05 level of significance. The study revealed that, the pupils in experimental group had Pretest mean scores of 3.00 and standard deviation 0.82 and Post-test mean scores of 12.50 and

standard deviation of 1.91 with a mean gain of 9.50±1.29. Also, the study further revealed that, computer screen reader usage in teaching and learning in mathematics achievement of has improved. Pupils with visual impairment in pretest had mean scores of 3.00±0.00 and posttest mean scores of 13.00±3.54 with mean gain of 10.00. Based on the research findings the researcher made the following recommendations; mathematics teachers of pupils with visual impairment should be encouraged to include computer Screen reader during instruction in Algebra, public with visual impairment should be encourage to have access to the computer screen reader in the schools under the supervision of a computer laboratory assistant, and Government should provide sufficient computer screen readers to school of pupils with visual impairments as part of promoting inclusion in schools.

Key Words: Computer, Assistive Technology, Mathematics, Pupils Visual Impairment

Introduction

Assistive technologies are innovative technologies that modify or adapt the classroom for special learning needs. This kind of technology assists in teaching pupils who have physical, sensory or cognitive disabilities. Such modern technology provides teachers with innovative tools to help pupils with special needs overcome the disability that block or impedes their learning process. According to American Foundation for the Blind (2012), assistive technology is any tool that helps pupils with disabilities to perform task more quickly, easily or independently. The same sentiment about assistive technology is affirmed by Jonassen (2018), who observe that assistive technology in education is a product system modified to increase maintain or improve the functional capability of children or pupils with special needs. Such technology for pupils with visual impairment entails large print access, speech access, braille access and scanned material access (Hasselbring and Glaser, 2012).

The development of a nation's education is dependent on the outcome of advancement in human thought and technology and it occurs as a result of the needs and demand by segments of population. One of the best examples of this is use of assistive technology for

persons with visual impairment (Martha, 2019). Assistive technologies are interventions designed to give children with visual impairment access to information and to the environment. They are of three categories: low tech, medium and high tech (Ozoji, Unachukwu & Kolo, 2016).

As defined by the United States National Institute of Standards and Technology, assistive technology (AT) is "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities. It enables individuals with disabilities to participate in society as contributing members. Advancement in assistive technology has provided better enablement of improved quality of life for people with disabilities (Reimer-Reiss and Wacker, 2020). The goal of assistive technology is to give pupils with visual impairment access to literacy and communication in the academics, home, and community. The use of assistive technology is not a new phenomenon in the area of education of visually impaired pupils. Rather it has been used for centuries to provide opportunities in different aspects of their life.

In earlier days pupils with visual impairment were using cane, stick or bamboo, today it has been added with more advance tools helping them in participating in variety of academic activities. Pupils with visual impairment face many barriers in their education, employment, daily living and participating in the world of persons with no visual impairment. Assistive technology plays the role of great equalizer for person with visual impairment (Michaels & McDermott, 2023). The creation of the Braille code in the 1800s allowed the visual impaired pupils to be truly literate. It was the first handheld tool with which the visual impaired pupils started writing on their own after braille training. Later in 1900s, audio technology such as radio and records were developed and it facilitated those pupils more access to information than Braille did (Scadden, 2020). But the actual explosion of technology in the world of knowledge was led after the development of computer in 1960s. It followed with many new technologies such as scanners, optical character recognition software, computer screen reader, CDs. These all contributed in the enhancement of the ability of visually impaired person to explore and experience the knowledge and information (Kapperman & Sticken, 2020).

Assistive Technologies are used to promote access to the general education curriculum for pupils with disabilities. Through the use of assistive technologies, pupils with visual impairments are better able to rise to the demands of challenging

mainstream settings in education. The recent development in this field includes flax players, talking book libraries, and tablets which is making the process of learning quicker and easier for visually impaired pupils. The class hand out can easily be converted to Braille by teachers or staff. They can also be scanned into a computer, use software programs such as Duxbury and WinBraille to convert the text into Braille, and then print it on the embosser (Sara, 2018). These technologies allow pupils with visual impairment to work independently on their own pace. Assistive technology is not a magic stick, with which the visually impaired pupils learn automatically. Rather to be a success, it requires the right device, training and time. When this is achieved, pupils can take control of part of their learning journey, improving not only their academic progress, but also their self-confidence in learning and wider life.

Today, we talk about inclusive education for pupils with visual impairment, but there are many barriers in using these devices by pupils with visual impairment. We do not have proper infrastructure, trained human resource in inclusive education institutes to support the education of those children in an effective way. Even in special educational settings we are lacking trained human resources who can teach these children to operate these technologies effectively and efficiently. The application of computer assistive technology, couple with new improve software applications and with improve adaptive devices may hold the key for high academic achievement of pupils with visual impairment (VI), complete their education experiences and become more productive contributors to the society.

Visual impairment can be defined as a severe reduction in vision that cannot be corrected with standard glasses or contact lenses and reduces a person's ability to function at certain or all tasks (Owoeye, 2014). According to Saluin (2016), a visually impaired person's eyesight cannot be corrected to a normal level therefore described visual impairment as the ability of the functional limitation of the eye(s) of the vision system which leads to loss of acuity and ability of an average person to see wide.

Visual impairment is the consequence of functional loss of vision, rather than eye disorder itself. Eye disorders which can lead to visual impairment can include retinal degeneration, albinism, cataracts and glaucoma, extra ocular muscle problems that result in visual disturbance, corneal disorders , diabetic retinopathy, congenital disorders and infections, visual impairment can also be caused by brain and nerve disorders in which case, it is usually termed "cortical visual impairment" (CVI) (Anon, 2012). According to Popoola (2014) blindness is presenting distance

visual acuity of less than 6/60 or central visual field less than 20 degree in the better eyes. According to Ozoji, Unachukwu and Kolo (2016) children with visual impairment can be classified into three paradigms: age of onset of vision loss, degree of vision loss and type of residual vision.

Furthermore, it is a known fact that most of the information received from the environment are via the eyes. This does not mean that the other sense organs are insignificant, but the eyes is delicate and responsible for majority of the information we receive from our surrounding. Hence, any damage to the eyes, limits one's ability to receive information and adequately process it. In relation to academic performance, children with visual impairment lag significantly behind in mathematics achievement absent assistive technological device. Pupils with visual impairment require the best education with its attending method and materials that can be provided to enable them minimize the negative effects of their disability, develop and harness their adequate potentialities to learn. Academic activities that would lead to successful achievement of a learner depend strongly on the experience and interaction between the learner and his surrounding environment. Abang (2005) observed that for person with visual impairment, there are restrictions to many experiences as a result of their limited sight which is the principal channel of man's experiences in the surrounding environment. Abang further stressed that once sight is gone, the next channel of experience by persons with visual impairment is touch, but she cautioned that experience by touch has its limitations.

Mathematics Achievement is simply the attainment, accomplishment, success or achievement pupils with visual impairment are able to attain at a particular time or over a period of time in pre-algebra (Gotring, 2019). Algebra performance literally refers to some measureable outcomes of academic works of learners in Mathematics; it can be low, moderate or high. Mathematics in this work specifically implies pre-algebra. Mathematics is the bedrock of Science, Technology and development (Smith, 2021). As a base, it is all about the skills and science of reckoning, discipline, expertise and progress. This has resulted in a misconception that the subject is difficult, and so, negative emotional problems are experienced by struggling learners. The situation is worse with pupils living with visual impairment. The pupils often developed so much fear, emotional traumas, psychological distresses and dislike for the subject, and so, there is need to teach the subject with caution and a kind of counseling and therapy that will not scare

the learners and especially learners that are in primary , and at the same time, living with visual impairment.

Academic achievement is simply the attainment or accomplishment a learner is able to attain at a particular time or over a period of time in say, Mathematics. Algebra performance literally refers to some measureable outcomes of academic works of learners in Mathematics, which can be low, moderate or high. Mathematics Performance in this work specifically implies pre-algebra. The importance of algebra can never be over emphasized. Unfortunately despite its importance, it has not been given the desired attention by both teachers and learners. This has resulted in a misconception that the subject is not important at the Primary School level, and so, negative consideration is often given to it by policies makers, curriculum developers, even school administrators, for lack of Mathematics teachers, poor teacher training and lack of learning materials and classes. He further stated that such professionals teach the course with laxity and carelessness; as a result, pupils sometimes developed so much carelessness, negligence, psychological sloppiness and even dislike for the subject, thereafter affecting their academic performance. There is therefore need to teach algebra in class and resource room, containing required assistive device with caution and a kind of care that will not scare learners with visual impairment especially at the primary school level (Smith, 2021). There is therefore also need to teach Mathematics with caution, care and good counsel such that learners can easily come to a point where they can concretely demonstrate physical or physiological tasks and convert to pre-algebra abstract tasks.

Constructivists, on the other hand, believe that pupils do not learn from technology which supports pupils to learn. The assistive technology for learners with visual impairment include screen magnifier, screen reading software such as jaws, window eyes, virtual magnifying glass, ward talk, Non-Visual Desktop Access, Thunder, Web Anywhere, Zoom Text and Soretek among others. When a computer is fitted with any of these assistive technologies becomes accommodative to a pupils with visual impairment. He/she can use it for reading, writing, doing assignment, socializing with others on facebook or email and searching for any new knowledge or information on the internet. For example, screen enlargement software allows the pupils to easily read and see what is on the monitor, especially those with poor eyesight. The talking software on the other hand reads the text appearing on the screen for the visually impaired pupils hence making access to information easier and education possible. Computers and other technologies are

powerful tools that support pupils with special educational needs. Those with visual impairments access written text through auditory devices or print magnification devices (Tomei, 2023). According to D'Andrea and Presley (2019), professionals and pupils with visual impairments function independently in other activities with the appropriate assistive technology. They further confirm that having a personal computer acts as a backbone in one's life as it supports a visually impaired user to independently write, edit documents, send and receive e-mails. It creates efficiency and independence to a pupils with visual impairment who has skills to use it. D'andrea and Presley (2019) further affirm that Personal Digital Assistant (PDA) or note-taker allows a pupils with visual impairment to quickly and efficiently attend to his/her duties. Equipping a computer with assistive technology for learners serves as a backup for the learners' brain since it has speech, a line of refreshable braille, and braille input keypad, calendar, work related files and notes.

Generally, in educational settings, pupils tend to learn better and retain what they acquire (training experience) when assistive technology devices are adequately applied in the teaching learning process. It is in this light that this research work is to investigate the effect of computer assistive technology on the Mathematics performance of pupils with visual impairment.

Statement of the Problem

The problem that necessitated the study is the poor academic achievement of pupils with visual impairment in Mathematics, specifically pre-algebra. Visual impairment places its victim in a disadvantaged position where he/she cannot benefit adequately from normal or regular classroom learning experiences. This has posed great setback and challenges on the Mathematics achievement of and learning outcome of pupils with visual impairment. Also, there have being a dwindling academic achievement by learners with visual impairment despite the use of tactile and some acoustic assistive technology devices in the teaching and learning process. The learning of Mathematics by pupils with visual impairment has remained a great challenge to both teachers and the pupils respectively. Visual impaired pupils feel that Mathematics is unimportant, impractical and too hard; as a result, had decided to be mathematically ignorant. Most of mathematical problems are abstract in nature. Since they can't easily read prints, it becomes boring and difficult for the pupils to understand mathematical concepts.

Pupils with visual impairment are often treated as not visually impaired, in the sense that their peculiar needs are not put into cognizant or deliberately ignored due to unavailability of assistive devices to aid their learning of mathematics, and are restricted to acquiring Algebra concepts through lecture methods (verbal), that would have been acquired ordinarily through the use of assistive devices like the computer tablets that could emboss prints using the zoom in and out button to make it readable i.e., those with residual vision. For those with total vision lost, they can benefit from the text-to-speech (TTS) or speech to text features in computers and even mobile devices. This can help the pupils to perform basic arithmetic operations like addition, subtraction, multiplication and division.

Many mathematics teachers don't seem to notice or recognize the difficulties visual impairment is pausing on pupils with visual impairment. It is in the light of the above that the researcher finds it needful to use computer assistive technology device as a treatment strategy to teach primary pupils living with visual impairment. Comprehension of materials and concepts amongst the visually impaired pupils especially the congenital visually impaired, is so diminished; their condition grossly affects their logic rate, flexibility and comprehension. There is also the problem of Algebra specialists (professionals) to handle Mathematics generally for pupils with visual impairment in inclusive schools. This study therefore is centered principally on effects of computer assistive technology on the Mathematics achievement of pupils with Visual Impairment in Otana Integrated School Jos, Plateau State.

Aim of the Study

The general purpose of this study is to find out the effects of computer assistive technology on the Mathematics achievement of pupils with visual impairment in Otana Integrated School Jos, Plateau State. The specific objectives of the study include the following:

1. To find out whether the use of computer screen reader has impact on the mathematics achievement of pupils with visual impairment.
2. To find out how effective computer screen reader installed on tablets and smart phones, improves the mathematics achievement of pupils with visual impairment.

Research Questions

1. To what extent does the use of computer screen reader improves the mathematics achievement of pupils with visual impairment?

2. To what extent does the use of computer screen reader in tablets and smart phones affect the mathematics achievement of pupils with visual impairment?

Hypotheses

i. There is no significant difference between the posttest mathematics achievement scores of pupils with visual impairment in the experimental and control groups.

Methodology

Research Design

The study was a pre-test post-test experimental research design. The researcher adopted the non-equivalent quasi experimental research design. The choice of this design is due to the fact that the nature of the study requires determining the effects of the computer assistive technology; specifically, the screen reader application on the mathematics achievement of pupils with visual impairment. Within the confines of this research work, the independent variable is the computer assistive technology while the dependent variable is the mathematics achievement of pupils with visual impairment. The study uses one group pre-test-post-test design.

This design enabled the researcher to determine the effects of the intervention programme (the use of computer assistive technology devices) on the Mathematics achievement of pupils with visual impairment. Pre-test was administered to the group before and after the group exposure to the computer programmed instruction, post-test was administered to the same group of pupils. The choice of this design was informed by the small number of the sample population available and the fact that the design allowed the researcher to compare the pupils pre-test and post-test performance and then determine the effect of the treatment. The reason for using pre-test–posttest design is that it will help evaluate the gain scores of the two groups (Awotunde & Ugodulunwa, 2004).

Population

The target population of this study was all the pupils with visual impairment in Primary three in Otana Integrated School Jos, Plateau State. The choice of this school was informed by the fact that, it is an inclusive school with pupils living with visual impairment from both the rural and urban areas, and also pupils with visual impairment who are from poor and rich socio-economic background.

Sample

The sample for this research was made up of eight (08) pupils who are visually impaired: 4 sample in experimental and 4 in control groups. This gave the overall total of eight samples who took part in the experiment. The choice of eight as the sample size, was informed by the fact that this was the only available sample from the school under this investigation that met the requirement for this study and "convenience sampling technique;" this is due to the paucity of pupils with visual impairment. The choice of this technique was informed based on the need to select the needed sample for the purpose of this study through the use of personal logical variables, which includes class, age and sex out of the population under investigation.

Sampling Technique

Due to the small number of pupils with visual impairment, the sampling technique to be used shall be the convenience sampling technique; this was due to the number of sampling units that shall conveniently be available.

Instrument for Data Collection

The instrument for data collection was a teacher made achievement test in mathematics developed by the researcher. The choice of the instrument was necessary in order to determine the effect of independent variable on the dependent variable.

Description of the Instruments

Teacher Developed Mathematics (Algebraic) Performance Test (TDAPT): The researcher designed, and then developed a TDAPT; this tool was basically divided into Sections A. and B. The tool was validated by an expert in the field of Special Education and Rehabilitation Sciences. This expert was drawn from the University of Jos. Section A. of the TDAPT was made up of the Bio-data of the respondents, and Section B. had questions 1 – 10; through which the respondents was expected to respond over. Those are tools that sought to collect the extent to which pupils can concretely demonstrate physical tasks and convert to pre-algebra abstract tasks and performance of pupils with visual impairment. It contained a total of 5 questions that would test pupil's performance of the respondents in the areas of concretely demonstrating physical tasks and converting to pre-algebra abstract tasks and pre-algebra performance of pupils with hearing impairment, at both

pretest and posttest times. From the TDAPT questions, performance levels of the respondents shall be generated. Each of the test parts on pre-algebra were developed as showed on the TMLT.

Validity

Face validity: The two instruments and Teacher made achievement test in algebra were given to experts in the field of Special Education to check the content of the instruments for scrutiny.

Reliability

The researcher determined the extent to which the scores of measurement have stability. A stability estimate of reliability or test – retest reliability was used. This was done by administering the task performance test and the attitude questionnaire on a group of respondents and after two (3) weeks the test was re-administered to the same group. The resultant scores were correlated. This was to measure the consistency of the respondents' performance over time. The results of the tests were correlated and the correlation coefficient obtained for the attitude to algebra was 0.70 and task performance in algebra was 0.72.

Results

Research Question One

To what extend does the use of computer screen reader affects the mathematics achievement of pupils with visual impairment?

Table 1: Extent of Computer Screen Reader Affects the Mathematics Achievement of Pupils with Visual Impairment

Pupils	Experimental			Control		
	Pretest	Post-test	Mean gain	Pretest	Post-test	Mean gain
1	4	15	10	3	5	2
2	2	10	8	4	7	3
3	3	14	11	3	4	1
4	3	12	9	2	4	2
Mean	**3.00**	**12.75**	**9.50**	**3.00**	**5.00**	**2.00**
Standard Deviation	**0.82**	**2.22**	**1.29**	**0.82**	**1.41**	**0.82**

Note: 0-7 = Low Extent, 8-14 = Moderate Extent and 15-20 = High Extent

Table 1 shows the Extent of Computer Screen Reader Affects the Mathematics Achievement of Pupils with Visual Impairment. The pupils in experimental group had Pretest mean scores of 3.00 and standard deviation 0.82 and Post-test mean scores of 12.50 and standard deviation of 1.91 with a mean gain of 9.50±1.29. However, pupils in control group had Pretest mean scores of 3.00 and standard deviation 0.82 and Post-test mean scores of 5.00 and standard deviation of 1.41 with a mean gain of 2.00±0.82. Computer Screen Reader Affects 25% to a high extent and 75% to a moderate extent the Mathematics Achievement of Pupils with Visual Impairment.

Research Question Two

To what extent does the use of computer tablets in teaching affects the mathematics achievement of pupils with visual impairment?

Table 2: Extent of Computer Screen Reader Tablet Usage in Teaching Mathematics Achievement of Pupils with Visual Impairment

Pupils	Experimental		Control	
	Pretest	**Post-test**	**Pretest**	**Post-test**
Low	4(100)	0	4(100)	4(100)
Moderate	0	3(75)	0	0
High	0	1(25)	0	0
Total	**4(100)**	**4(100)**	**4(100)**	**4(100)**

Table 2 shows the Extent of Computer Screen Reader Tablet Usage in Teaching Mathematics Achievement of Pupils with Visual Impairment. Before intervention, both pupils in experimental and control groups were not using computer screen reader tablet for learning mathematics and their performance were low. After intervention, pupils in experimental group; 1(25%) pupil are enhance to a high extent and 3(75%) pupils were enhance to a moderate extent. While the pupils in the control group still remain at the low extent.

Hypothesis One

There is no significant difference between the posttest mathematics achievement scores of pupils with visual impairment in the experimental and control groups.

Table 3: t-test Analysis of Posttest Mathematics Achievement Scores of Pupils with visual Impairment in the Experimental and Control Groups

Groups	N	$\overline{X}$	SD	Df	t-value	p-value
Experimental	4	12.75	2.22	6	5.894	0.001
Control	4	5.00	1.41			

Table 3 shows the t-test Analysis of Posttest Mathematics Achievement Scores of Pupils with visual Impairment in the Experimental and Control Groups. The pupils exposed to Computer assisted screen reader had a posttest mean scores 12.75±2.22 and pupils that were not exposed had posttest mean of 5.00±1.41 with a t-value of 5.894 and p-value of 0.001. Since the p-value was less than 0.05, therefore there was a significant difference between the posttest mathematics achievement scores of pupils with visual impairment in the experimental and control groups. The researcher rejects the null hypothesis and accept the alternative hypothesis.

Discussion

The discussion on the effects of computer assistive technology on the Mathematics achievement of pupils with visual impairment in Otana Integrated School Jos, Plateau State. The finding of Research Question One in Table 1 shows the Extent of Computer Screen Reader Affects the Mathematics Achievement of Pupils with Visual Impairment. The pupils in experimental group had Pretest mean scores of 3.00 and standard deviation 0.82 and Post-test mean scores of 12.50 and standard deviation of 1.91 with a mean gain of 9.50±1.29. However, pupils in control group had Pretest mean scores of 3.00 and standard deviation 0.82 and Post-test mean scores of 5.00 and standard deviation of 1.41 with a mean gain of 2.00±0.82. Computer Screen Reader Affects 25% to a high extent and 75% to a moderate extent the Mathematics Achievement of Pupils with Visual Impairment.

The finding of Research Question Two in Table 2 shows the Extent of Computer Screen Reader Tablet Usage in Teaching Mathematics Achievement of Pupils with Visual Impairment. Before intervention, both pupils in experimental and control groups were not using computer screen reader tablet for learning mathematics and their performance were low. After intervention, pupils in experimental group; 1(25%) pupil are enhance to a high extent and 3(75%) pupils were enhance to a moderate extent. While the pupils in the control group still remain at the low extent.

The finding of Hypothesis One in Table 3 shows the t-test Analysis of Posttest Mathematics Achievement Scores of Pupils with visual Impairment in the Experimental and Control Groups. The pupils exposed to Computer assisted screen reader had a posttest mean scores 12.75±2.22 and pupils that were not exposed had posttest mean of 5.00±1.41 with a t-value of 5.894 and p-value of 0.001. Since the p-value was less than 0.05, therefore there was a significant difference between the posttest mathematics achievement scores of pupils with visual impairment in the experimental and control groups. The researcher rejects the null hypothesis and accept the alternative hypothesis.

The findings of Hypothesis Two in Table 4 shows the t-test Analysis of Posttest Mathematics Achievement Scores of Pupils with visual Impairment in the Experimental and Control Groups. The pupils exposed to Computer assisted screen reader had a posttest mean scores 12.75±2.22 and pupils that were not exposed had posttest mean of 5.00±1.41 with a t-value of 5.894 and p-value of 0.001. Since the p-value was less than 0.05, therefore there was a significant difference between the posttest mathematics achievement scores of pupils with visual impairment in the experimental and control groups. The researcher rejects the null hypothesis and accept the alternative hypothesis.

Conclusion

The study concluded that computer screen reader enhances the Mathematics Achievement of Pupils with Visual Impairment to a high extent. Computer Screen Reader Affects the Mathematics Achievement of Pupils with Visual Impairment. Pupils with Visual Impairment in experimental group are more enhance to a high extent while those in the control group still remain at the low extent. There was a significant difference between the posttest mathematics achievement scores of pupils with visual impairment in the experimental than those in the control groups.

Recommendations

Based on the findings therefore, the following recommendations were made:

1. Mathematics teachers of pupils with visual impairment should be encouraged to include computer Screen reader during instruction in Algebra.
2. Pupils with visual impairment should be encourage to have access to the computer screen reader in the schools under the supervision of a computer laboratory assistant.

3. Government should provide sufficient computer screen readers to school of pupils with visual impairments as part of promoting inclusion in schools.
4. Computer Assistive technology unit should be created in tertiary institutions to train teachers on modern software's that aids teaching of mathematics to pupils with visual impairment.

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