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TEACHING MATHEMATICS TO VISUALLY IMPAIRED STUDENTS: case study of Margaretta Hugo Schoolsfor the Blind: Zimbabwe

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ABSTRACT

A case study of how visually impaired, (VI), students are taught mathematics, was conducted at Margareta Hugo Primary and Secondary Schools for the blind in Masvingo Province, Zimbabwe. Data was collected using interviews with teachers, lesson observations, and participant observation of both teachers and students. The study revealed that the VI students learn the same curriculum as their sighted colleagues in ordinary schools. Only Primary teachers have had some training in Special Needs Education while the secondary teachers learn on the job. There is an acute shortage of special equipment for the students due to lack of funding since students do not pay school levies. Both the students and the teachers displayed very low motivation. The students lament the lack of models whom they can emulate, as only one blind student passed mathematics with a 'B' in the last ten years The study recommends that the Government provides timeous, special grants to the school, to cover recurrent expenditure and some special allowance for the teachers. The school is encouraged to make a concerted effort to source donor funds for equipment.

Key Terms

Special needs education; disability; visual impairment; Braille; integration / inclusion

BACKGROUND TO THE STUDY

INTRODUCTION

In Zimbabwe, a common site at street corners is a child leading a blind beggar singing, in an effort to attract sympathy from the public. The majority of people are not aware that these visually impaired (VI) members of society are normal people, capable of leading an independent life. Some people give the impression that the VI need assistance to move around, bath and even dress up. Very few are aware that the VI can manage on their own when in familiar environments. Most have had some educational experience enabling them tocount money and read in Braille.

The researcher hasmarked ordinary level ('O' level) mathematics examinations scripts for the VI for about ten years in Zimbabwe. The VI candidates aretaught together with, and write the same examinations as their sighted colleagues.They meet a number of challengesandperform badly compared to their sightedcolleagues and very few of them, pass external examinations. When their mathematics examination papers are set, at the item writing stage, there is stress on minimizing questions with diagrams and those that require use of mathematical tables or calculators, the argument being that the VI students cannot comprehend when too many lines are involved and they do not use calculators. Yet we read in history about the 'World of blind mathematicians' , like the celebrated blind mathematician and Newtonian, Michael Sanderson, who was a lecturer, Bernard Morin, the blind geometer, Emmanuel Giroux, a geometer, Lawrence Baggett, a lecturer in analysis, to mention a few (Jackson 2002) . The researcher is interested in finding out how the VI students are taught mathematics in Zimbabwe, and what seems to drive them away from the subject.

In Zimbabwe quite a number of VI students have gone through 'O' and advanced level ('A' level). Most of those who did 'A' level have gone through universities or have had some form of training, mostly in the Arts subjects. To date none has taken mathematics at 'A' level as reported by the teachers at M. Hugo. The researcher is interested in finding out how these VI students are taught mathematics and why they fail it at 'O' level. Could it be because of the way they are taught, the attitudes of the teachers, attitudes of the students, or is it a question of non-availability of resources?

A worrying observation is that your references are too old. If you need to use them then link them with something more recent, i.e. in the last ten years or less**.**

The concept of visual impairment

Educators differentiate between blind and low vision students. The educational definition of VI considers the extent to which a child's vision affects learning and makes special methods and materials necessary (Hergarty 1993). A blind student is totally without sight or has so little vision that he/she learns primarily through other senses. Most use their sense of touch to read Braille. A low vision student on the other hand is able to learn through the visual channel and generally learns print.

Educational provisions for the VI

Herward et al (1988), report that in the USA, educational alternatives for VI students include residential (special) schools and regular public schools. In a residential school, the blind learn on their own, while in the regular school they learn together with sighted peers. Supportive help for the VI is usually given by an itinerant teacher- consultant. The specialist teacher may be expected to perform the following roles among others:instruct the VI students directly individually or in class, prepare specialised learning materials; translate reading materials and assignments into Braille, large print or tape recorded form; or arrange for readers, and interpret information about the child's visual impairment to other educators and parents. Public schools have resource rooms where the VI students in integrated settings receive specialist help.

In the UK, Hergarty (1993) reports that the number of special schools has dropped drastically and predicted that they would fall further. “Special needs provision is considered an entitlement and, both the moral imperative and current legislation, require that it should be made in the ordinary school to the greatest extent possible” (Hergarty 1993: 188). There was a lot of speculation on the new Info-Tech developments and their magical qualities, as Hergarty (1993: 193) puts it, “we marvel that the blind can see and the deaf hear”.

In Zimbabwe, the Government has legislated through the Disabled Persons’ Act (1992) and various Circular Minutes issued by the Secretary for Education, which specify placement procedures for special classes, resource rooms and special schools for children with varying degrees of visual, hearing and mental handicaps. Currently VI students learn together with their sighted peers, either in special schools or in inclusive settings close to their homes. They are taught by the same teachers who may not even be visual specialists. Chimedza and Peters (2001) report that in Zimbabwe, education for the VI was started by Dutch missionaries at Chibi Mission station in 1927, which was later moved to Copota, now known as Magaretta Hugo Schools and workshops for the blind. In Bulawayo the Jairos Association started to offer education to the blind in the late 1940s. The Council for the Blind, founded in 1956, used to provide special equipment for VI students. To date special schools exist, but thereis a move towards inclusive education, where the regular primary schools establish what are termed Resource Units to cater for the VI in schools close to their homes. The former special schools now accommodate both blind and low vision (partially sighted) students, of whom Albinos are in the majority.

Whatever the educational provision, whether special school or inclusive setting, it calls for a great deal of work on the part of the teacher to adapt instruction so that it benefits the VI students.

Special adaptations for VI students

VI students obtain most of their information through the senses of hearing, touch and smell. As such, children need to systematically develop listening skills. Hergarty (1992) contends that this is an important component of the educational program for the VI children. Herward and Orlansky (1988: 296) say “Blind people are not gifted with an extra ordinary sense of touch; rather they may learn to use their sense of touch to gain information about the environment”. However Socks (1992: 140) says

It has been well established in blind people who read braille that the reading finger has an exceptionally large representation in the tactile parts of the cerebral cortex. One would suspect that the tactile (and auditory) parts of the cortex are enlarged in the blind and may even extend to what is normally the visual cortex……It seems likely that such a differentiation of cerebral development would follow the early loss of a sense and the compensatory enhancement of other senses.

Similarly Jackson (2002) says that the blind mathematician, Morin’s blindness may have enhanced his extraordinary visualization ability. He says Morin noted that “disabilities like blindness reinforce one’s deficits, so there are more dramatic contrasts in disabled people” (Jackson 2002:1248). From the way the blind go about their daily tasks, one would concur with Socks and Jackson that the loss of sight seems to have enhanced other senses like touch, feeling and smell. Jackson (2002) reports that the French believe that it was the mathematician Lebesgue who suggested to the blind mathematician Louis Antoine that he should study two- and three-dimensional topology partly because “in such a study, the eyes of the spirit and the habit of concentration replace the lost vision” (p1247).

Gearheart and Gearheart (1988) say that early professionals realised that the VI could be educated together with their sighted peers with only minor modifications and adaptation and that the limitations imposed by visual disability did not require a special curriculum. So the VI follow the same curriculum as their sighted colleagues, but do need compensatory skills, what Gearheart et al (1988: 161) call “plus factors”.

Blind students use Braille , which is a system of reading and writing in which letters, words, numbers and other systems are made from arrangements of raised dots, developed by Louis Braille in 1830 who was blind (Herward et al 1988:306). Braille is complex; it is like some form of shorthand. Abbreviations called ‘contractions’ help to save space and permit faster reading and writing. They say the regular classroom teacher is not expected to learn braille, but many find it helpful and interesting to do so.

Adapted Educational materials and equipment

Materials must be provided in different media or in modified form so that the student can learn through sensory channels other than vision. For those who cannot read material in print form, it can be provided through the tactile (touch) or auditory channels. If the student can read print with difficulty, the material may be enlarged or the student can use magnifying devices or reading machines.

Mathematical Aids for blind students include the Cramer Abacus, adapted to assist blind students to learn number concepts and making calculations; raised clock faces, geometric area and volume aids, wire forms for matched planes and volumes; braille rulers compasses, and protractors. For more advanced mathematics functions, the students may use Speech-Plus talking calculators which talk by voicing out entries and results aloud and also presents the material in digital form visually. Talking clocks and spelling aids are also available. 3-D models can also be used where the blind can actually manipulate the objects. In addition to textbooks and special adapted materials from an agency, there is always need for teacher-made materials used on a day to day basis, such as, teacher made tests, worksheets, and special games and activities. These must be reproduced in the desired form by the resource teacher.

For basic writing, the VI students use the Braille write orthe slate and stylus. This is a six key machine corresponding to the 6-dots in braille cell, operated manually, and types braille. Students have to be taught to use a slate and stylus when they start primary school. This is the basic writing tool for VI students and it is the cheapest. The teacher may use raised line drawing board and raised line paper to draw geometric shapes, script letters and diagrams.

Students may use tape recorders for taking notes, formulating compositions, listening to recorded texts or other recorded programs. They can also use portable braille recorders which may be interfaced with a computer that will convert braille to standard print or vice versa. Where there is adequate funding, the school can purchase a number of IT gadgets that can make the life of a VI student easy. Such equipment includes; speech compressor or modified tape recorder which compresses the material and speeds up the listening process;the Optacon, an instrument that scans printed material electronically and raises the print feature so that it may be read tactically; talking calculators which present results visually and auditorily;or the Kurzwell reading machine, a computer based device which provides direct access to typed or printed material by converting it to synthetic speech, among others. The speed and tone can be controlled and the machine can spell a word, letter by letter (Gearheart et al 1988).

Low vision students are able to benefit from special optical aids such as glasses, contact lenses, small telescopes or magnifiers andbooks that are available in large print.

It is important that the regular classroom teacher has a basic understanding of the various kinds of tangible apparatus to ensure their proper use and thus maximise their value to the student. Susan Osterhaus of Texas School for the Blind says that teachers of the VI need to be aware of the different kinds of technology available and be able to teach students how to use them.

Teaching strategies and adaptations

General approaches to teaching the VI include tactile representations, audio aids, tonal representations, haptic devices and integrated approaches. Reading and writing texts in print is completely different from reading and writing mathematics. Mathematics can be considered a language on its own. So how can we teach mathematics to VI students?

Tactile representations are used to represent texts with raised characters as per traditional 6-dot Braille. It has limitations in character set and also presents a more difficult way of representing equations. There can only be 64 characters with the traditional braille. These can be extended to the 8-dot system which will allow for 256 characters. Professor Abraham Nemeth, a blind mathematician and computer science professor, developed the Nemeth Braille system in the 1940s, for representing mathematics in tactile form, as well as a spoken structure for reading equations (Jackson 2002). The Nemeth code employs the ordinary six-dot Braille codes to express numbers and mathematical symbols, using special symbols to set mathematical material off from literary material. Jackson (2002: 1250) contends that:

The Nemeth code can be difficult to learn because the same characters that mean one thing in literary Braille have different meanings in Nemeth. Nevertheless it has been extremely important in helping blind people, especially students, gain access to scientific and technical materials.

So in addition to learning the normal braille, students in mathematics have to learn extra braille mathematics notation, the Nemeth code, which is used to represent the various mathematical signs and symbols. The Royal National Institute for the blind (1989) developed a table of braille signs and advised that in a few cases however, more than one braille sign has the same print equivalent and for these, the correct braille sign should be used according to the meaning or use stated in brackets on the table of signs. This calls for a lot of effort on the part of the students; hence the majority develop a negative attitude towards mathematics and drop the subject.

Gearheart et al (1992) say that it is generally not necessary for the classroom teacher to significantly change teaching strategies to accommodate a student with VI. It may however be helpful to consider a few suggestions that have been found to be effective, especially in inclusive settings. Whenever possible, instruction should start at a concrete level. It should start with concrete materials, moving more to the abstract as students develop the concept. The use of manipulative, tangible or auditory material is preferred to totally verbal instruction, especially in mathematics and science subjects. In Arts subjects, the students can tape record the lesson and listen to it later. In mathematics, hands-on learning should be emphasized as much as possible, and students may need repeated contact with objects. Although a model may be necessary as a teaching/learning aid, a real object or situation is much preferred. The resource or itinerant teachers could assist in obtaining actual objects or making models. Gearheart et al (1992) also stress that experiences that are unified can help students to form concepts. They claim that a trip to a clothing factory or store, supermarket, restaurant and record shops, provides a basis for reinforcing and unifying concepts related to quantity, money, percentages, size, shapes, and social skills, and provide opportunities for integration. It could, for instance, assist the learner to appreciate topics like linear programming, transformations, etc, that most students, including the sighted, shun away from. Learning by doing and teaching by unifying experiences are particularly important for VI students because some students may not have the same experiential background as others of the same age.

Seeing that most VI students learn in integrated settings, it means when writing on the chalkboard, the teacher should be certain to explain verbally the concepts or actual writing being presented, for the benefit of those who cannot see. The teacher should be as specific as possible when giving instructions and possibly repeat the instructions to allow the VI students to internalise.

Visually impaired students need extra time to complete assignments and examinations. Some systems allow time and a half while others give an extra 25% of the time allocated for examinations, the adequacy of which may be subject to debate. It is clear that reading braille takes considerably longer than reading print, and it is worse when a student has to revise what he/she would have written in braille. There is no room for correction when writing in braille, otherwise the student has to write afresh; hence it is necessary to extend time for examinations. Assignments may be completed in a resource room or at home at the student's own pace.

In developed countries like the USA and the UK, it may not be necessary for the classroom teacher to learn braille since the itinerant teacher can write or print whatever has been written directly above the dots. However in third world countries where the economy cannot afford a resource or itinerant teacher, it may be necessary for teachers of the VI to learn braille since they have to mark students' work on their own.

Wood (1998) says making appropriate adaptations of the learning environment, format of content, teaching techniques and testing procedures will enable the student with special needs to be graded according to the same methods used for other students in the classroom. The NCTM (1988) stipulated that during test construction, instructions for the VI students need to be short and simple, given at the beginning. Test items need to be adapted so as to make them more appropriate for students experiencing difficulties, not to water down the test. When designing the test items, there is need to use items that reflect techniques used during teaching. Manipulative objects that make the problems more concrete for the blind students, and coloured pictures for the partially sighted could be provided. Certain key words may need to be underlined and formulas may need to be given as reminders of operations to be used. In all cases, the teacher should avoid use of wordy problems which may be testing language and measuring skills above the level of the learner.

The learning environment, both the socio-emotional and the behavioural, also need to be adapted. Teacher attitudes and expectations, student attitudes, social adjustments, behaviour management and motivation of students, are issues that may drastically affect the performance of learners if the right tone is not set.

THEORETICAL FRAMEWORK: Realistic mathematics education (RME)

What is RME?

Realistic Mathematics education is regarded as the Dutch answer to the world –wide felt need to reform the teaching and learning of mathematics. RME was first conceptualised in the early seventies but is still considered as work in progress (Marja van der Heuvel-Panhuizen 1998). Its foundations were laid down by Freudenthal in 1977. According to him, mathematics must be connected to reality, stay close to children and be relevant to society, in order to be of human value.

Freudenthal (1991)sees mathematics as a human activity, and says that education should give students the 'guided' opportunity to 're-invent' mathematics by doing it, and that the focal point should be on the process of what he calls mathematization. Treffers (1978, 1987) formulated the idea of two types of mathematization, thatis, horizontal and vertical. In horizontal mathematization, students come up with mathematical tools which can help to organize and solve a problem located in a real life situation, like when they carry out the following activities: identifying or describing the specific mathematics in a general context, schematizing, formulating and visualizing a problem in different ways, discovering relations, discovering regularities, recognizing isomorphic aspect in different problems, transferring a real world problem to a mathematical problem. Vertical mathematization is the process of re-organization within the mathematical system itself, and the following activities are example of vertical mathematization: representing a relation in a formula, proving regularities, refining and adjusting models, using different models, combining and integrating models, formulating a mathematical model, and generalizing

According toFreudenthal (1991) horizontal mathematizationis going from the world of life into the world of symbols, while vertical mathematization means moving within the world of symbols.The Dutch reform of mathematics education was called "realistic" is partly because of its connection with the real-world and partly because of the emphasis that RME puts on offering the students problem situations which they can imagine. For the problems to be presented to the students, this means that the context can be a real-world context, but this is not always necessary. The fantasy world of fairy tales and even the formal world of mathematics can be very suitable contexts for a problem, as long as they are real in the student's mind. This is where RME would be a suitable strategy with VI students who rely mainly on their listening skills, touch and memory.

De Lange (1996) stated that problem situations can also be seen as applications or modelling. In addition,he stresses the idea of mathematics as a human activity.He says Mathematics education is organized as a process of 'guided reinvention', where students can experience a similar process compared to the process by which mathematics was invented. 'Invention' is taken to mean steps in the learning processes, and 'guided' refers to the instructional environment of the learning process.

Gravenmeijer, (1994) gave a model of guided reinvention where the learning process starts from contextual problems. Using activities in the horizontal mathematization, for instance, the student gains an informal or a formal mathematical model. By implementing activities such as solving, comparing and discussing, the student deals with vertical mathematization and ends up with the mathematical solution. Then, the student interprets the solution as well as the strategy which was used, to another contextual problem. Finally, the student uses the mathematical knowledge. For the VI

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problems from topics like locus, linear programming, 3-D geometry, etc, could be given as contextual problems which they can discuss and use models to find solutions.

Van der Heuvel(1998) says that historically, the characteristics of RME are related to the Van Hiele's levels of learning mathematics. According to Van Hiele, (cited in de Lange 1996), the process of learning proceeds through three levels:

(1) a pupil reaches the first level of thinking as soon as he can manipulate the known characteristics of a pattern that is familiar to him/her;

(2) as soon as he/she learns to manipulate the inter-relatedness of the characteristics, he/she will have reached the second level;

(3) he/she will reach the third level of thinking when he/she starts manipulating the intrinsic characteristics of relations.

The combinations of the three Van Hiele's levels, Freudenthal's didactical phenomenology and Treffers' progressive mathematization result in the following five basic characteristics of realistic mathematics education: the use of contexts, the use of models,the use of students' own productions and constructions,the interactive character of the teaching process and the intertwinement of various learning strands. These characteristics make RME a suitable framework to use with the VI students.

PURPOSE OF THE STUDY

The purpose of the study was to find out how mathematics is taught to the visually impaired students, with a view to getting an insight into why the VI students never proceed with mathematics beyond 'O' level.

RESEARCH QUESTIONS

The main research question was; 'How is mathematics taught to VI students?'

The sub-questions were;

1. What special equipment is available and how is it used?

2. What modifications, in terms of teaching strategies, do teachers make when teaching VI students?

OBJECTIVES

The objectives of the study were to

Establish how mathematics is taught to VI students.

Establish the adequacy of learning resources for the VI students.

METHODOLOGY

A case study of how mathematics is taught to visually impaired students was carried out at Margaretta Hugo Primary and Secondary schools for the Blind in Masvingo Province, Zimbabwe. Tuckman (1995: 364) postulates that "a case study has a natural setting which is the data source, and the researcher is the key data collection instrument". A case study can also be considered as a way of organizing social data with a purpose of viewing social realities, an in-depth investigation of an individual, group or institution to determine the variables influencing the current behaviours or status of the subject of study; it examines a social unit as a whole (Bestand Kahn 1993, Fraenkel and Wallen 1996). The researcher chose M. Hugo schools because the schools operate in an inclusive setting and they enrol the largest number of VI students in the country among those that provide education for VI students as reflected by the yearly ZIMSEC marking statistics.

The method used for sampling was purposive, the researcher wanted to have a complete picture of what educating the VI involves. The school Administration suggested the primary classes to be employed in the study, while in the secondary section, the forms threes werechosen because they were less busy. Four primary and two secondary mathematics teachers, involved in teaching the chosen classes, were interviewed separately. During interviews, the researcher wanted to find out how the teachers conducted the lessons, whether they had specialist training and how they felt about teaching VI students. The respondents demonstrated and explained the state of equipment availablefor use by the VI children. This was done in order to establish the adequacy of resources. The researcher alsoobserved some lessonsin progress. In particular the researcher was observing how the teacher was explaining the concepts, what sort of questions he would ask, how the students were reacting and how the teacher would deal with student responses. Parerewa (1993) defines observation as a technique which involves systematic selecting, matching and recording behaviour and characteristics of human beings, objects and phenomena. The critical aspect of observation is looking, taking in as much as you can without influencing what you are looking at

PRESENTATION AND ANALYSIS OF RESULTS

In this section, data is presented under the following headings: educational provision for the VI, curriculum, special equipment and materials, teacher requirements, lesson observations and challenges.

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Educational Provision

Why do VI students have to learn mathematics? Paling (1982:2) defines mathematics as follows; “We see mathematics as a way of finding answers to problems; a way in which we use information; use our knowledge of numbers, shapes and measures; use our ability to calculate and , most important, think for ourselves in seeing and using relationships”. Thus the VI students need to develop, as far as possible, the ability to think for themselves in acquiring the mathematical knowledge and skills that are passed on to each child in school.

M. Hugo School was formerly a special school for the blind but presently accommodates both the totally blind and the partially sighted students. The population of the partially sighted is set to increase as a result of awareness campaigns that are being conducted in the districts by the Zimbabwe Association for the Visually Handicapped (ZAVH). ZAVH officers discovered that most parents were still keeping their disabled children at home, far from the public eye. The officers reported that some parents of the VI had taken the issue of having a VI child as a curse, as Linder (1983: 158) rightly puts it, “…..These parents are mourning the loss of the expected normal child and the birth of a handicapped child”.

The children learn in an inclusive setting with both the totally blind and the partially sighted in the same class. It was learnt that the classrooms used to have chalkboards,but these were removed after the totally blind students complained against their use, they felt that the boards gave an advantage to the partially sighted students. The blind students still consider the school as their own since that was the original intention. The situation may change with time since the population of partially sighted students is increasing. The boards could benefit the partially sighted students. Some of the partially sighted students who can read print prefer to ‘read’ the braille dots rather than feel the dots.

Curriculum

This study established that the VI students use the same curriculum as their sighted counterparts both at primary and secondary level. At primary level, the VI students start in the reception class where they are taught braille for beginners, as well as mobility and basic living skills like bathing, cleaning teeth and toilet training. The reception class may have children of different ages depending on when they are brought into the school, or when they lost their sight. Some may lose their sight while already attending school or before starting school, so this will also determine the time that they have to spend in the reception class. In the reception class the children are taught to read and write in braille using pegboards. Later when they get into first grade they are then taught to use the slate and stylus.

Since the VI students study the same curriculum as sighted students, their lessons are also 35 minutes long. They have the same timetable, they study the same four year mathematics course at secondary level and they write the same grade 7 and ‘O’ level examination as the sighted students. They are allowed 25% more time for the examination which is inadequate.

In addition to learning braille (the alphabet and numerals), the VI students have to learn extra mathematical notation, what is termed the Nemeth code. As a result they require more time to cover the syllabus. Before beginning a topic, the teacher has to start by teaching the specific notation involved in each particular topic before the children can learn the concepts. At secondary level the extra notation appears to be quitedemandingsuch that most students are driven awayfrom the subject by this seemingly extra work. There is no way in which the VI can cover the syllabus at the same pace as their sighted colleagues. It would greatly benefit the VI students if their mathematics syllabus was to be covered in five, instead of the current four years. That way the learning of mathematics by VI students would be more realistic.

It was established from the interviews, that at form 1 and 2 level, the students do mathematics becauseit is compulsory, but at form threelevel, most decide to drop it. One teacher reported that most students do not want to learn the additional mathematical notation, and they have developed a negative attitude towards mathematics because of having to learn extra notation. Without the extra notation however, which is a form of mathematical language, the students are not able to learn mathematics.They are not able to make their own constructions, or to go from the world of life into the world of symbols, even if they were to be provided with suitable contexts and suitable models. Without the extra notation, moving within the world of symbols is out of question. It was also learnt that the students have also developed a negative attitude towards diagrams. They find it difficult to comprehend diagrams with many intersecting lines, and as a result they have problems with topics like graphs, circle theorems, constructions andtransformations.

Special equipment and materials

At M. Hugo School, most of the equipment available was donated. At the time of the visit, the school had received a consignment of textbooks, like all other schools in the country, courtesy of the Minister of Education, Art, Sport and Culture. The books were enough for each student to have his/her textbook, but all the books were in print, which meant the VI students could not use them unless they use special equipment to read the texts, of which the equipment was found to be highly inadequate, or get the books transcribed into braille. There is a Braille Press at the school but the workload gets too much for the staff to transcribe all the required booksas each book can have up to six volumes in braille, since braille paper is bulky. A few of the partially sighted students could however benefit, especially those who are able to use magnifiers.

The school used to benefit from the Dorothy Duncan Library in Harare but the facility was withdrawn after the school had flouted lending regulations. In the school library there is asinglePortset reader which scans, reads aloud and can print on a computer printer, and students have to take turns to use it with the help of the teacher. There is also a tactile image enhancer that was donated by some well-wisher,but was not being used because the pen that operates it was misplaced.

The school also has a Dictaphone, a Videomatic machine which enlarges print and can be read on screen; and a braille note taker. There is also a Thermoforming machine, a sort of braille photocopier which uses translucent braille paper and rubber mats to raise diagrams. The teachers use this machine to reproduce tests and examination papers so that each pupil is able to get a copy, but since it is only one, it cannot be used to reproduce all the material required by the students. One then wonders whether the system is being fair to these disabled students, whether we are being realistic in the education we offer to them

There is a computer laboratory where students get assistance on how to use a computer from a special teacher. At the time of the visit, only six computers were operational, the rest having packed up due to over-use. These were installed with ‘Jaws’ and NVDA programs which translate text on screen into spoken words using speech synthesizers, they produce sound when a key is struck. These are talking computers which read out loudly the letters that are struck to spell each word. Repairing the dysfunctional computers was a problem since the school could not afford, their technician had left to join one university where the pastures are greener. If adequate well maintained computers were available, it would be easy for students to write their assignments and examinations using these.

It was learnt that in the past secondary students used Perkins machines to write their assignments and examinations, but most of the machines have broken down and the school has no qualified person to repair them. New ones were reported to be very expensive and the school could not afford to buy them. Students use slates and stylus, which have the disadvantage that one cannot make a correction if they make an error. With a slate and stylus, the student places braille paper between the slate pages then punches holes going from right to left. When (s)he wants to read what has been written, (s)he has to remove the paper from the slate, turn over the paper, then read by feeling the dots from left to right. To continue, one then has to return the paper back into the slate and there is a danger of misaligning the paper or even writing on top of pre-written material. In all cases, even with a Perkins machine, it is impossible to correct what has been written, one would have to re-write the whole thing, which takes time. Under these circumstances it is prudent that the VI get extra time to write their examinations, say 50% more.

Lesson observations

The researcher observed a lesson each in the reception class;in form one and another in form three. The grade 7 pupils were writing a test and the researcher could only observe the teacher-made aids in the room and discuss with the teacher. In the reception class there were 4 children aged about 6 or 7 and the fourth was blind, deaf and dump. Two teachers were manning the class alternating between the three VI children and the one with multiple disabilities. The children demonstrated what they could do, writing the numerals that were called out by the teacher, using pegboards. These were not permanent markings so the teacher was testing their memory on how to follow the sequence of grooves in the pegboard which resembled a slate and stylus.

There was greater use of teaching and learning aids in primary classrooms compared to secondary classrooms. Primary teachers have always been innovative. Perhaps this has been happening because the primary teachers are trained to make media at college during initial training, and to use media in every lesson they teach, which is not the case with secondary teachers.In the grade 7 class there were lots of teacher-made aids and models that the VI students could handle and feel. It helped them to appreciate concepts that may seem abstract. There were 3-dimensional models for mathematics and geography, graphs drawn on a plane and even a model of electricity power lines from Kariba power station to Masvingo city. The teacher explained that he had to make the model because the pupils were failing to appreciate how electricity ‘travel’s to different consumers. Eventually even their sense of the distance between Kariba and Masvingo was enhanced by use of the model. This shows that if one uses models of real objects and gives pupils a chance to manipulate the models, they can learn effectively. The researcher also feels that if models were provided in the examination for questions that normally have diagrams, then the VI students could easily answer all questions without any hustle.

In the form one class, the lesson was on addition of fractions, they were adding 1/2 and 1/3. Some of the pupils were sighted and the teacher being sighted also used the regular method of adding that the sighted use. It took a long time for the pupils to come up with the common denominator for 2 and 3, and because there was no board all the work was done mentally. Then the teacher would ask the pupils to say out the next step where we are dividing each denominator into 6, then multiply each by the respective numerator and finally add the numerators. For the partially sighted, it would have been easier with a chalkboard, though some could not see too far, but for the totally blind it was difficult to imagine how the fractions looked like, where to write the common denominator, the fraction line and so on. The VI students have to rely solely on their memory. The teacher did not mention use of brackets, so for the VI, at the stage (2+3) divided by 6, it appearedlike 2+3/6 which naturally would simplify to 2 and a half. The whole lesson was spent on adding the two fractions. It goes to show how crucial it is for the teacher to understand a bit of braille. It then dawned on the researcher how, during marking of examinations she had noted that candidates were not getting the quadratic formula,

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$, right. At item writing they would say that the VI students could handle the quadratic formula since it is not a diagram, but during marking it was noted that the formula presents problems if candidates do not make use of brackets. The candidates ended up dividing just the term under the square root sign by 2a. This was one lesson where it became clear that the VI students cannot complete the mathematics syllabus in the same time as sighted students.

The lesson taught to the form 3 class was on number types, the natural numbers, integers, etc. There were 23 pupils in the class, two classes had been combined since there was just one teacher; the normal class size is 10. There was no board in the classroom so it was all oral. The lesson started with revision of the previous exercise where pupils were supposed to identify different types of numbers from a given list which included whole numbers, surds and other irrational numbers. It was noted that even during the revision, some pupils would pick on numbers not on the list, and some did not understand the instruction, so they had done all sorts of different things with the numbers because instructions were oral and easily forgotten. It could have helped if the pupils had written down both the exercise and the instructions. Some partially sighted students were reading the dots, not touching them as is normal practice with braille. The teacher had to refer to both print and braille when explaining fractions and sometimes advised them to write in words if they forgot the number types. One pupil commented in the local language “Maths dzinogozha” (maths is difficult). The teacher also stressed that students should know the definitions of the different number types. So the whole lesson was spent on revision and no new work was covered. Surprisingly this was a fairly experienced teacher who has been at the school for almost ten years. One then wonders how a new teacher would cope. At that rate there is no way the teacher can complete the ‘O’ level syllabus in four years.Since the lesson was all orally done, it was difficult to imagine how the VI students could carry out horizontal and vertical mathematization. Most students were not even referring to their homework books during the revision and the teacher did not insist on it.

Recommendations

In view of the foregoing discussion, it is recommended that;

Concerted efforts be made, during training, to equip all secondary teachers with skills to assist VI students in inclusive settings.

Practising secondary teachers be given in-service education and training on how to teach mathematics to the VI.

VI students be given extra time to complete the ‘O’ level course (the 5-year programme could be ideal), and for writing the examination (50% extra time).

Examinations for the VI include tangible 3-D models in place of diagrams since VI students seem to have good spatial visualisation.

Secondary teachers be sensitised on the importance of using teaching aids in mathematics lessons.

Serious efforts be made to provide adequate braille texts and computers for the VI students.

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