Volume 24 Issue 12
Originally issued as G2

Global Journal of human-social science: G
Linguistics & Education
Volume 24 Issue 2 Version 1.0 Year 2024
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-460X & Print ISSN: 0975-587X

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Keywords: *hearing impairment, inclusive education, integrated science and teaching.*

GJHSS-G Classification: *LCC Code: LC 4818-4823*

INCLUSIVETEACHINGOFINTEGRATEDSCIENCETOSTUDENTTEACHERSWITHHEARINGIMPAIRMENTSINZAMBIA

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Inclusive Teaching of Integrated Science to Student Teachers with Hearing Impairments in Zambia

Brighton Kumatongo [α] & Nixon Musukwa [σ]

Abstract- Integrated science is one of the core curriculum subjects for trainee teachers pursuing primary teachers' diploma in Zambian colleges of education. This study aimed at exploring teaching integrated science to student teachers with Hearing Impairments in an Inclusive environment. Five (5) participants from Kitwe College of Education in Zambia who comprised three (3) student teachers with Hearing Impairments and two (2) lecturers took part in the study. Some of the findings were that student teachers with Hearing Impairments and Lecturers of science had mixed views on the attitude of student teachers with Hearing Impairments towards learning integrated science, but generally felt that students with Hearing Impairments were not adequately attended to during science lessons. The study also revealed that lecturers had challenges explaining scientific concepts, science terminologies were distorted during sign language interpretation and that student teachers with Hearing Impairments had difficulties comprehending scientific terms. The study concluded that adaptive measures for inclusion of student teachers with Hearing Impairments were not adequate and recommended the use of visual aids and assistive technology or multimedia approach during teaching integrated science as well as developing and standardising word-signs for scientific terms to help enhance the learning of integrated science to students with Hearing Impairments.

Keywords: hearing impairment, inclusive education, integrated science and teaching.

I. Introduction

Inclusiveness and equity is one of the guiding principles of education in Zambia. Under inclusivity, all learners, irrespective of differences in age, gender, ethnicity, language, disability among other forms should access, participate in, and benefit from quality education in Zambia (Ministry of Education, 2023). From Inclusive Education perspective, students with Hearing Impairments are supposed to learn together with their peers. Student teachers pursuing Primary Teacher Education under the Zambian College Curriculum are expected to study integrated Science as one of the Core Teaching Courses (Ministry of Education, Science, Vocational Training and Early Education, 2013). Core curriculum courses are meant to be taught to all students in a particular programme (Levander & Mikkola, 2009).

Hearing Impairment is inability to hear and interpret sounds due to problems in the auditory system, implying that an individual is unable to process linguistic information through hearing with or without amplification (Kumatongo et al., 2021; World Health Organisation, 2015). Hearing Impairment or deafness can be congenital (present at birth) or acquired during developmental stages in an individual's life.

Studies on teaching science to students with Hearing Impairments have shown that the use of experimental methodology increased interest in science, self-esteem and self-confidence of students (Flores & Rumjanek, 2015). Similarly, Saowalak (2015) reported positive learning attitude towards science by students with Hearing Impairments. Others studies indicate that students with Hearing Impairments felt less integrated into the learning institution, had preference for educators and experienced communication challenges (Lang, Dowaliby & Anderson, 1993; Foster, Long & Snell, 1999; Martins, 2006; Kigotho, 2016).

a) *Study objectives*

The study was guided by the following objectives;

i. To explore the views of lecturers towards teaching integrated science to student teachers with Hearing Impairments in an inclusive institution.
ii. To establish attitude of student teachers with hearing impairments towards learning integrated science.
iii. To determine barriers towards learning integrated science by student teachers with Hearing Impairments.

b) *Theoretical Framework*

Sociocultural theory by Lev Vygotsky (1896-1934) is based on the social constructivist paradigm anchored on the belief that knowledge is constructed socially through interaction and shared by individuals. Sociocultural theories consider learning and development as results of social events occurring when learners interact with other people, objects, and events in the collaborative environment (Vygotsky, 1978). Vygotsky (1978) argued that development in learners occur in two locations, externally from social interactions and internally (Lee, 2015).

In reference to learning and cognitive development as results of interactions, Vygotsky coined the term *More Knowledgeable Others* (MKOs) which refers to anyone who has a better understanding or a higher ability level than the learner, with respect to a particular task, process, or concept. The MKO is

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normally thought of as being a teacher, parents, older adult or peers. The concept of MKO was used in this study in that students require interaction with educators who are lecturers of science to comprehend scientific concepts because lecturers are more knowledgeable than students.

Based on the understanding that learners require assistance in order to learn effectively, Vygotsky used the term *scaffolding* to refer to the significance or the help learners receive when performing tasks beyond their levels. Vygotsky (1978) indicated that, scaffolding provides an effective way to reach potential levels of cognitive development (Wang, Bruce, & Hughes, 2011). The concept of scaffolding in this study was likened to adaptive measures required to help students with Hearing Impairments to learn integrated science in an inclusive learning environment.

Vygotsky indicated that a learner's cognitive is enhanced when they work in their Zone of Proximal Development (ZPD), the gap between what the child is capable of doing without help and what the child can potentially be capable of doing with the help others (Munsaka & Matafwali, 2013). Vygotsky argued that there are two levels of Zone of Proximal Development. The first level being the present level of development, which describes what the child is capable of doing without help, and the second level is the potential level of development, which is what the child could be capable of doing with the help of others who are more knowledgeable than the child. The concept of ZPD was helpful in this study in terms of analysing the barriers towards learning integrated science by students with Hearing Impairments despite them having inherent potential to learn and comprehend scientific concepts.

II. Literature Review

a) Concept of Inclusive Education

Inclusion is not merely placing learners with impairments and disabilities in a classroom to learn with other learners (Muzata, 2021), but institutions must uphold the principle of inclusion which promotes the idea that quality education must be accessible by all learners (Abosi, and Koay, 2008). Inclusion refers to the merging of special education practices and regular education with the belief that all children should have access to and benefit from the same curriculum (Preston, 2023). It is the type of education in which learners with diverse education needs learn together in the same environment.

In an inclusive setting, quality education must be *accessible, available, acceptable and adaptable* for all learners. *Accessibility* entails that educational institutions and programmes must be accessed to all learners without discrimination ((United Nations, 2014), *Availability* implies that functioning educational institutions and programmes for all learners must be available in sufficient quantity within their jurisdiction (Kumatongo, Musuka & Muzata, 2021). The concept of *acceptability* entails providing a welcoming hand to every learner in every learning institution whereas Adaptability in inclusive education refers to flexibility to meet the needs of learners with special learning needs or disabilities (Kumatongo et al., 2021; United Nations, 2014). During inclusivity, learners can learn under Full Inclusion or Partial Inclusion.

b) Full Inclusion

Learning institutions that practice full inclusion teach all learners in the same environment, regardless of their diverse learning needs or disabilities in a standard classroom. In order for, full inclusion to meet the student's needs of exceptional learners, appropriate support must be provided. Full inclusion can prove to be a viable option if the environment is not restrictive and if the expectations of a special child are fulfilled (Muzata, 2021). Barriers that hinder the full participation of learners thus must be removed (Kumatongo et al., 2021).

c) Partial Inclusion

Teaching learners under partial inclusion model allows a learner with special education needs to interact with their peers socially and academically in the mainstream, but the learners with special education needs and disabilities do not remain in a standard classroom for all lessons. In many cases, exceptional learners will meet with a special education teacher, speech therapist and other professionals in a separate class or resource room for other services (Kumatongo & Muzata, 2021) to avoid disrupting the learning dynamic of the standard classroom.

d) Difference between Inclusion and Integration

Integration from education perspective is an act of bringing someone into an existing education system, while inclusion means creating an environment that values and respects all individuals, regardless of their differences (Preston, 2023). The concept of integration entails learners with special education needs to adjust according to the mainstream education system. This implies that learners with special education needs and disabilities must fit in the standard curriculum regardless their exceptionality and impairments. Unlike integration, inclusivity promotes flexibility in education system. Adaption or changes in the curriculum and/or education system are made to ensure that every learner's needs are met.

e) Teaching science to students with hearing impairments

Science of education is a systematic body of knowledge that deals with quantitative and objective aspects of the learning process, in which precision instructions are employed when submitting the hypothesis of education to the test of experience,

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usually in form of experimentation (Prakash, 2015). Integrated science involves presentation of general scientific concepts alongside demonstrations of how different disciplines interact with scientific concepts (Åström, 2008). The scientific concepts may be studied by learners from Chemistry, Physics and Biological perspectives at different school levels, to ensure that learning occur in a 'Science Context' environment (Åström, 2008),

Teaching science to students with Hearing Impairments requires adequate preparation. Science lessons for students with Hearing Impairments should occur in a learning environment that is rich with visual organisers and centered on content vocabulary development, educators require adequate knowledge of science, as well as incorporating assistive technology when teaching students with Hearing Impairments (Graham, 2012; Mangrubang; 2005; Drigas et al., 2005). Engaging students with Hearing Impairments in experiments with multiple tools that include technology and other science tasks that promote hands-on and minds-on, authentic, and problem solving oriented can help the students grasp scientific concepts. Educators for students with Hearing Impairments thus require excellent communication skills to engage in scientific discourse (Graham, 2012).

Possessing adequate knowledge in science is cardinal for educators of students with Hearing Impairments. Limited knowledge in science by educators can affect effective delivery of science lessons to students with Hearing Impairments. Mangrubang (2005) found that most educators of students with Hearing Impairments exhibited limited knowledge of science and the subject was complex to teach. Other studies by Easterbrooks, Stephenson & Mertens (2006) revealed that teachers of students with Hearing Impairments were more concerned about preparing science lessons because of overemphasis on language development and time constrains.

Appropriate pedagogy is key to delivering science lessons to students with Hearing Impairments. A study on pre-service teachers with Hearing Impairments revealed positive findings on teachers' pedagogical skills. Mangrubang (2004) established the impact of a kit-based curriculum on deaf education and pre-service teachers' skills in developing inquiry-based science lessons. Positive results in improving pre-service teachers' pedagogical skills were reported. In another study, participants expressed the need to use multiple strategies when teaching students with Hearing Impairments including inquiry based instruction and focus on content as well as the need for vocabulary development (Graham, 2012). Participants also felt that assortment of engagement strategies and instructions are essential to successful learning of science by students with Hearing Impairments.

Visualisation plays an important role in the education of students with Hearing Impairments. Visualisation sciences strongly suggest that students with Hearing Impairments learn well with images (Skyer, 2016). Visual representations, tactile experiences, incorporating concrete ideas and use of appropriate examples in instruction that are meaningful and authentic to students is inevitable in that students with Hearing Impairments are "*visual learners*" whose comprehension of scientific ideas depend on seeing things (Kumatongo et al, 2021). Students tend to grasp ideas better when they see and manipulate objects than abstract objects that they cannot visualise (Graham, 2012). Students with Hearing Impairments can also benefit from visual aids such as videos, posters, Smart Boards, iPads, projectors and demonstrations (Schultz, Lieberman, Ellis & Hilgenbrinck, 2013; Kigotho, 2016) in that appropriate use of visual aids provide best ways of conveying information and instruction to students with Hearing Impairments.

Assistive technology, multimedia, promoting hands-on, discovery learning, inquiry learning and internet services can be useful in teaching science to students with Hearing Impairments (Saowalak, 2015; Chatwirakom; 2018; Drigas et al., 2005). Multimedia, such as a movie, animation or slide show as well as equivalent alternatives to these types of presentations and captions which provide access to audio tracks and audio descriptions which provide access to visual tracks (Drigas et al., 2005), can help to facilitate grasping of scientific concepts among students with Hearing Impairments. The use of multimedia when teaching students with Hearing Impairments has been proven to yield positive results (Lee & Kamisah, 2014; Saowalak, 2015), in that students were found to participate actively during science lessons (Lee & Kamisah, 2014) and demonstrated understanding of scientific processes (Saowalak, 2015). Chatwirakom (2018) suggests that students with Hearing Impairments should be allowed to practice more to be good at teaching science and develop self-confidence to teach in class.

The use of digital lessons can help improve leaning for students with hearing impairments in inclusive settings. In a study to compared digitalized to Interpreted Biology Instructions, Adigun & Nzima, 2020) found that deaf learners in the digital Biology class performed better than their peers in the interpreted Biology instructions despite variations in the attitude toward Biology based on onset of hearing loss being observed. Twenty-seven students with hearing impairments were exposed to eight (8) weeks digitalized and interpreted Biology instructions (Adigun & Nzima, 2020).

Activities that promote hands-on, discovery learning, inquiry learning as well as experiential learning as well as helping learners take control of their learning, and allow learners to learn together (Richardson,

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Marschark, Sarchet & Sapere, 2010; Bransford & Donovan, 2005). The use of pedagogical strategies that promote passive, rote-oriented learning and that focus on basic skills and the memorisation of disconnected facts (Namukoa, 2014) should be discouraged when handling students with Hearing Impairments.

Appropriate communication is cardinal when delivering science lessons to students with Hearing Impairments. Understanding complexities in deaf students' communication abilities is critical for effective teaching (Kumatongo eta al, 2021; Schultz et al., 2013). Educators of students with Hearing Impairments need to understand the complexities of both receptive and expressive language, regardless of the strategy an educator employs, bearing in mind that despite hearing loss not affecting a student's intellectual capacity or ability to learn, it is likely to affect speech, language, social and emotional development as well as attention span (Schultz et al., 2013) and subsequently have an impact on a student's reading, writing, comprehension, and overall academic performance.

In relation to complexities of deaf communication, Supalla & Byrne (2017) note that educators must realise that deaf students encountering English text do not rely on what is called *spoken-language knowledge* due to their being disabled in terms of thinking in and processing English or any spoken language and as such, the English text winds up being strange and inconsistent with how they sign. Supalla & Byrne (2017), note that American Sign Language (ASL) *gloss* enables the deaf to learn to read in their own language and simultaneously experience a transition to written English. Based on reading and writing disparities between the deaf and hearing students, educators of the deaf should therefore be mindful of the challenges deaf students are likely to encounter in processing scientific literature and terminologies.

Students with Hearing Impairments may also experience difficulties to assimilate what the teacher is writing on the board and the interpreter's translation at the same time (Sobel & Hill, 1999), hence the need to provide a ready copy of notes and thereafter students with hearing Impairments can then generate their own class notes outlining their personal interpretation of the salient details (Sobel & Hill, 1999).

The mode of delivering science lessons to students with Hearing Impairments can affect their understanding of concepts. A study by Kurz, Schick & Hauser (2015) revealed that students with Hearing Impairments can perform differently under different modalities. In study to compare learning of 6-9th grade students with Hearing Impairments under two modes of educational delivery, interpreted vs. direct instruction in science lessons, Kurz et al.,(2015) found that students Hearing Impairments who received direct instruction in American Sign Language (ASL) from the Hearing Impaired teacher scored higher on content knowledge. Nineteen students with Hearing Impairments participated in the study in which they were taught six science lessons in American Sign Language, of which in one condition, the lessons were taught by a hearing teacher in English and translated in American Sign Language by a professional and certified interpreter whereas in the second condition, the lessons were taught to the students in ASL by a Hearing Impaired teacher. All students saw three lessons delivered via an interpreter and three different lessons in direct ASL and the order of delivery of each presentation was counter balanced between the two groups of students (Kurz et al., 2015).

f) Attitude of students with Hearing Impairments towards science

Students with Hearing Impairments were found to have developed increased interest in science (Flores & Rumjanek, 2015), developed self-esteem and self-confidence when exposed to experimentation pedagogy (Martins & Rumjanek, 2013; Flores & Rumjanek, 2015), whereas other studies revealed a feeling of less integration among students with Hearing Impairments during learning processes (Foster, Long & Snell, 1999) Increased interest in science by learners with Hearing Impairments was reported by Flores & Rumjanek (2015), in their study which cited the use of experimental methodology which resulted increased interest in science to learners with Hearing Impairments in elementary schools in Brazil. The study revealed that students who took part in the activities presented language refinement, increased self-esteem and self-confidence (Flores & Rumjanek, 2015), which was an indication of the positive impact of experimental pedagogy to teaching science.

Self-esteem among students with Hearing Impairments was reported by Pinto-Silva, Martins & Rumjanek (2013). Students with Hearing Impairments involved experimentation to answer their own set of questions using collaborative, hands-on approach and inquiry approach, exhibited increased understanding of scientific processes, in that the learners developed a critical mind, autonomy and an increased self-esteem (Pinto-Silva et al.,2013).

Gratitude towards science and high achievement among students with Hearing Impairments was recorded in science other (Lee & Kamisah, 2014; Saowalak, 2015). Students with Hearing Impairments were able to exhibited gratitude towards the study of chemistry (Lee & Kamisah, 2014) during interactive multimedia module; in which the teacher was the mediator in the management of electrical chemistry as well as examining students' needs. The students who participated in learning through the multimedia module were reportedly happy and that the students were able to apply the knowledge learned. Another study by Saowalak (2015) on learning achievement and attitudes

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towards science by using knowledge-based learning with multimedia in Neuroscience and sensory organs indicated positive learning achievement and attitude toward Biology by students. Students who were taught to discover knowledge through multimedia about nervous system and sensory organs exhibited higher achievement than before the experiment with the statistical significance at the 0.05 level (Saowalak, 2015).

Motivation is cardinal is every field of study. Students who lack motivation may not excel in any field. Ndhlovu & Matafwali (2020) write that students with Hearing Impairment are not motivated to learning Integrated Science due to fewer opportunities to get employed in science related professions. The aspect of motivation may also be from teachers. Ting & Gilmore (2012), Indicate that some teachers perceive teaching science subjects to students with Hearing Impairments a share waste of time due to students' limited opportunities to venture into science related carriers. There is also a perception of a wide gap in attitude towards science, scientific reasoning, experience, ability to form the mental model necessary for the integration and understanding of scientific facts and ideas among students with hearing impairments (Adigun & Nzima, 2020).

Students with Hearing Impairments require appropriate adaptation in learning institutions to feel accommodated. A study by Foster, Long & Snell (1999) on the experience of students Hearing Impairments in higher education revealed that deaf students felt less integrated into the learning institution. The study further revealed that teachers did not bother to make adaptations that favoured deaf students for inclusive learning purposes.

Preference for some educators was recorded among Students with Hearing Impairments in a study by Lang, Dowaliby & Anderson (1993).Preparedness and knowledge of course content is cardinal by educators of students with hearing impairments. the study revealed that students with Hearing Impairments developed attitude of preference for some educators. University students with Hearing Impairments were found to value instructors who were knowledgeable about subject matter and those who used visual materials, communicated effectively and provided clear assignments, lectured students at a good pace, to make sure students understood and grasped concepts (Lang et al., 1993).

g) Barriers towards teaching science to students with hearing impairments in inclusive settings

Studies have recorded various barriers towards teaching science to students with Hearing Impairments in inclusive settings some of which include; inability of hearing people to understand a language of a different modality when handling students with Hearing Impairments (Wallang, 2016), Communication barrier (Mandyata & Kamukwamba, 2018), Lack of specialised training to handle students with hearing impairments (Ndhlovu & Matafwali,2020) and lack of adequate training in sign language interpretation (Graham, Solomon, Marchut, Kush-alnagar, & Painter, 2012; Grooms, 2015; Kurz et al., 2015).

Inability of hearing people to understand a language of a different modality is cited as the main barrier in Deaf pedagogy. Most educators fail to understand that language can function beyond speech modalities (Wallang, 2016). Effective implementation of inclusive education require the existence of a system well in-place, were learning resources and requirements for deaf students are easily accessed, but most learning institutions practicing inclusive learning rely on the expertise of special education specialists to handle the more severe cases(Wallang, 2016).

Flexibility in curriculum is cardinal in the education of students with Hearing Impairments. Successful inclusion for students with Hearing Impairments requires an effective communicative environment with access to formal curriculum which has flexible assessments and teachers possessing required skills and positive attitude to teach the students (Powers, 2002; Wallang, 2016). Communication has been shown to be a barrier towards learning in inclusive institutions (Chibuye, 2013; Mandyata & Kamukwamba, 2018). In most cases, sign language interpreters are used to bridge the gap between students with Hearing Impairments and teachers (Martins, 2006). Sign language interpreters should be capable of perceiving the difficulties of students with Hearing Impairments, as well as discovering ways and methods for mitigating them. Hence, the need for interpreters to have a depth of theoretical knowledge of different fields of study, familiarity with the language used in each situation and educational experience (Martins, 2006; Kigotho, 2016). Lack of sign language interpreters and limited vocabulary among students with Hearing Impairments (Muzata & Mahlo, 2019) create learning barriers in inclusive learning environments.

Lack of specialised training to handle students with hearing impairments can cause barrier to teaching science. Ndhlovu & Matafwali, 2020) found that teachers who were qualified to teach Integrated Science, had challenges to deliver science lessons to learners with Hearing Impairment due to their lack of specialization to teach learners with hearing impairments despite being professionally trained science teachers. Other barriers to teaching Integrated Science to learners with Hearing Impairment were inadequate instructional materials, ill-training of teachers, inappropriate syllabus, communication barriers and inappropriate Integrated Science facilities (Ndhlovu & Matafwali, 2020).

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Students with Hearing Impairments are likely to incurred challenges in terms delays in receiving information during learning, that is the time between what is spoken and translation of information; assimilating what the teacher is writing on the board and interpreters translation (Foster et al., 1999; Sobel & Hill, 1999) can cause delays in grasping content among students with Hearing Impairments. In relation to learning science, the act of observing a teacher demonstrating how to handle and manipulate objects in the lab or images and looking at the interpreter for clarity of information(Foster et al., 1999) can present learning challenges leading to failure to grasp appropriate concepts by deaf students(Kumatongo et al., 2021).

Teaching students with Hearing Impairments according to their learning pace is cardinal, in that rapid pacing creates a learning barrier. A study by Crume, Moran & Shiekh (2001) on barriers to effectively educating students with Hearing Impairmnts in Kenya, revealed that pressure exerted on teachers of learners with hearing impairment by education officials to ensure that educators keep pace with the curriculum and syllabus by teaching rapidly at the expense of learners with Hearing Impairments created learning barrier, in that learners had challenges to learn at a rapid pace due to different learning abilities. Namukoa (2014) states that learners with Hearing Impairments enter learning institutions with limited background knowledge, hence the need to promote differentiated learning to support their learning gaps. Insufficient resources both human and material (Ndonyo, Matafwali & Chakulimba, 2017; Manchishi, 2015; Muzata, 2013) have also been found to create learning barriers to students with hearing impairments in Zambian schools.

Interpreting for students with hearing impairments require adequate training. Lack of adequate by sign language interpreters can impede learning. Graham et al., 2012) indicate that hearing impaired and hard-of-hearing students were reported to experience difficulty in following lecture due to sign language interpreters who did not have scientific training. Students with hearing impairments thus are likely to have less comprehension from interpreted lectures (Grooms, 2015; Kurz et al., 2015).

III. Methodology

This study was be guided by constructivism philosophy and qualitative case study was be used as a research design in that qualitative research is inductive in nature, providing researcher's opportunity to generally explore meanings and insights in a given situation (Mohajan, 2018). The study comprised three (3) student teachers with Hearing Impairments and two (2) lecturers, making the total number of five (5) participants. Participants were selected purposively. Lecturers of integrated science and student teachers with Hearing Impairments were selected based on convenience in that convenience sampling helps in selecting participants who are often readily and easily available (Taherdoost, 2016) for the study.

Data was generated from student teachers with Hearing Impairments as well as lecturers via interviews. Students with Hearing Impairments were interviewed using sign language whereas speech interview was used to generated data from lecturers. Data was analysed qualitatively using thematic data analysis technique in that thematic techniques are effective for analysisng salient themes emerging inductively from the texts often consisting of words or short phrases that symbolically assign an essence-capturing evocative attributes (Neuendorf, 2019). Prior to undertaking this study, consent was sought and permission was granted to conduct interviews from participants. The participants who took part in the study were also informed about the nature of the study and assured of high levels of confidentiality.

IV. Findings

The findings are based on interviews with Lecturers and student teachers with hearing impairments. Student teachers used sign language during interviews and their signs have been written in another language. The term "*Glossing*" is used in reference to writing a language in another language. The written information in this context is known as '*gloss*'. The difference between "writing in a language" and "glossing of a language" has to do with the fact that the target language may not have equivalent words to represent the original language. It has to be noted that when an individual with Hearing Impairment gloss sign language in English, what they write is not English but sign language written using English words. In this context, the glossed information maintains the grammatical structure of the original language. Nevertheless, responses from students with hearing impairments in this were transcribed into English.

a) *Experiences of lecturers towards teaching integrated science to student teachers with Hearing Impairments in an inclusive environment.*

Following the interview with Lecturers on their experiences towards teaching integrated science to student teachers with hearing impairments in the college, two (2) themes imaged from the study; (i) Lecturers experienced challenges teaching integrated science to student teachers with hearing impairments; (ii) Lecturers put in place adaptive measures towards deaf students' learning of integrated science.

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i. *Challenges faced by lecturers towards teaching integrated science to students with hearing Impairments*

Lecturers indicated that teaching integrated science was challenging on their part due to communication barriers as expressed bellow;

"*I find teaching integrated science to deaf students a bit of a challenge due to communication barrier. A lot of patience and attention is required when teaching the deaf, but I face challenges when trying to communicate to them,*" said Lecturer 1.

Communication challenge was reported to interfere with effective explanation of scientific concepts as expressed by Lecturer 2 who said that;

"*The other challenge we face as Lecturers is difficulties to explain scientific concepts. We find it difficult to explain scientific ideas to deaf students due to communication problems.*"

The response of Lecturer 2 in the verbatim above is that Lecturers of integrated science experienced to explain scientific concepts and ideas to student teachers with Hearing Impairments.

ii. *Adaptation measures put in place by lecturers when teaching students with Hearing Impairments*

Lecturers felt that there was need to put in place measures to help student teachers with hearing impairments during integrated science. Using sign language interpreters was one of the measures taken as expressed below;

"*Due to communication challenges, we usually assign a sign language interpreter during science to help with translation for deaf students. When the college sign language interpreter is not available we use a fellow student teacher to interpreter*," said lecturer 1.

Encouraging students with hearing impairments to work together with their hearing colleagues as a way of helping them learn scientific concepts during interactions was also cited by the lecturers.

"We encourage deaf students and non-deaf students to form socially mixed discussion groups. We also encourage non-deaf students and lecturers to learn sign language for the purpose of communication during group discussions, said Lecturer 2.

The verbatims from lecturers 1 and 2 are that lecturers involved sign language interpreters during science lessons or used student teachers conversant in sign language in the absence of sign language interpreter as well as encouraged students with hearing impairments to form group discussions with their hearing counterparts.

b) Attitude of students with Hearing Impairments towards Integrated Science

The second objective was to establish the attitude of student teachers towards learning integrated science in an inclusive environment**.** Mixed views were expressed by lecturers and students with regards to attitude of students with hearing impairments towards learning integrated science. The view of deaf students expressing interest in science and some not showing positive attitude towards science was reported from both students and lecturers. Deaf students also felt not adequately attended to as expressed below.

i. *Views of lecturers on attitude of students with Hearing Impairments towards integrated science*

Lecturer 1 felt that the attitude of deaf students towards integrated was not good as expressed during the study;

"*I feel their attitude towards learning integrated science is not so good, they feel that they require a lot of time learning science. I feel this is attributed to the little time for them to learn science*," said Lecturer 1.

Views of lecturer 2 were different from lecturer 1 who felt that students with hearing impairments hard positive attitude towards integrated science;

"*I feel deaf students have interest in integrated science. They are eager to learn, but it seems lecturers don't pay much attention to them due to communication challenges,"* said Lecturer 2.

ii. *Views of students with Hearing Impairments towards learning integrated science*

The views of students with Hearing Impairments towards learning integrated science were expressed as follows;

"*The deaf don't understand some words when learning integrated science, hence do not feel good. We read words on the board but fail to understand. When hearing students raise their hands to answer questions in class, the deaf remain quiet*," signed student 1.

The response above is that students with Hearing Impairments were unable to understand some scientific words, hence did not feel good, and that students with Hearing Impairments remained 'quiet' when their hearing counterparts contributed by way of answering questions in class.

The response of student 2 in reference to attitude of deaf student teachers' towards integrated science was that;

"*Student teachers who are able to hear have interest to learn science and pay more attention, but deaf students only copy from hearing students during science lessons."*

Student 3 expressed the view that;

"*The deaf feel good to learn science, but the problem is facing difficulties to understand some words. Sometimes you ask a lecturer, what does this word mean? The Lecturer fails to explain. It is better for a Lecturer to show a video, for example on digestion system or reproduction, in that way the deaf would understand*."

In the response above, student 3 indicated that students with hearing impairments experienced difficulties to understand some scientific words and felt that the use of videos would help students understand the meaning of concepts such as digestion system or reproduction.

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Student 3 also responded that;

"*Sometimes the deaf complain because of lecturers' concentration on hearing students and not the deaf. Time and again, the deaf fail science tests. Hearing students score higher marks while deaf students score low marks*."

The response from student 3 above indicate that students with hearing impairments felt that Lecturers paid more attention to hearing students than students with hearing impairments during science lessons, and that hearing students recorded high marks in science tests compared to students with hearing impairments.

c) *Barriers towards learning Integrated Science by Students with Hearing Impairments in Inclusive Environment*

The third objective sought to establish barriers towards learning integrated science by deaf students, three themes emerged from the study; (i) challenges by deaf students to understand scientific concepts; (ii) distortion of information during interpretation and (iii) lack of adequate resources to teach integrated science.

i. *Understanding scientific concepts by students with hearing impairments*

Understanding of scientific concepts was cited as a barrier towards learning integrated science by both deaf students and lecturers. Lecturer 1 was of the view that deaf students have difficulties to understand scientific terminologies;

"Deaf student students have difficulties to understand scientific terminologies, which is one of the major learning barriers," said lecturer 1. *"It seems like sign language interpreters find it very difficult to interpret science terms."*

Lecturer 2 expressed the view that it was difficult for science lecturers to explain science terms to deaf students.

"It is difficult to explain scientific ideas to deaf students, due to lack of sign language knowledge by science lecturers, leading to deaf students finding it difficult to understand scientific ideas," explained lecturer 2.

Student 1 in reference to understanding of scientific terms had this to sign;

"*The deaf students experience problems in that lecturers use speech and don't know sign language. Every time they write science words on the board, deaf students don't understand. The deaf don't understand chemicals. Lecturers use speech and hearing students understand, while the deaf are watching*."

Student 2 expressed the view that understanding and differentiation of scientific terms was difficult for deaf students as signed below;

"*It is hard to understand the meaning of some words, for example the difference between the word 'mass' and 'density'. The interpreter just fingerspells and does not explain the meaning making it difficult for the deaf to understand*."

ii. *Distortion of scientific information during interpretation*

Lecturers and deaf students cited distortion of scientific information as a learning barrier to integrated science.

"Sometimes information on scientific terms is distorted during the course of sign language interpretation, because the sign language interpreter has not done science," said Lecturer 1.

Lecturer 2 was of the view that*; "Lack of knowledge in sign language by science lecturer makes deaf students not to receive accurate information, because sometimes fellow students are used to interpret information and end up missing certain concepts."*

Distortion of information was also cited by deaf students as expressed below;

"*Sometimes the deaf would copy scientific information from the internet and show lecturers, but instead the lecturers would cancel the information wrong, as a result the deaf are suffering*."

iii. *Lack of adequate resources to teach integrated science*

Lack of adequate teaching and learning resources to teach science to deaf students was cited by lecturers during the interview;

Lecturer 1 cited time factor as not adequate to teach practical to deaf students;

"*The major barrier is little time to do science practicals, since the deaf students seem to do good in practical work, I feel time is not enough for them to do practicals*," said lecturer 1.

Lecturer 2 also expressed that,

"*I feel there is need for extra time to do remedial work for deaf students, especially in practicals*."

Inadequate teaching and learning resources were also cited as a barrier towards teaching integrated science to deaf students.

"*Teaching and learning resources are not adequate, we usually use and encourage students to use locally available materials as teaching and learning resources in science lessons*," said lecturer 2.

Lack of professionally trained sign language interpreters was also cited as a factor contributing to barriers towards learning integrated science.

"We have a challenge of teaching science due the fact that we have only one sign language interpreter in the college, and when he is not available or attending to other classes, we usually use fellow student teachers to interpret for the deaf," Said Lecturer 2.

V. Discussion

The first objective of the study was to find out the views of lecturers towards teaching integrated science to student teachers with hearing impairments in an inclusive institution. The study revealed that Lecturers experienced challenges when teaching integrated science to student teachers with hearing impairments.

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The challenges were that lecturers found it difficult to communicate effectively and explain scientific concepts to student teachers with Hearing Impairments. The findings on communication concur with studies by (Chibuye, 2013; Mandyata & Kamukwamba, 2018). Unlike other findings on that cited communication barrier between educators and students with Hearing Impairments, explaining scientific concepts and ideas to students with Hearing Impairments by lecturers was the underlining communication barrier in this study, thus making it difficult for students to grasped scientific concepts and terminologies. Difficulties to explain scientific concepts to students with Hearing Impairments was also echoed by *student 3*, who cited lecturers failure to explain scientific concepts and terminologies to student teachers with Hearing Impairments. Educators of students with Hearing Impairments require adequate preparation to avoid communication challenges during lesson delivery in inclusive learning environments.

The study further revealed that lecturers had put in place adaptive measures to accommodate student teachers with Hearing Impairments such as assigning sign language interpreters during science lessons to help with translation for students with Hearing Impairments and; encouraging the students to work in collaboration with hearing students to form socially mixed discussion groups. Measures taken by the lecturers may not have been adequate to cater for the learning needs of students with Hearing Impairments during integrated science in that students with hearing impairments require more measures than just assigning sign language interpreters and collaborative learning for them to adapt to an inclusive learning environment (see Graham, 2012; Schultz et al., 2013; Kigotho, 2016; Drigas et al., 2005; Lee & Kamisah, 2014; Saowalak, 2015).

Teaching science to students with Hearing Impairments require appropriate pedagogy that promotes hands-on activities which could have been used by lecturers in that hands-on activities promote easy grasping of scientific concepts and knowledge retention as well as using digitalized lectures (see Flores & Rumjanek, 2015; Adigun & Nzima, 2020). Incorporating assistive technology can also play a significant role in adapting the teaching and learning processes for students with Hearing Impairments in inclusive settings. With reference to the Sociocultural theory by Lev Vygotsky (1896- 1934), incorporating assistive technology when teaching science to students with Hearing Impairments is likely to provide scaffolding to students, in that scaffolding *is* significance or the help student receive when performing tasks beyond their levels. In this context, assistive technology is likely to provide assistance in terms of making scientific concepts clear. Recorded scientific videos and use of scientific information on internet can provide scaffold to students with Hearing Impairments.

Encouraging student teachers with Hearing Impairments to study groups was also cited as one of the adaptive measures taken by lecturers to encourage social and academic cooperation. With reference to the Sociocultural theory by Lev Vygotsky, forming study groups can be very beneficial to students if the groups are effective, in that the concept of More Knowledgeable Others (MKOs) which refers to anyone who has a better understanding or a higher ability level than the student on a particular task, process or concept can be applied in this context. Some students with Hearing Impairments or their hearing counterparts within an inclusive setting may have better understanding of scientific concepts and their knowledge maybe beneficial to students with Hearing Impairments. In some cases, student teachers may explain scientific concepts to their colleagues easily and clearly as compared to some lecturers who may experience communication challenges with Hearing Impaired students.

The second objective of the study was to establish the attitude of student teachers with hearing impairments towards integrated science at the college. The findings were that lecturers and student teachers with Hearing Impairments expressed mixed feelings towards the attitude of the student teachers to integrated science but generally felt that students with Hearing Impairments were not adequately attended to during integrated science lessons. The feeling of not being adequately attended to may have resulted into students with Hearing Impairments developing the feeling of not being accommodated during inclusive learning of integrated science. Lecturers were of the that students with Hearing Impairments paid little attention towards integrated science lessons and that they required more time to learn, whereas students with Hearing Impairments felt that lecturers paid more attention to their hearing counterparts.

Despite students with Hearing Impairments showing interest towards integrated science to some extent as expressed by student 3, the students felt that lecturers used inappropriate methods which made students with hearing impairments not grasp scientific concepts easily and suggested that visualisation and digitalized learning should have been used by the lecturers. Suggestion to use appropriate pedagogy by students with Hearing Impairments should not be overlooked but taken seriously in that students with Hearing Impairments may have a better understanding of themselves and what regard to be appropriate methods of delivering scientific methods to the hearing impaired by virtue of them being 'visual learners'.

The third objective was to establish barriers towards learning integrated science by student teachers with hearing impairments. The study revealed that

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student teachers with Hearing Impairments faced challenges comprehending scientific concepts during integrated science lessons creating a learning barrier towards integrated science. Difficulties to understand the difference between the word 'mass' and 'density' because the sign language interpreter just fingerspells the words as cited by student 2 and difficulties understanding chemicals which resulted student teachers with Hearing Impairments to just copy from their hearing were some of the learning barriers experienced by student teachers with Hearing Impairments. it has to be noted that inclusion is not merely placing learners with impairments and disabilities in a classroom to learn with other learners (*see* Muzata, 2021), there is need to find out and attend to learners needs and difficulties, in this context partial inclusive could have been practiced in which remedial or extra assistance provided to students with Hearing Impairments in a resource room. Scaffolding must be provided to students in inclusive settings in that inclusion is different from the concept of integration which entails learners with special education needs to adjust according to the mainstream education system.

The study also revealed that scientific information was distorted during interpretation by sign language interpreters. Inability to interpret scientific terminologies appropriately could have contributed to student teachers with Hearing Impairments facing challenges with scientific terminologies. The findings on distortion of scientific information concur with suggestions made by other scholars (see Martins, 2006; Kigotho, 2016) and the need by sign language interpreters to have depth of theoretical knowledge of different fields of study, for instance knowledge in science and its terminologies, unlike merely specialising in sign language. Additional knowledge of subject matter can be of help when interpreting for students with hearing impairments during teaching and learning processes in inclusive environments.

The study also found that lack of adequate resources to teach integrated science to student teachers with Hearing Impairments created learning barrier. Adequate and appropriate learning resources is paramount towards learning science (see Graham, 2012; Schultz et al., 2013; Kigotho, 2016; Drigas et al., 2005; Lee & Kamisah, 2014; Saowalak, 2015). The use of appropriate teaching and learning resources such as visual aids or videos as suggested by student 3 could have had helped students with hearing impairments understand scientific ideas, hence minimising on learning barriers faced during learning integrated science in the college.

VI. Conclusion

Based on the first objective which sought to find out the views of lecturers towards teaching integrated science to student teachers with hearing impairments in the college, it can be concluded that lecturers faced communication challenges due to their lack of knowledge and skills in sign language and that lecturers did not employ adequate measures for student teachers to learn integrated science in an inclusive learning environment.

With reference to the second objective which sought to establish the attitude of student teachers with Hearing Impairments towards integrated science at the college, the feeling of not adequately attending to students with hearing impairments during integrated science lessons as expressed by both lecturers and students teachers with Hearing Impairments resulted into deaf student developing mixed attitudes towards learning integrated science.

The study can further conclude that misunderstanding of scientific concepts experienced by student teachers with Hearing Impairments was largely as a result of misinterpretation of scientific terms by sign language interpreters who lacked appropriate word-signs for scientific terms, coupled with their insufficient knowledge in science as a subject as well as lecturers lack of knowledge in sign language, resulting in learning barriers.

VII. Recommendations

1. There is need for educators of science to use pedagogy that promotes hands-on activities as well as incorporating assistive technology when teaching students with hearing impairments.
2. Sign language interpreters need to have knowledge in subjects such as science to enhance effective interpretation of key terminologies.
3. There is need to develop and standarndised word-signs of scientific terminologies to facilitate effective communication when teaching science to students with hearing impairments.

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