

INSIDE PRACTICE OF SCIENCE TEACHERS FOR STUDENTS WITH HEARING IMPAIRMENTS IN BOTSWANA PRIMARY SCHOOLS**Sourav Mukhopadhyay**

and

Emmanuel Moswela*University of Botswana*

In this qualitative study the authors describe how students with severe to profound hearing impairments learn science subjects in primary school in Botswana. Twenty-two teachers from two centres of deaf education in Botswana were recruited purposively to take part in the current study. Multilayered data collection methods were utilized to gain an understanding of classroom practice of science teaching. A constant comparison method was employed to analyse the data. Findings revealed four themes that highlighted the experiences of science teaching. These include curriculum related issues, language related issues, and resources related issues, and teaching methods. Through this study, the investigators gained an insight of current practices of science education in primary schools in Botswana for students with hearing impairments. The findings of this study could shape policy on educational support for students with hearing impairments and provide a framework for alternate assessment for learners with hearing impairment.

Since the last two decades, significant changes have taken place in the education programs, policies and strategies for students with disabilities. The reauthorization of the 1997 Individuals with Disabilities Education Act (IDEA) further reaffirmed the need to promote and enhance access to the general curriculum for students with disabilities. Providing access goes far beyond physical presence of students with disabilities in the classrooms. In fact, Wehmeyer, Sands, Knowlton and Kozleski (2002) rightfully assert that *teacher must ensure that students are actively engaged in learning; that is, the subject matter is cognitively challenging them, regardless of their developmental level.* (p. 47).

Despite these curriculum reform agendas, these changes are occurring at a very slow pace in developing countries. Developing countries are still grappling with late identification, acute shortage of trained professionals (educational and rehabilitation), inadequate resources (assistive and instructional technology) and the pervasiveness of authoritarian instructional strategies, which are often context insensitive to the learning needs of students with disabilities. In this backdrop, meeting the consistent demands for quality science education is a daunting task for the practicing teachers in developing countries.

A significant body of knowledge reveals that students with hearing impairments face barriers in gaining access to information in the classroom (Ministry of Education, 2004). Very little is known about access to science concepts for students with hearing impairments in Botswana and the possible solutions to address the problem. In addition, there is a dearth of research on the effectiveness of classroom instructional practice for students with hearing impairments in Botswana (Moswela, 2009).

In this paper the researchers were interested in exploring the challenges faced by students with hearing impairments when accessing the general curriculum. Science subject was considered as a case for understanding the difficulties faced by students with hearing impairments when learning science concepts in Botswana primary special schools. Students with hearing impairments in Botswana primary schools are substantially lagging behind when it comes to acquiring science concepts instanced by their poor performance in science subjects as measured in Primary School Leaving Examinations (see Table 1). This problem could be attributed to inflexible curriculum, language barriers and inadequate support services.

Table 1
Performance of Students with and without Hearing Impairments in Science in Primary School Leaving Examinations.

Year	A	B	C	D	E	Pass rate of deaf students	Pass rate of students Without Hearing impairments
2001	0	4	8	7	1	67% (n= 20)	83%
2002	0	0	5	5	1	45% (n=11)	78%
2003	1	0	2	11	4	17% (n=18)	83%
2004	0	0	3	17	1	14% (n=21)	80%
2005	0	0	0	16	2	6% (n=18)	72%

Source: Republic of Botswana: *Primary Leaving Examination Reports 2001-2005*

Literature abounds with information about the difficulties faced by students with hearing impairments when learning science subjects or concepts due to lack of linguistic proficiency, factual knowledge about the world and limited opportunities to learn science concepts. Stewart and Kluwin (2001) highlighted four challenges of teaching science to students with hearing impairments. They are:

- (a) students with hearing impairments require authentic experiences,
- (b) students with hearing impairments need vocabulary that is conducive to the acquisition of science concepts,
- (c) students with hearing impairments need opportunities to talk about science related matters with others,
- (d) students with deafness need science role models. Science in schools must be for all students regardless of age, sex, cultural or ethnic background, disabilities, aspirations, or interest.

Therefore science education must be oriented towards acquisition of skills, self and social empowerment (Kyle, 2002). It is not enough to place a student with disabilities in the classroom, it is important to ensure that students with disabilities learn the content, skills and competencies required by the science education curriculum. This approach to teach science enhances access and equity in science achievement for all students. Students must be given equal opportunities to participate in science curriculum so that they can attain high level of science literacy (Kumar, 2002). It is also important to provide wide range of age appropriate science experiences in schools and communities (Fisher & Frey, 2003). Science for all is realized through setting learning opportunities that are suitable for all students. Teachers should respond to students' diverse learning needs in order to enhance acquisition of scientific skills, knowledge, attitudes and create interest in the science curriculum and make sure that students are not isolated, or denied access to scientific equipment, and digital divide (Sears & Sorensen, 2000; Ward, Roden, Hewlett & Foreman, 2005).

There has been a growing interest among researchers (Mayer, Tane & Stewart, 2002; O'Connor & Jenkins, 1996) to examine the use and the influence of learner centered pedagogies such as cooperative learning and dialogic inquiry model when teaching students with disabilities including deaf students. The findings of these studies indicated that more than half of students with disabilities thrived in cooperative learning and dialogic inquiry model. Roald (2002) highlighted key factors which are central to the science education of deaf students. These factors are:

- (a) teachers' ability to communicate fluently in sign language,
- (b) lucid explanations of science concepts as well as their connection to others concepts,
- (c) the need for classroom discussions
- (d) differentiated teaching,
- (e) realistic expectation,

- (f) building students' experiences through the use of experiments,
- (g) enhancing access to information and
- (h) time-on-task.

In a related study, O'Connor and Jenkins (1996) found that Dialogic Inquiry Model (DIM) is an effective mode of practice while teaching deaf students. DIM gave opportunities to teachers to engage deaf students in meaningful and knowledge building interactions to access broader curriculum goals. In this way, deaf students negotiated and gained understanding and meaning of abstract concepts as they investigated the problem at hand.

However some challenges may not be applicable in all situations because some challenges are context specific. For example in Botswana, students with hearing impairments hardly go up to senior secondary schools, while individuals with hearing impairments from United States of America can attain a higher degree or even a Doctoral Degree. In developing countries where students with hearing impairments are identified at the age of seven years and the schools are battling with acquiring adequate resources to ensure quality education; getting a deaf science role model is a dream.

Special education in Botswana

Upon gaining independence in 1966, major thrust was given to the education of Botswana citizens, and all efforts were made to enhance open access. Historically, educating children with disabilities in Botswana started around 1970 by some Non-Governmental Organizations (NGOs). In those early years, the Government of Botswana showed very little interest in educating children with disabilities because this was not considered a *sound investment of resources* (Abosi & Makunga, 1995, p 263). However, as education reforms developed and the need for open access and equity was emphasized, the government declared interest in educating all Botswana, individuals with disability included. In 1994, a document that brought hope for all, the National Policy on Education, was produced. Its approval by the National Assembly on the 7th April 1994 was a sign that indeed Botswana is committed to embracing the sentiments of the *right to education* (Republic of Botswana, 1994) including children with disability. Since then, the situation has been steadily changing although the pace of interest as reflected in policy formulation and implementation is very slow and worrying.

The current scenario of Deaf Education in Botswana

Historically, educating students with hearing impairments in Botswana started around 1979, Christoffel Blinden Mission from Germany. In 1979 they opened the first unit class of deaf at Mogopane Primary School in Ramotswa. The Unit Class at Magopane was changed to Special School for the Deaf and moved from Magopane Primary School to Ramotswa Centre for Deaf Education (Ramotswa Centre for Deaf Education Report, 2001) Table 2 displays educational options for students with hearing impairments in Botswana.

Table2
Educational Options for Students with Hearing Impairments in Botswana

Name of the School	Level	Type of Placemen	Facilities
Ramotswa Centre for Deaf Education	Primary	Special School	Residential
Fransistown Centre for Deaf Education	Primary	Special School	Residential
Makolojwane Primary School, Serowe	Primary	Special Unit in Mainstream School	Day
Boyei Primary School, Maun	Primary	Special Unit in Mainstream School	Day
Ramotswa CJSS, Ramotswa, Ramotwa	Secondary	Special Unit in Mainstream School	Residential
Tashatha Primary School, Tatitown, Francistown	Secondary	Special Unit in Mainstream School	Residential
Maun Senior Secondary School, Maun	Sr. Secondary	Mainstream School	Residential

Source: R.N. Lekoko, & S. Mukhopadhyay, (2008)

Placement

The education of students with hearing impairments is carried out in three strata of education. The students start at preschool level at specialised centre, which are residential. The students then proceed to primary level, which is seven years of schooling in the same centre. The education policy of Botswana recommend ten years of basic education students with hearing impairments are automatically promoted to a *junior secondary school* for three years (Republic of Botswana, 1994). Some of the

students with hearing impairments may proceed to *senior secondary schools* based on passing National Examinations.

Method of Instruction

The first two teachers of the deaf were trained in America and Ghana. These teachers were given different forms of education of the deaf. One was trained in American Sign Language and total communication while the other was trained in oralism; these teachers were both given chance to train in England where they both studied the use of sign language and total communication. The volunteers from UK, USA and Holland influenced the mode of instructions in the classrooms and contributed in the development of Sign Language, which is practiced in the school. This is not a standardised American Sign Language (ASL) it is pseudo ASL. However, in most cases Total Communication was advocated and became the official medium of instruction for students with learning difficulties. However the students with hearing impairments in both the centres preferred to be taught in sign language and leading to pedagogical dilemma (Lekoko, Mukhopadhyay, 2008). Currently, the Ministry of education is trying to develop Setswana Sign Language Dictionary to be used in the classroom.

Curriculum

The students with hearing impairments follow the National curriculum without any modifications and adaptation. The students use the same textbooks and sit for same examinations. However the policy makers have realized the importance of curriculum adaptation but yet to implement in real practice (Kisanji, 2003; Ministry of Education, 2004).

Purpose of this study

The purpose of this study was three-fold. First, it explored the teachers' perceptions about the suitability of the current science curriculum for students with hearing impairments. Secondly, it sought to understand the problems faced by teachers when teaching students with hearing impairments science and how do teachers overcome these challenges/problems. Finally, we investigated the inside practice of teaching science to students hearing impairments.

Method

Research site

This research was carried out at two centres for deaf education in Botswana. Both centres offer pre-school education and primary school education. Botswana Society runs these centres for the Deaf, however Government of Botswana pays teachers salaries and necessary teaching learning resources.

Research design

Qualitative research approach was used for this study. In this study researchers used multilayered methods of data collection such as interviews, classroom observations and document analysis to obtain *thick data* (Lincoln & Guba, 1985). The researchers were not interested in making generalizations but were interested in gaining an insight about the teacher's day-to-day experiences in the centres. Therefore, the researchers employed qualitative framework to obtain *thick data* about phenomena under study. Phenomena in this context are *the classroom practices* of the teachers' day-to-day operation in the classrooms. More than other paradigms of qualitative research phenomenology offered an opportunity to the researchers to explore and present the lived experience (Creswell, 2003) on the challenges while teaching science to students with hearing impairments.

Participants

Twenty-two teachers of students with hearing impairments participated in the current research. Participants were selected using purposively sampling. Since researchers were interested in the lived experience, of the teachers, purposive sampling became the choice of selecting participants of the study. While selecting the participants, the following criteria was addressed; (a) the teachers should have at least acquired diploma in Special Education with specialization in Deaf education, (b) more than two teachers of teaching students with hearing impairments in a particular centre, and (c) willing to participate in a study voluntarily.

Instruments

The researchers particularly for this study designed a semi-structured interview-guide. The purpose of this interview guide was to gather data on the teachers' day-to-day experiences when teaching science to students with hearing impairments The semi-structured guide was written in English language and given to four two from research department and two from special education department) faculty

members to review. All the corrections were incorporated. Then six final year (fourth year) in-service student-teachers majoring in deaf education and who had undergone teaching practice in deaf centres were recruited for the purpose of pilot testing the instrument. A focus group discussion was conducted for pilot testing the instrument. This gave the researchers an opportunity to find out the suitability of the language and cultural conformity. In addition to this, the pilot testing exercise enabled the researchers to rehearse the interviewing processes and measure the duration of the interviews. The final instrument was based on the comments given by the student-teachers. Semi-structured interviews were complemented by non-participatory observations. Non-participant observations allowed the researchers to capture the inside practice of science teachers in the natural setting/environment. Later on the data was triangulated with document review and the following documents were reviewed such as pupil's science textbooks, past examination papers, lesson plan notes, and science syllabus. The researchers also designed a non-participatory observation guide based on Creswell (1998).

Procedures

The data were collected in four phases. In phase one researcher obtained permission from the head teachers of the two schools and familiarized themselves with the settings for three weeks. During this phase researchers informally discussed about teaching students with hearing impairments and explained in detail about the current research and sought their consent. This process helped the researchers to build rapport with the participants of the study and the participants of the study (Chilisa & Preece, 2005; Miles & Huberman, 1994). In the second phase participants were interviewed using a semi-structured interviews protocol by the researchers who were experienced educators in deaf education. Each interview lasted for 45 minutes to one hour and in total 22 interviews were conducted. All the interviews were audio taped by the researchers and later on transcribed. In the third phase, one of the researchers then carried out non-participatory observation for selected teachers who agreed to participate in classroom observations. The data was entered immediately in the pre-designed observation guide (also designed by the researchers). During classroom observations reflexive memos were kept. Just right after the end of the lesson (while teachers are still *rich* in experiences from the lessons) the researcher discussed with the teachers to clarify certain contextual issues of classroom practice. This post-observation interview gave the research *rich data* since participants were *experience rich* from the lesson that they have conducted. In the last phase researchers triangulated the data by making use of document analysis. Researchers analysed students' textbooks, teacher preparation lesson notes, and science syllabus. Apart from these documents research randomly analysed the students exercise books and past exam papers. These helped the researchers to gather information about the classroom practice and enhanced the validity of the data (Lincoln & Guba, 1985). The data was collected from May 2008 to July 2008.

Data analysis

The interviews were transcribed verbatim. A constant-comparison method (Strauss & Corbin, 1994) was used to examine the similarities and differences in reflections across the participants. The information collected from the two settings gave the research diversity, which helped the researchers to identify the commonalities, and differences in lived experiences that helped in capturing the themes as they emerged. The data was analysed in step-by-step fashion. In Step one, the data from each participant was analysed the transcripts employing line-by-line open coding. In Step two, each transcript was examined separately, and whenever a new theme emerge-out, it was highlighted. The identified themes within the transcript were then compared across transcripts in Step three. Overall themes were then developed in Step four. This procedure was followed for each transcript analyzed. Selective coding was employed which enabled the researcher to confirm central categories so as to organize the results. A summary of all transcripts was compiled in which sub-themes were compared to come up with overall themes that were later used to report the finding of this study. This process of data analysis was carried out by individual researcher and then compared among them to agree on the final themes. This process enhanced the reliability of the data analysis.

Conformability

After the preliminary findings, researchers presented their finding to the participants in a group for the member check exercise. The exercise lasted approximately one hour. The major themes that were identified were presented to the participants in to groups to comment on. This stimulated recall further evoked the participants to discuss and add on the existing information. The participants were free to discuss on the theme and agreed that they represented their own opinions (i.e., to comment on the accuracy of the information). All participants agreed with the summaries and informed the investigators that the information accurately reflected their contributions to this investigation. This information was

then used to confirm primary categories established and to further understand relationships as they exist among the categories.

Results

Analysis of the data agreed with the research questions and revealed themes that emerged from the responses to the questions asked. Four major themes emerged: These consisted of curriculum related issues, language related issues, and resources related issues and teaching methods. Under each theme several sub-themes emerged.

Curriculum issues

Participants revealed that the curriculum is highly packed with content. Certain topics like sound and music are difficult to teach and for students with hearing impairments to conceptualize since they are taught abstractly. They further revealed that the syllabus is very abstract and cannot be fully accessed. Most participants felt that the curriculum is not suitable but necessary for all children given the fact that the current world revolves around science, so students with hearing impairments should fit in perfectly. Lessons were predominately characterized by question and answer and telling methods. Student interaction was very minimal even during experiments. There were no structured reflexive conversations with students. When asked to describe the methods of teaching she employs, one of the teachers pointed out that:

Nna mostly ke dirisa (Personally I use) lecture method. Since you cannot tell them everything I ask them questions to involve them in the lesson. For easy tasks I use group work. For difficult task I simply lecture. Kana (The truth is) these deaf students tota (entirely) depend on the teacher for everything (Teacher 1).

When probed into how they solve the problems they encounter regarding curriculum adaptation, one of the participants that:

I try by all means to modify the curriculum so that the curriculum meets the needs of pupils with hearing impairments (Teacher 5).

Contrary to these sentiments, the classroom observations indicated that teachers failed to modify the curriculum to suit the students' learning needs. At the same time the work sample of teachers' lesson notes and students' portfolio did not show any evidence of curriculum modifications. This issue was discussed in the post observation interview one of the participants revealed that: *who really knows what to adapt and how to adapt here? They did not teach us at the UB (Teacher 3).* The above sentiment indicates the shortfall of teacher preparation, which needs to be addressed.

Teaching methods

Some of the participants indicated that they used child-centred approach such as demonstration, observation, exploration, experimenting, field excursions and question and answer. This was confirmed in the lesson observation. Classroom discourse seemed to be oriented towards traditional methods of teaching (e.g. lecture methods, rapid question-answer method and drilling). Learning was confined mostly to the class. One of the interviewees revealed, *We simply use lecture method most of the time because it is easy (Teacher 2).* It also emerged from the data that the participants did not undergo any training (pre-service and in-service). Teachers reported that they used general methods of teaching and common sense. A documented review of lesson notes for science brought out in the open that lesson plans were scanty and teaching methods such as question and answer, textbook approach were common.

It was observed that teaching methods such as question and answer, textbook approach were common. Learning was confined mostly to the class and this was confirmed in the lesson observation. Classroom discourse seemed to be oriented towards traditional methods of teaching (e.g. lecture methods, rapid question-answer method and drilling). One of the participants revealed, *We simply use lecture method most of the time because it is easy (Teacher 4).* On the contrary, some participants indicated that they use child-centred approach such as demonstration, observation, exploration, experimenting, field excursions and question and answer. Another interesting finding was that majority of the participants did not undergo any training (pre-service and in-service) which could equip them skills to teach science subjects. It was found that the lesson plans were scanty and there was no evidence of differentiated teaching. To justify why her teaching was not informed by learner-centred pedagogies, one of the teachers revealed that; *Learner centred methods are demanding (Teacher 7).*

Language Related Issues

For the most part of the lessons observed, there was evidence of the pervasiveness of traditional methods in classroom discourse with teachers preoccupied with transmitting knowledge to the students. The dominant methods of teaching were mostly the *talk and chalk*, telling, question and answer approaches mostly employed to introduce lessons and throughout the interactive phase. The dynamic use of prior knowledge has no place in the lesson. On the whole teachers initiated the stimulus while students supplied answers to low order questions posed by the teachers during teaching. It was also observed that there was no *wait-time* for responses. Mostly teachers would quickly move on and ask the next student a question or even supplying the right answer to the students without trying to elicit more correct responses from the same students.

Linguistic incompetence is one of the major themes, which emerged from the data. Expressing concern about linguistic incompetence of students with hearing impairments, one of the participants of the study expressed that:

Students with hearing impairments have limited vocabulary and come to school with no formal language. It is not easy to teach the children with limited vocabulary. Should I teach vocabulary or should I teach science. It appears I have to teach science language before I teach them science (Teacher 2).

Another participant echoed the same sentiments and reported that:

Because of hearing impairments they are not able to access information about phenomena because of the fact that they are hearing impaired (Teacher 8).

All the participants of this study were highly concerned about unavailability of standardized scientific signs for classroom use. One of the participants lamented that:

There are no signs for certain scientific words. It is a problem to explain certain concepts such as photosynthesis, pollution and sublimation. There are no signs for these scientific words. Due to lack of scientific signs we tend to explain the concept using informal signs that differs from one teacher to another. As a result there is no uniformity in teaching (Teacher 6).

On a similar issue one of the participants reported that:

I do not have anywhere to get the signs and end up coming up with my own which are not standard and as pupils move up the standards other teacher will also come up with their own signs. Changing the signs acquired from the previous teacher (Teacher 10).

These comments were consistent with data, which were collected through classroom observations and reflective journals. Home signs for scientific concepts differed from all the classes we observed. In few cases teachers were found to be using one sign for a scientific concept. Sampled science examination past papers were not language appropriate for students with hearing impairments. Also the syllabus document and pupils' science textbooks reflected the same problem.

Lack of resources

The majority of the participants expressed concern about lack of appropriate science materials for students with hearing impairments. Therefore, stressed the need to provide appropriate and adequate science materials for students with hearing impairments. They recommended textbook books and CD ROMs with lots of visual aids that could help to explain meaning of science concepts. The phrase *appropriate resources* was frequently used to describe the importance of resources, which could enable students with hearing impairments to acquire skills, competencies and content of the science curriculum. Perhaps the concern about inadequate and appropriate is best summed up by one of the participants, who revealed that:

Pupils' textbooks are packed with abstract language with no or very little visual aids to aid construct meaning. Textbooks have been designed for normal pupils. Some activities require students to listen and record or speak. The school never orders materials, which are appropriate for pupils with hearing impairments (Teacher 11).

When acknowledging the dearth of appropriate science materials and emphasizing the need to procure appropriate science materials for students with hearing impairments, one of the participants expressed that:

There are no models, audio visual aids and books with lots of pictures and no science equipment to engaging pupils with hearing impairments in experiments. Those that are there are inappropriate for pupils with hearing impairments (Teacher 15).

In sharp contrast to majority of the participants' view to provide appropriate science materials for students with hearing impairments, some participants used the phrase *same materials* to explain the

importance of using the same materials since students with hearing impairments follow the same curriculum. One of the participants stated:

They are going to write the same Primary School Leaving Examinations and they are using the same curriculum why the difference in resource materials. Visual aids that accompany the texts are okay and adequate enough to convey meaning. They further asserted that there is no how the materials can be made to suit pupils with hearing impairments (Teacher 15).

When asked about how she overcomes the problem of inappropriate science materials one of the participants of the study expressed her comments in the following statement:

I try to adapt the materials to suit their level. Yeah! I improvise. It proves very difficult to solve the problem but I simply improvise for other material that can be of help (sic) (Teacher 16).

These findings were affirmed by a resource materials audit and document review of science inventory. Students' textbooks were not accessible had lengthy text with little if no visual aids at all. For example of Standard four science pupil's book the concept of planet is discussed abstractly with little visual aids to demonstrate the concept. Though there are computers in the Centre, they are not used in teaching science. In addition software such as Jump Start could be used in the teaching of science for students with hearing impairments.

Discussion

The findings of this research indicate that teaching science to students with hearing impairments is mixed by challenges. Stewart and Kluwin (2001) found that students with hearing impairments encounter difficulties in constructing their knowledge of science. These challenges are influenced by factors such as pedagogical dilemma and lack of appropriate curriculum support materials. To support this point, Barba (1995), argued that the science knowledge of an individual learner, is a *product of social interactions* (p.100).

Our analysis of the experiences of 22 primary teachers of students with hearing impairments revealed complexities of accessing science curriculum which do not allow students with hearing impairments to attain science skills, content and competencies required by the general curriculum. These problems resulted in: language, curriculum, material resources, and teaching methods. Participants of the study revealed that the vocabulary of science is new and difficult to explain to students with hearing impairments. As a result this impedes them from learning science because science can only be understood through understanding its language. These findings echo those of other researchers who had engaged in similar research (Wellington & Osborne, 2001). Sears and Sorensen (2000) similarly reported the benefits of educating students to their potential within their communities. Findings of these researchers emphasize the need for students with hearing impairments to acquire the same skills as their peers, which would amount to equal educational opportunities, and enhanced access to the general education science curriculum.

Another finding, which emerged out of the data, reflects a dearth of appropriate science resource materials for students with hearing impairments at the Centre. Therefore, the need for teachers to carefully select, define and design science teaching materials to meet the learning needs of students with hearing impairments so as to promote acquisition of skills, competencies is a key to enhancing access to the general science curriculum. As identified in the present research, this is a critical component of actualizing progress and participation in the general curriculum as it is supported in literature (Spooner & Browner, 2006).

The investigators observed that teachers of students with hearing impairments seemed to lack knowledge, skills and creativity on how to teach science to students with hearing impairments. This was evidenced by the frequent use of *question and answer* and *telling methods*. Of interest to us was that the teachers' choice of instructional methods seemed not to be informed by the students' learning needs. Classroom discourse remained highly authoritarian devoid of student-to-student interaction and investigative exercises. The use of teacher-centred pedagogies was seen as fitting in the situation and not demanding. In addition to this, this was attributed this to limited experience and lack of training. The use of teacher-centred pedagogies is not in line with research, which criticizes teacher-centred approaches for not promoting acquisition of science skills, content, and competencies required by the general curriculum (Scruggs, Mastropieri & Magnusen, 2006).

Findings from our study unearthed critical issues regarding accessing science curriculum by students with hearing impairments in Botswana Primary Schools. Some of these critical issues included; universally designed materials and high quality instructional strategies that harmonize well with students' varied learning needs. These findings were consistent with the recommendations of research by Wehmeyer, Lance and Bashinski, (2002).

In a nutshell, our study highlighted the problems of accessing science curriculum for students with hearing impairments such as highly packed with content and inaccessible topics (sound, rhyming) and objectives. In addition to this, students seem not to relate the current science curriculum content to real life situations. Consequently, they failed to acquire scientific skills, concepts and content required by the science general curriculum. From the findings of our study, it could be inferred that students with hearing impairments are not given equal opportunities to succeed in science curriculum.

Recommendations

Although the teachers' experiences were restricted to the context of Botswana, lessons learnt from this research could be utilized in the context of other developing countries. Our recommendations were based on the themes that emerged from the experiences of the teachers. These themes included: curriculum related issues, language related issues, and resources related issues and teaching methods.

Inaccessible curriculum

In order to promote accessing science curriculum by students with hearing impairments in Botswana Primary Schools, there was a need for *re-culturing* (Fullan, 2001, p.44) our practices. This study revealed complexities, which impede acquisition of scientific skills, content, and competencies required by the general curriculum. The current scenario called for an in-depth study which explored ways of promoting access to science curriculum by students with hearing impairments in Botswana Primary Schools. Furthermore, policy and decision makers should consider science 'curriculum stretching' to allow students with hearing impairments to learn science content adequately before moving to the next level. Finally, alternate modes of assessment; student explains a concept in sign language, examiner videotapes and gives others to grade and use of inter-rater correlation) should be utilized.

Inappropriate resources

To access curriculum, appropriate culturally and linguistically suitable science materials need to be available. The practicing teachers should be encouraged to design their materials. The centres should have professionals who are trained in material production could be employed. Currently, information and communication technologies (ICT) have shown the potential to bridge the gap in this aspect. Interactive software could be used to enhance acquisition of scientific knowledge and skills. At the same time ICT can be utilized to so that students with hearing impairments can gain authentic experiences, which could lead to attain skills, content, and competencies required by the general science curriculum (Spooner & Browner, 2006). It is important to develop Sign Language dictionary focusing on culturally suitable science vocabulary and analyze its efficacy. Further research is needed in promoting access to general science curriculum for students with hearing impairments and measures the outcome of science literacy.

Lack of knowledge and skills in teaching science

The teachers' knowledge and skills of teaching science could be enhanced through in-service training. The continuous professional development through regular in-service training to use ICT could be done through web-based learning or e-learning.

Conclusion:

Teaching science is all about giving students with hearing impairments requisite knowledge and skills needed to understand and apply scientific concepts in academic and everyday life. The findings of this study reveals that teaching science to students with hearing impairments was not a simple task. It is a complex interaction between the environment and the learners. Curriculum plays an important role in proving overall academic success and independent productive living in the community. In order to promote access to the science curriculum for students with hearing impairments, it is important to ensure that students' learning needs, curriculum and instructional adaptation are harmonised well.

References:

Abosi, C.O., Makunga, J. (1995). Special education in C.O. Abosi & I. Kandiji-Murangi. (Eds.). *Education in Botswana* (pp.266-291). Gaborone: Macmillan,

- Babra, R. H. (1995). *Science in multicultural classroom: A guide to teaching and learning*. Boston: Allyn & Bacon.
- Chilisa, B., & Preece, J. (2005). *Research methods for adult educators in Africa: African perspectives on adult learning*: Cape Town: Pearson Education.
- Creswell, J.W. (1998). *Qualitative inquiry and research design choosing among five traditions*. London: Sage Publications.
- Creswell, J.W. (2003). *Research design qualitative, quantitative and mixed methods approaches*. London: Sage Publications.
- Fisher, D., & Frey, N. (2003). *Inclusive urban school*. Baltimore: Paul.H Brookes.
- Fullan, M. (2001). *Leading in a culture of change*.(2nd ed.). San Fransisco, CA: Jossey-Bass.
- Kyle, W. R. (2002). Critical issues of school and teacher education reform: transforming science teaching and learning for a new millennium. *Science,technology and mathematics education in Africa*. (pp. x-xxiii). Gaborone.: Faculty of Education Research and Publication Committee and Department of Mathematics and Science Education.
- Kisanji, J.(2003). *A situation analysis for the adaptation and modification of the basic and senior secondary curriculum for hearing-impaired students*. Gaborone: Curriculum Development and Evaluation Department.
- Kumar, D.D. (2002). Inclusion policy and science teaching: A view from the USA school. *Science Review*, 83, 84-87.
- Lekoko, R.N. & Mukhopadhyay, S. (2008) Practice and preferences of sign languages in the instruction of the deaf students: some reflection on the mainstream secondary schools of Botswana. *Asia Pacific Disability Rehabilitation Journal*, 19 (1), 79-92.
- Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry*. London: Sage Publications.
- Mayer, C.C., Akamatsu, T., & Stewart, D.(2002). A model for effective practice: Dialogic inquiry with students who are deaf. *Council of exceptional children*, 68 (4), 485-502.
- Miles, M.B., & Huberman, A.M., (1994). *Data management and analysis methods*. Thousands Oaks, CA: Sage.
- Ministry of Education, (2004). *Education development in Botswana*. Gaborone: Government Printers.
- Moswela, E. (2009). A critical analysis of pedagogical styles and access to the general curriculum for deaf students. University of Botswana: Unpublished Masters Dissertation.
- O'Connor, R.E., & Jenkins,J.R. (1996). Cooperative Learning as an Inclusion Strategy: A closer look. *Exceptionality Research Journal* 6(1), 29-51.
- Ramotswa Centre for Deaf Education Report, (2001) *Annual report*. Ramotswa Centre for Deaf Education. Ramotswa. Unpublished Report.
- Republic of Botswana, (1994). *The revised national policies on education*. Ministry of Education. Gaborone: Government Printer.
- Republic of Botswana, (2001). *Primary school leaving examinations report*. Examinations, Research and Testing Division (ERTD). Ministry of Education. Gaborone: Government Printers.
- Republic of Botswana, (2002). *Primary school leaving examinations report*. Examinations, Research and Testing Division (ERTD). Ministry of Education. Gaborone: Government Printers.
- Republic of Botswana, (2003). *Primary school leaving examinations report*. Examinations, Research and Testing Division (ERTD). Ministry of Education Gaborone: Government Printers.
- Republic of Botswana, (2004). *Primary school leaving examinations report*. Examinations, Research and Testing Division (ERTD). Ministry of Education Gaborone: Government Printers.
- Republic of Botswana, (2005). *Primary school leaving examination report*. Examinations, Research and Testing Division (ERTD). Ministry of Education Gaborone: Government Printers.
- Roald, I. (2002). Norwegian deaf teachers' reflections on their science education: Implication for instruction. *Journal of Deaf Studies and Deaf Education*, 7 (1), 57-73.
- Scruggs, E., Mastropieri, M.A., & Magnusen, L. (2006). Activities – oriented science instruction for students with disabilities. *Learning Disability Quarterly*, 22, 240 – 263.
- Sears, J., & Soresen, P. (2000). *Science for all: The change of inclusion*. London: Paul Chapman Publishing.
- Spooner, F., & Browner, D.M.(2006). *Teaching language arts, math, and science to students with significant cognitive disabilities*. Baltimore: Pault Brookes.
- Stewart, D.A., & Kluwin, T.N. (2001). *Teaching deaf and hard of hearing students: Content, strategies, and curriculum*. Boston; Aylln and Bacon.
- Strauss, A., & Corbin, J. (1994). Grounded theory methodology: An overview. In N. Denzin and Y. Lincoln. (Eds), *Handbook of qualitative research* (p.273-285).Thousands Oaks, A; Sage.
- Ward, H., Roden, I., Hewlett, R.C., & Foremnan, J. (2005). *Teaching science in the primary classroom: A practical guide*. London: Paul Publishing.

Wehmeyer, M.L., Lance, D., & Bashinski, S. (2002). Promoting access to the general curriculum for students with mental retardation: A multi level model. *Education and Training in Mental Retardation and Developmental Disabilities*, 37(3), 223-234.

Wehmeyer, M.L., Sands, D.J., Knowlton, H.E. & Kozleski, E.B. (2002). *Providing access to general curriculum: Teaching students with mental retardation*. Baltimore: Paul, H. Brookes Publishing Company

Wellington, J., & Osborne, J. (2001). *Language literacy in science education*. Buckingham: Open University Press.