Experiences of Science teachers on the teaching of learners with hearing-impairment in Lesotho secondary schools

By

Maretsepile Relebohile Molahloe (2017297520)

MSc. Ed. Science Education (Wits), BSc. Hons (Wits), B.Sc. in Ed. (NUL)

Submitted in fulfilment of the requirements for the Degree of

Philosophiae Doctor in Education (PhD Education) in Curriculum Studies

In the

Faculty of Education

at the University of the Free State Bloemfontein

June 2023

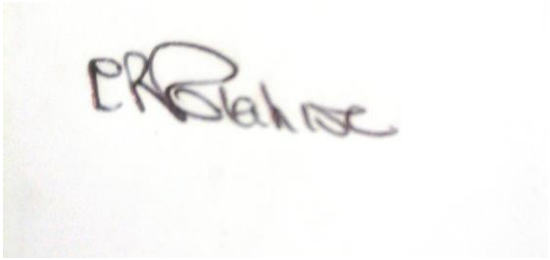
Supervisor

Professor Matseliso Mokhele-Makgalwa

Declaration

I Maretsepile Molahloe (2017297520) declare that this Doctoral thesis titled "**experiences of Science teachers on the teaching of learners with hearing impairment in Lesotho secondary schools"** is my own independent work. All sources I have used or quoted have been acknowledged by means of complete references.

I further declare that the work has never been submitted to any other university or the faculty for the purpose of obtaining a degree.



……..

M.R. MOLAHLOE

Dedication

I would like to dedicate this study to my late mother who never ceased to believe in me even at times I doubted my potential. My children: Tello and Retsepile for their unconditional love even at times I could not be there when they needed me most. My father, brothers and sisters for their unwavering support and words of encouragement throughout this academic journey.

Acknowledgements

I would like to pass my greatest gratitude to my God for his love and protection. I would also like to thank my supervisor, Professor Matseliso L Mokhele-Makgalwa for her academic guidance and support. Her patience and willingness to assist me kept me going. I cannot forget the SANRAL research team with its financial support and their fruitful comments in shaping my study.

My special thanks to my colleague and a friend Dr Matobako for his support and believing in me even at times I felt like giving up. My friends Nthoesele, Lieketseng and Maqoni for their prayers and words of wisdom.

I would also like to thank the school principals for allowing me to collect data at their schools. I cannot leave behind teachers who have given me their consent to work with them.

Another special thanks to my seasoned editor, Derek Gripper who dedicated his time to carefully reading my work.

List of Abbreviations and Acronyms

CAP - Curriculum and Assessment Policy

CASS-Continuous Assessment

CPD - Continuous Professional Development

EFA - Education For All

HIL - Hearing Impaired Learners

IBL - Inquiry Based Learning

ICT-Information and Communication Technology

LCA - Learner Centred Approach

LELP-Lesotho Education Language Policy

LI - Learners with impairments

LIEP-Lesotho Inclusive Education Policy

MoET-Ministry of Education

List of Tables

Summary of The Study

There is a global concern through the 'education for all' initiative that all learners, regardless of their disabilities, should be in school. This enables learners with diverse needs to study Science as a subject, which, according to different researchers, is a cornerstone for economic development. This subject also equips learners with the knowledge and skills that capacitate them as individuals to contribute positively towards their communities. However, research shows that hearing-impaired learners (HIL) lag behind and their performance in Science is not always satisfactory. The problem is implicated in the fact that very little research work has been directed towards Science teaching for HIL. For this reason, this study seeks to understand teachers' experiences when teaching Science to HIL in Lesotho secondary schools. Opportunities to learn (OTL) and capabilities frameworks are used to guide this study. OTL variables are used in this study and include teachers' beliefs about teaching approaches and learning activities that accommodate HIL. The inclusion of a capability framework is for studying the teaching approaches customised for increasing learning opportunities for HIL. The paradigm that was used in this research is interpretivism. This study also follows a qualitative approach and falls within a case-study design. The sample comprised of four Science teachers teaching learners with hearing impairment. The findings of this study show that the use of experiments is effective for teaching Science to HIL, even though they are time consuming in preparation and deliberation of the lesson. Teachers also believed that the use of information and communication technology (ICT) could not only improve their teaching of Science but could as well respond to the many challenges they encounter when teaching HIL. The study also indicates that teachers teaching HIL require different accommodative strategies, but due to different challenges and contextual factors HIL's opportunities to learn Science concepts are compromised. The study concludes that, since HIL are taught like any other learners in their Science lessons, it's imperative that teacher capacity building be provided to maximise the opportunities to learn Science for HIL.

Keywords: Science teaching, opportunities to learn, capabilities framework, hearing impairment

Table of Contents

Chapter One: Orientation and Background of the Study

1.1 Introduction

This chapter provides a background context for the study followed by a problem statement. More so, the chapter further delineates research questions guiding the study as well as its aim and objectives. Furthermore, the delimitation of the study is clarified after which operational terms used in the study are defined. Lastly, it concludes with the presentation of an outline for the whole study**.**

Science is considered as an important subject since it develops critical thinking, an important skill for learning (Ahmad, Bokhari & Waqar 2020). Consequently, Timms *et al.* (2018) posit that recently the integration of Science has received a lot of attention in the world with the intention being to address the problem of real-life issues. Guided by this aspiration, as indicated by Sağlam and Şahin, (2017) many education systems throughout the globe have undertaken reforms with the objective of improving proficiency in scientific literacy. These researchers Sağlam & Şahin, (2017) further indicate that it is in the implementation of these reforms that teachers become noticeable as being the cornerstone of educational reforms and are trained how to teach Science in an effective manner. It therefore becomes pertinent for research to focus on teachers in order to understand their experiences, views and concerns on issues pertaining to curriculum enactment.

There are several factors that contribute towards achieving quality teaching and learning of Science. Hankebo (2018) considers teaching a difficult task, as there are many factors that need to be considered for effective teaching and learning to take place. Amongst these factors, Khuyen *et al.* (2020) confirm that the beliefs and views of teachers contribute a lot towards teachers' classroom practices. Teachers' ability to accommodate learners' diverse capabilities and learning difficulties can as well define an effective way of teaching Science. Bayram-Jacobs *et al.* (2019:1208) support the idea that "the

recognition of student difficulties makes the teacher consider specific teaching strategies which are in line with the learning objectives." This indicates that it is not only the policy prescriptions that give direction to teachers on how to conduct teaching and learning. Teachers' experiences of teaching Science are also important to clarify; in order to attain the quality education aspired to. Additionally, content difficulty may as well shape and guide teachers' choice of teaching approaches to employ in the classroom. This suggests that teachers must know learners' problems and choose teaching approaches accordingly. It is as well worth noting that what the teacher knows plays a vital role in learners' opportunities to learn. Thus Baitanayeva *et al.* (2020) regard quality education as resting upon teacher competences.

According to Akben (2020), Science is considered an important subject for socio-economic growth and resources are invested for improving teaching and learning in schools. Mkimbili (2019) echoes this, but brings another aspect, namely that Science should be taught in a meaningful manner, especially when another language is exploited to facilitate learning. That is when learners' native language is not used as the medium of instruction. This is seen in many countries, including Lesotho, with a policy prescription that English be the medium of instruction from Grade four (MoET, 2009). Begaliyev, Otojonova and Tadjibaev (2021) add that inter-relationships between subjects should be established so that the teaching of Science can be improved. That is bringing together different Science disciplines to enhance in-depth learning called the interdisciplinary integration of Science.

Several countries have adopted this interdisciplinary approach where content is drawn from three Science disciplines at a secondary school level, namely: Biology, Science and Physics (Winarno *et al*., 2021). Lesotho is no exception, as its basic education aims at "developing scientific, social, entrepreneurial and technological skills to promote independent and critical thinking in solving socio-economic problems" (MoET, 2009: 10). The policy prescribes Science as a compulsory subject at secondary level and regards "scientific, technological and creative skills" as one of the core competences that learners deserve to be able to develop.

As with other countries, the teaching of Science is one of the curriculum goals stipulated in Lesotho policy prescriptions and is a subject compulsory for all learners at junior secondary level (MoET, 2009). However, the teaching of Science presents challenges even in developed countries due to several reasons, including teachers being incompetent with the subject matter (Hackman, Zhang & He, 2021). Again, Science teachers face challenges presented by a pedagogic shift in curriculum reforms, especially when the shift does not allow them to add new knowledge to what they already know (Chen & Xiao, 2021). Lesotho, like many countries, invests a lot towards improving the teaching and learning of Science in schools. However, a lack of resources and the use of inadequate teaching methods are contributing factors to a low Science performance in most Lesotho secondary schools (George, 2017).

Thus, this study has explored Science teachers' experiences of teaching Science, specifically focusing on learners with impaired hearing (HIL). This is in part because different suggestions as to how Science could be taught to learners without impairments are made but little is said about teachers' experiences of teaching Science to HIL. While it is a challenging task to teach Science to learners without impediments, it becomes so much more when teaching learners with hearing impairment. It was therefore intriguing to explore teachers' experiences of teaching Science to learners with hearing impairment. Ertzgaard *et al*. (2020) view hearing impairment as a global concern mostly prevalent in developing countries. These authors, Ertzgaard *et al.* (2020) argue that the term 'hearing impairment' is mostly used to refer to hearing loss to differing degrees. In their conceptualisation, these authors further differentiate the two hearing losses to that of being hard of hearing, which is when an individual has a less severe hearing loss, and deafness, which refers to a complete loss of hearing. For this study, hearing impairment will be used generally to refer to both partial and profound deafness.

According to Murray, Hall and Snoddon (2019), learners born with hearing impairment have been shown to struggle with language acquisition. As a result, communication remains a barrier that hinders their ability to learn (LeClaira & Saunders, 2019). These authors, LeClair and Saunders (2019) took the discussion further to indicate that

regardless of the severity of the hearing impairment, their learning is compromised. With the aforesaid explanation on how hearing impairment complicates the acquisition of quality and equitable education, what then are the experiences of Science teachers teaching learners with hearing impairment? This question is important in relation to Science as an abstract subject that demands language for one to engage with critical thinking. With 'Science for all', there is open access to every learner including HIL, yet it is difficult for them to understand abstract scientific concepts (Atika, Ediyanto & Kawai, 2018). This may lie with HILs' limited proficiency in language, which impacts negatively on their academic tasks and continues to be a barrier to learning (Khalid & Asghar, 2021). The concern is taken further by Hameed (2020) who show that HIL are challenged by reading for comprehension. With this challenge, hearing impaired learners may not benefit from instructional materials such as textbooks provided to support teaching and learning in schools unless sign language interpreters are involved.

Sign language is HIL's language that can be used to facilitate their learning in schools. Silvestri and Hartman 2022 suggest that for hearing impaired learners to participate in classroom activities, sign language has to be integrated into their teaching and learning. The discussion held further asks that the use of sign language becomes a medium of instruction for hearing-impaired learners and should be qualified in the national policy. With this, HIL can learn sign language as a subject and interpreters can be used as resource teachers to assist the regular teachers. Besides this, sign language carries deaf culture and enables hearing-impaired learners identify themselves with subjects such as Science (Gormally, 2017). On the same note, Meghdari and Alemi (2020) show that hearing-impaired learners continue to face challenges in Science academia due to teachers' limited understanding of deaf culture. It is on this basis that the authors Meghdari and Alemi (2020) regard sign language as solving a myriad of communication challenges learners with hearing impairment that are confronted in schools.

Language deficiency continues to present a challenge for 'education for all' (EFA) in the teaching of Science, as most teachers are not familiar with sign language and cannot easily facilitate learning (Lucas, Pimentel & Luccas, 2018). With this, HIL fail to participate

and feel excluded and as a result do not attend classes regularly until they eventually drop out of school (Khalid, 2021). As a way of mitigating this, most schools incorporate sign language interpreters to facilitate the teaching and learning for hearing-impaired learners. However, competent teachers rely on interpreters who arguably lack content knowledge (Bamu *et al*., 2017). Besides this, Science is an international language that has its own terms, but the lack of sign language vocabulary makes it difficult for interpreters to clarify the scientific concepts (Andrews, 2017: Lucas *et al.,* 2018).

The same sentiment is shared by Adigun (2020), namely that there are scientific terms in Biology that interpreters find difficult to explain due to limited sign language, hence it is often the case that the performance of HIL is not satisfactory in this subject. Teaching learners with impediments therefore calls for a change in classroom practice where teachers ought to use methods tailor-made for addressing the diverse needs of learners (Buli-Holmberg & Jeyaprathaban, 2016). However, this shift seems to pose new challenges for regular teachers as they lack expertise as to how to address the diverse needs of learners. This is in line with Priyanka & Samia's (2018) assertion that the realization of quality education is challenged by teachers' lack of expertise.

The main purpose of this study was to explore in detail the experiences of Science teachers when teaching learners with hearing impairment. While a lot has been said about the most important approaches to Science teaching, little is known about teachers' own experiences specifically when teaching learners with hearing impairment. Shah *et al.* (2016) therefore argue that ignoring teachers' experiences or concerns on issues pertaining to teaching Science to learners with hearing impairment could be the barrier for their acceptance. It is on this basis that I found imperative to investigate and understand the experiences of Science teachers when teaching learners with hearing impairment. Teachers' experiences play a significant role in their classroom practice.
Besides this, some teachers may appreciate and go along with educational reforms, while others may be uncomfortable. This may lie with the experience teachers have received in their in-service journey, as they play a significant role in influencing classroom behaviour and instruction (Margot & Ketteler, 2019). The earliest work of Richardson

(1996) attests that experiences are capable of shaping teachers' attitudes and beliefs, the attributes mainly responsible for individuals' behaviour. Wang and Lee (2017) elaborate this point in that attitudes could be classified into three different components: cognitive, affective and behaviour, which are: what one knows, likes and the actions made. Therefore, teachers' acceptance or rejection of anything is determined by the attitudes they hold (Maison *et al.,* 2019). Based on these deliberations, it is intriguing to explore teachers' experiences of teaching Science to HIL.

1.2 Problem statement

Science is globally considered an important subject to study in schools because it is responsive to societal and economic development (Kaluyu & Ndiku, 2020). However, there is a global concern that students perform poorly in Science education, as reflected by the Program for International Student Assessment (PISA) (Firman, Ertikanto, & Abdurrahman, 2019). Lower achievement in Science is also a prevailing challenge in African countries regardless of the initiatives carried out to make improvements (Prinsloo, Rogers & Harvey, 2018). There are several reasons behind poor performance in Science. The major reason is teachers' lack of expertise to execute the teaching of Science in an integrated manner (Song, 2020).

Again, teachers' beliefs and attitudes are not aligned with best practices stipulated in curriculum reforms (Chia & Maat, 2018). In the African context, one of the reasons for poor performance in Science is teachers' lack of content knowledge, which taps negatively on their confidence, beliefs, and attitudes (Ogegbo & Ghaigher, 2019). Lesotho is no exception to this; hence this study seeks to explore Science teachers' experiences of teaching Science to learners with diverse needs, particularly those with a hearing impairment.

While teaching Science is a complex activity, even in the best circumstances where one has well-resourced classrooms and learners without difficulties like hearing impairment; how then would it be to teach Science to learners with impairments, as stipulated by the goals of Education for All (EFA)? 'Education for All' embraces education as a human right

and initiates that all doors should be opened for all learners regardless of their disabilities (Riza & Firdaus, 2018; Madani, 2019). Apart from this, agenda 2030 of the United Nations suggests that there is a need for all people including people with disabilities to be empowered in all spheres of life. Agenda 2063 of the African Union is also of the same view that education is a key to having skilled citizens; particularly in Science and technology, and no child should be left behind (African Union, 2015). These international protocols also embrace access to quality education for all.

In realisation of this international protocol, several countries, including Lesotho, developed policies that advocate for access to education for all learners including learners with disabilities (MoET, 2018). The Lesotho National Strategic Development Plan (NSDP II 2018-2023) also emphasizes that all learners regardless of their disabilities should have access to education and be acquainted with skills that necessitate them to be productive citizens. The emphasis that all learners should be present at school, participate in all activities and achieve (Florin & Manzini, 2018), open doors to learners with hearing impairment. As a result, their enrolment in schools increased at primary level, but decreased when transiting to the upper classes (Education Management Information System, 2017; M'mbijiwe *et al.*, 2018).

EFA looks forward to providing quality education for all learners through the provision of effective reading and writing skills (Madani, 2019). This is in agreement with Terzi's (2007) assertion that education is a requirement for everyone as it contributes to an individual's wellbeing. However, reading and writing skills are mostly deficient basic skills for hearing-impaired learners, which can make their learning very slow and keep them behind their counterparts (Baglama, Haksiz & Uzunboylu, 2018). Again, Warnock and Norwich (2010) indicate that EFA does not always meet the needs of learners with disability, and that amounts to exclusion within education vicinities. Therefore, it becomes teachers' role to provide many opportunities that learners with special needs could choose from (Matobako & JIta, 2022).

These aforesaid challenges need the attention of researchers, since little is known about teachers' experiences, views, beliefs and attitudes to teaching Science to HIL. The listed attributes are the components of teachers' competences and enable effective teaching and learning in schools (Thibaut *et al*., 2018). Science is also an abstract subject that requires a language for critical thinking to enable the acquisition of concepts (Lucas, Pimentel & Luccas, 2018). With HIL, written assessment becomes a challenge due to their inability to understand a difficult vocabulary (Susetyo, 2021). This may lie on the fact that HIL are deficient in language, therefore, it is a challenge for them to comprehend some words and with a difficult vocabulary the situation is appalling.

These challenges result in the low performance of HIL in Science education (Im & Kim, 2019) and extend further to their career choices. This leads to a situation where HIL are under-represented in Science related careers (Listman & Dingus-Eason, 2018). Lastly, there is a lot of research pertaining to Science education and how best it could be implemented in classrooms to improve different academic skills such as problem solving (Akben, 2020). However, there is limited data assessing and comparing learners' performance between learners with impairments and general learners in Science (Kang & Martin, 2018). For this reason, there is limited information about how teachers experience teaching Science to learners with hearing impairment.

1.3 Research questions

To explore teachers' experiences of teaching learners with hearing impairment, the main research question is as follows: What are Science teachers' experiences of teaching learners with hearing impairment. The subsidiary questions are:

a) What teaching approaches do Science teachers employ when teaching learners with impairment in Lesotho secondary schools?
b) What professional development opportunities are available for Science teachers, teaching learners with hearing impairment in Lesotho secondary schools?
c) What are the challenges of Science teachers in the teaching of learners with hearing impairment in Lesotho secondary schools?
d) How can teachers' experiences of teaching learners with hearing impairment in Lesotho secondary schools be understood and interpreted?

1.4 Aims and objectives

The study seeks to explore Science teachers' experiences of teaching learners with hearing impairment in Lesotho schools. The objectives are as follows:

a) to investigate the teaching approaches of Science teachers in the teaching of learners with hearing impairment in Lesotho secondary schools.
b) to explore teachers' professional opportunities of teaching Science to learners with hearing impairment in Lesotho secondary schools.
c) to determine teachers' challenges while teaching hearing-impaired learners in Lesotho secondary schools.
d) to demonstrate how teachers' experiences of teaching learners with hearing impairment in Lesotho secondary schools can be understood and interpreted.

1.5 Significance of the study

Achievement of the aims and objectives of this study will form the basis for further research on how Science teachers might cater for the needs of HIL. Understanding how the needs of professionals who work closely with learners with impediments might allow the education system in general to act collaboratively towards accommodating such learners. The study might provide insights for relevant stakeholders including policy

makers and institutions of higher learning about the attributes Science teachers require for teaching Science to HIL. The findings of the study may guide teacher-training institutions on the kind of teachers they should model and produce. It might also provide information for developing the intervention strategies required to improve Science teaching to include learners with hearing impairment.

Successful implementation of curriculum reform depends on teachers' willingness to accommodate and teach learners with special needs. While some teachers may appreciate and go along with educational reforms, other teachers may not feel comfortable with such changes, like accommodating learners' differences. It is therefore imperative to understand teachers' experiences when they implement policies in schools. Additionally, the study might be an eye opener as to how opportunities to learn for HIL could be achieved without compromising the learning needs of their counterparts. This is because teaching learners with different disabilities could be a challenge for teachers; namely, deciding who is engaged. The study may as well enhance relevant stakeholders' understanding about 'education for all' and might change the negative attitudes individuals hold regarding the teaching of hearing-impaired learners. Findings may help to motivate teachers to appreciate and understand what is expected of them when teaching learners with diverse needs. Lastly, the findings might add new knowledge to the existing scholarly work about the teaching of Science to learners with hearing impairment.

1.6 Scope and delimitations of the study

This study is focused on teacher experiences about teaching Science to hearing-impaired learners. There are ten districts in Lesotho, but data was only collected from four schools, and by virtue of this, the study is a case study, which focused on four participants and warrants that the findings cannot be generalised. Only secondary schools were selected for this study, as this is where integrated Science is taught. Even though all the participants were teaching Science at secondary schools, three of them had majored in Physics.

1.7 Definition of operational terms

Education for all: Education that considers all learners regardless of their abilities or disabilities (Peters, 2017).

Hearing impairment: Includes both partial and total loss of hearing, which could be caused by heredity, sickness, or accidents (Hinchcliffe, 1997).

Opportunities to learn: Situations that enhance learning for all learners (Schwartz, 1995).

Sign language: A visual gesture language amongst HIL performed using hands and facial expressions.

1.8 Chapter outline

This thesis is divided into five interrelated chapters listed below:

Chapter 1: Background context for the study, as well as the problem statement are presented in this chapter. Research questions, objectives and significance are also outlined in this chapter.

Chapter 2: Literature Review and conceptual framework: Relevant literature is engaged with to ground the study and provide the theoretical basis for this study. The theoretical framework guiding this study is discussed and teachers` experience of teaching learners with special needs in different countries is explored.

Chapter 3: Methodology: This chapter indicates the paradigm, approach, design, sampling techniques and research instruments to be used.

Chapter 4: Data presentation and analysis: This chapter presents the data from the detailed case studies of the teachers who were interviewed for this study. Data from document analysis is also presented in this chapter.

Chapter 5: Summary of findings, conclusions, and recommendations: Discusses findings with reference to the literature. It also provides concluding remarks and recommendations.

Chapter Two: Literature Review and Conceptual Framework

2.1 Introduction

This study seeks to explore Science teachers' experiences of teaching Science to learners with hearing impairment. The presentation of this chapter is twofold. The first component is intended to lay the conceptual and contextual base for this study. Here, the discussions are guided by the research objectives to ensure that the literature survey is within the scope of the study and to identify the existing gaps. The two theories underpinning this study are discussed in the second component and these are 'capability framework' and 'opportunities to learn'. These theories have been used to characterise teachers' experiences expressed as views, beliefs, and attitudes towards the teaching of Science to HIL in regular classrooms. The teaching of Science

Teaching is a worthy activity but a demanding task, as it needs to consider factors such as time management, the availability of resources and the accommodation of learners with differing needs (Hankebo, 2018). All these are responsibilities of the teacher; hence it is important to know about their experiences when they teach Science. Similarly, the teaching of Science should consider several factors so that it can remain relevant to economic growth and equipping learners with the skills essential for understanding and improving the world around them (Iwuanyanwu, 2019). In addition, learners who study Science contribute positively towards solving societal problems (Kaluyu & Ndiku, 2020) and Science develops the 21st century skills required to deal with the ever-changing problems of this world (Fairuz, 2019). Based on these benefits, one would understand why Science is a compulsory subject in most secondary schools. Lesotho is no exception and prioritises the teaching of Science to all learners regardless of their disabilities and extrapolates that the teaching of Science is regarded as a determining factor (Aldrich, 2020) for learner achievement. However, Petrus (2018) indicates that, for different reasons, there is low performance of Science across the board. It is on this basis that the study investigates teachers' experiences that entail their views on teaching approaches

that are effective when teaching Science. According to Taylor (2020), effective teaching of Science includes proper planning of the lesson and effective teaching approaches. These factors are explained in detail below.

2.1.1 Planning of the lesson.

Sahin-Taskin (2017) argues that there is a relationship between a well-planned lesson and the effective deliberation of the lesson, this scholar Sahin-Taskin (2017) further posits that, passively following the plan may compel teachers to deviate from it. As a result, Moiinvaziri and Shatery (2022) assert that many teachers' opinion is to develop lesson plans according to their beliefs. The implication of this is that there are many factors surrounding teachers' abilities to develop a lesson plan; some can be personal, while others can be guided by theories, as explained below.

According to Iqbal, Siddiqie and Mazid (2021), an effective lesson plan should be based on the following: constructivism theory, Gagne's nine events of learning, formative assessment, seating arrangement in the classroom, monitoring class activities and teaching experience. Seating arrangement is an important factor to be considered from the inception of the lesson plan, especially in classes with HIL, since it allows the learners to see both the interpreter and the regular teacher (Harahap *et al*. 2020). The lesson plan is also about informing teachers of the kind of activities and resources needed to facilitate teaching and learning. Another conception of the lesson plan development is given below:

> Gagne's nine events of learning help a teacher to design lesson plan steps chronologically and make the lesson more attractive and effective. Formative assessment helps a teacher to design an effective lesson plan. (Iqba *et al*., 2021: 5).

The extract above shows that the success of teaching and learning in the classroom depends on the lesson plan. It also outlines the importance of formative assessment in

developing the lesson. The feedback the teacher receives in class could as well be useful in informing what and how the learners should be taught. It is on this basis that Fithriyyati and Maryani (2018) regard the lesson plan as an integral part of teaching and learning. Being guided by the lesson plan is different from a situation where the teacher does not have one or has one that is rarely followed. Researchers clarify that in the absence of a lesson plan, the learner remains passive, and the teacher fails to connect the previous lessons with the current one (Iqbal *et al*., 202

2.1.2 Teaching Approaches in Science

There are many approaches to teaching and learning, but Science as a subject has its own opted way of teaching. This may lie on Großmann and Krüger (2022)'s assertion that pedagogy is an important component to consider from the inception of planning Science lessons, as it addresses the different activities to be undertaken in the learning process. A learner-centred approach and inquiry-based teaching are hailed as being the best approaches to Science teaching (Bremner, 2021), because they do not consider knowledge as a package of transmissible facts and instead construct ideas in learners' minds. A detailed description is given below.

2.1.3 Learner-centred approach

Teachers are battling with a critical question which says: what is the best way of teaching Science to learners? In response to this, there is a global shift in Science teaching where teachers are expected to move from the traditional way of teaching to a learner-centred approach (Lehesvuori, Ramnarain & Viiri, 2017). This is the approach where learners interact with each other and are actively engaged in learning (Lehesvuori *et al.,* 2017). With this approach, assessment is used as a tool to gauge learners' prior knowledge essential for understanding new knowledge (Keiler, 2018). This says that what learners know is taken into consideration in their learning and may as well enable the teacher to know where to start, basing themselves on learners' knowledge base.

The explanation of this approach is also given by Bremner (2021) in three different ways, which firstly state that the teacher is no longer authoritative in class, instead supports the learner to negotiate meaningful learning. This says that the teacher does not only talk to passive learners, but they are also given an opportunity to engage in learning. Secondly, learners are responsible for their own learning and content should be relevant to real life issues. With this, learners do all it takes to understand the content taught in class by asking questions and reading further. Thirdly, learners are taught in accordance with their different needs, abilities and interests, an important aspect in the implementation of 'education for all'. With this, proper lesson planning inevitably impacts positively on learners' learning, as this awareness should enable teachers to identify appropriate teaching approaches that are relevant to learners' needs.

Lesotho, like other countries, advocates for the use of a learner-centred approach when teaching Science (MOET, 2003). The syllabus prescription considers learners' prior knowledge as a central part of teaching, as the teachers should start from what the learner knows. Based on Bremner's (2021) explanation of a learner-centred approach, not only should the teacher have the proper content and pedagogical skills but also a positive attitude, required for addressing learners' needs. Anyolo *et al.* (2018) strengthen the point that teachers' educational background plays a vital role in teachers' beliefs. The same point is raised by Hassanein, Alshaboul, and Ibrahim (2021), namely that positive attitudes are founded on teacher pre-service training. With this argument, one would think that teachers with adequate qualifications and experience in teaching would show positive attitudes towards teaching Science. However, a study conducted in Malaysia by Nasri, Nasri and Talib (2020), reveals that novice teachers displayed a more positive attitude towards teaching physics than experienced teachers. Another finding is that highly qualified physics teachers pointed out many more challenges of teaching Physics, even though they were knowledgeable and confident with the content. The earliest work of Richardson (1996) gives clarification to this in that experience shapes teachers' attitudes, beliefs and is attributed to determining their behaviour. Therefore, it is not a given that experienced or qualified teachers should have positive attitudes

towards teaching Science, but this also depends on their teaching experiences. It is on this basis that the following sub-section explains how teachers experience inquiry-based teaching approaches in their teaching.

2.1.4 Inquiry based teaching approaches.

As previously mentioned, there is a global shift in Science teaching from a traditional method towards inquiry-based teaching (Fitzgerald, Danaia & McKinnon, 2019). This newly established approach is regarded as effective for the teaching and learning of Science, as it prepares learners to be scientists and researchers (Firman *et a,* 2019). This says that learners are taught through mimicking what real scientists do and, in the process, not only are learners acquainted with scientific content, but are also trained to find and interpret new knowledge (Jerrim, Olover & Sims, 2022). With this, learners get the opportunity to physically interact with the concept under discussion and this enables them to solve real life issues through following scientific processes. This, according to Kolb (2014), is called experiential learning and is where learners get information from the experiences they have had.

There are different ways of describing inquiry-based teaching, but Fitzgerald *et al*. (2019) affirm that a holistic description is obtained when interpretations are brought together. Their definition is in line with the earliest work of Schwab (1962) and Herron (1971) who outline that the approach is on four levels, as follows: firstly, there is confirmation-inquiry where learners are guided to get the given results; secondly there is structured-inquiry where learners are guided on how to carry out an investigation where their responses are supported by their results and thirdly there is guided-inquiry where learners are provided with the problem to research and have to design how they will carry out the investigation and also explain the outcome. Guided inquiry, according to Margunayasa *et al.* (2019) initiates a deeper understanding of the scientific concepts. It is also important to highlight that a deeper understanding of concepts enables learners to relate what is learnt in class to real life issues. Dewi and Wardani (2018) also found that a guided inquiry-based

approach improves learning for learners who have difficulties in learning chemistry. Lastly, there is open inquiry that does not have a prescribed outcome, but learners design all steps by themselves.

The use of experiments is an inquiry-based practise. One of the ways that experiments are conducted is by following given procedures which step by step guide learners on what to be done in the laboratory (Zulfiani & Herlanti, 2018) and is called 'cook book'. This approach is acknowledged as being effective in instilling facts, rules and procedures but has the weakness that it does not engage learners' minds in learning (Zulfiani and Herlanti, 2018). With this, learners end up forgetting the purpose of the experiment while procedurally following the given steps. This weakness could be corrected by incorporating discussion and allowing learners to think deeper about the topic under discussion (Kabir, 2021).

The use of experiments can also be effective when teaching learners with impairments. This is based on that experiments facilitate meaningful learning, especially when learners are given opportunities to manipulate materials and build scientific concepts (Kabir, 2021). According to Liu (2020), the manipulation of concrete materials and the use of visual representation are essential for HIL's learning. Xohua-Chacón *et al*. (2022) reiterate that HIL mainly access information using visual material. Experiments remain appropriate for providing learners with multiple ways of accessing information, including manipulatives and observation of scientific processes. Based on this discussion, experiments seem to respond to classroom diversity as the different senses are engaged with in learning.

On the other hand, Najami *et al* (2020) show that doing experiments improve learners' ability to argue in Science related issues, as they draw conclusions from results they obtained in the laboratory. Consequently, this may increase the opportunity to learn for all learners regardless of their impairments. The main argument in this is that when teaching Science, learners should be given an opportunity to do things on their own to facilitate the effective acquisition of content. In this way, inquiry-based learning can be

considered a tool that contributes massively to knowledge construction in the minds of learners. That is, learners are not considered as passive receivers of information, instead are actively engaged in the exploration of scientific processes (Constantinou, Tsivitanidou & Rybska, 2018). With this, learners are as well not always exposed to a memorisation of facts, which does not necessarily enhance a deeper understanding of the concepts (Chai, Jong & Yan, 2020.). The approach shifts the roles of both teachers and learners, where the teacher is no longer authoritative in the classroom, but assists and guides learners to achieve the objectives of the lesson (Gholam, 2019).

The teacher should not be the only one talking to learners who are passive in class, instead they should facilitate learning for knowledge to be constructed in the learners' minds. With this approach, the teachers' role as a facilitator cannot be over emphasised, hence Orosz *et al.* (2023) elucidate that activities encouraging inquiry tend to be associated with higher outcomes. This comes when teachers assist learners to understand processes presented by the experiments undertaken. Therefore, one could conclude that learners achieve when the teacher's role on how to facilitate learning through an inquiry-based approach is clear.

Shambare (2022) conducted a study aimed at understanding rural teachers' experiences of using experiments when teaching Science. The author Shambare (2022) indicates that there is a need to integrate laboratory experimentation into Science teaching as this promotes learning. The study shows that due to lack of laboratory equipment, teachers are unable to utilise laboratory experiences, hence virtual laboratories could be an alternative to address this challenge. This indicates that even though experiments are reported to promote learning, teachers may not use them due to limited resources.

With laboratory experiments, learners make discoveries of new knowledge, requiring special laboratory equipment for this to be done (Maričić, Cvjetićanin & Anđić, 2019). It is noteworthy to mention that at other times experiments could be conducted without the use of special apparatus or expensive chemicals but readily available materials (Maričić *et al.,* 2019). It was also indicated that these kinds of experiments differ from the ones

carried out in the laboratory in that they are confirming what is already known even though it would be new to the learners. It is emphasised that experiments are not for learners to recall facts but to engage with concepts and understand them allowing for the acquisition of high order skills (HOS) such as observation and analysis (Dewi & Wardani, 2018). This shows that the use of experiments does not automatically enable effective learning, instead, it is how the teacher facilitates teaching and learning with experiments that matters most.

The implementation of inquiry-based learning could be affected by different factors such as teacher attitudes, unavailability of resources and time. Ramnarain and Hlatswayo (2018) conducted a study in South Africa to explore teacher beliefs and attitudes towards an inquiry-based method of teaching. The study found that teachers had a positive attitude towards this approach to the teaching and learning of Science. The study also found that teachers realised what opportunities this approach brought to learners, which among others included an increased willingness to learn and their ability to comprehend abstract concepts. However, due to a lack of resources, teachers were often unable to execute inquiry-based learning, as explained. This indicates that positive attitudes alone cannot increase learners' opportunities to learn Science.

Another challenge stated by Fitzgerald *et al.* (2019) is that time constraint is one of the issues that limits teachers from adopting an inquiry-based approach. This is because a lot of time is needed to conduct experiments so that learners are given an opportunity to do things by themselves and be able to write up a report. It is on this basis that Lee and Sulaiman (2018) suggest that teachers should, as a minimum, conduct experiments at least once a week so that learners can reflect on concrete laboratory experiences and understand concepts better. This shows that even though teachers find experiments effective for teaching Science, they cannot always be used because they are time consuming. This can have negative implications on the syllabus in that it cannot always be completed within the stipulated period of time. Thus Jerrim, Oliver and Sam Sims (2022) enlighten us that experiments can be effective when used moderately under optimum guidance and support from the teacher. This challenge presented by limited time

could be dealt with by integrating Communication and Information Technology (ICT) in teaching.

ICT is another form of conducting an inquiry-based approach and when used appropriately could improve learner performance in Science (Chai *et al.,* 2020). With ICT learners are able to acquire the 21st century skills needed to address the problems of this world. It is also indicated that ICT plays a pivotal role in making abstract concepts easier to understand and learners' interest in learning is enhanced (Pradipta *et al.*, 2020). Again, Nawzad, Rahim and Wakil (2018) echo this point and show that with ICT the performance of learners in the Sciences improves and they are able to do their assignment easily as compared to the traditional way of teaching. Besides this, Khurshid and Bibi (2020) found that integrating ICT in teaching is helpful even for slow learners who are challenged by an understanding of abstract concepts. That is, with ICT, concepts could be understood within a shorter period of time thus helping curriculum coverage. Not only does ICT promote learning, but according to Chatwirakom (2018), it improves both learner attitudes and performance.

It is on this basis that a teacher skilled with the integration of ICT and new roles in teaching is considered relevant for producing learners responsive to 21st century needs (Anagun, 2018). Similarly, Bajaja and Sharma's (2018) indicate that a kind of the teacher currently needed in schools is the one that can align learners' needs and interests with the objectives of the curriculum. This according to Ratheeswari (2018) is the skill teachers need to modify their teaching approaches so that learners can have access to the curriculum content. Jita (2018) is also of the view that teacher preparation without the integration of ICT in teaching compromises their opportunities to learn and may mean they are not considered competent in teaching scientific concepts. The implication of this is that teachers' roles are redefined, as they need to master the integration of ICT in the teaching and learning of Science. Again, Fadzil (2020) indicates that technology maximizes learning opportunities for learners with diverse learning abilities. This leads to the discussion of how Science is taught to hearing-impaired learners where I found it imperative to give a review of how hearing-impaired learners are taught.

2.1.5 Teaching learners with impairments

The declaration in the Salamanca statement regards education as a human right (UNESCO, 1994). This called for global concern that all learners should be at school regardless of their disabilities. According to the United Nations (2006), people with disability, including those with physical, mental, intellectual, or sensory deficiencies, impacts negatively on their participation and achievement in school. This international protocol opens access to all learners including learners with a hearing impairment; hence it is important to understand teachers' experience when teaching such learners. To respond to the EFA initiative, a new role for teachers emerges and they need to manage diverse classrooms and provide every learner with quality education:

> Education is the right of every child whether able-bodied or disabled, it is important that each child of school going age receives education in the manner he/she is receptive to. To achieve this aim, it is important for teachers to address the learning needs of all children. (Priyanka & Samia, 2018: 1).

The evidence shows that learners with special needs are taught alongside their able-bodied peers and the role of the teacher is to teach them according to their needs and abilities. The success of this initiative rests upon maximizing the participation of all learners in both educational and societal activities (Bacca *et al.*, 2015). Achieving this may not only depend on teachers' competences but may as well need to consider their experiences, views, and beliefs about teaching learners with impediments. This agrees with Skoumios and Skoumpourdi's (2021) assertion that teachers' experiences affect their decision-making. It has been discussed earlier that experiences include individual's beliefs, attitudes, and views. Therefore, it is important to understand what other scholars found teachers' experiences important when teaching learners with impairment.

With guiding educational policies, teachers have the liberty to choose how to teach learners at school, including learners with impairments. It is on this basis that they are

called key implementers of policies or agents of change (Bourke *et al.*, 2022). This suggests that teachers have a big responsibility when choosing opportunities to learn in line with learners' needs and abilities. This aligns with the capabilities framework principle that individuals are given the ability to choose what works for them to achieve their well-being unless the situation involves a minor (Sen,1992). In the education fraternity learners do not design how and what they need to learn at school, instead this depends on what and how teachers have planned their lessons. Hence this study found it intriguing to explore what teachers experience when they are teaching HIL.

Kang and Martin (2018) take the argument further; that learners could do well in Science when given an appropriate Science-learning environment. This point also reveals that it is the teachers' role to create a stimulating environment for learners to learn. Their study revealed that teachers changed their views and regarded learners with impairments as Science learners who are unique, but with different capabilities. As stated earlier, the teaching and learning of learners with impairments depends on teachers' views and attitude. One would anticipate that with a positive attitude from the teacher and an enabling environment learner with impairments (LI) could achieve.

Aas (2020) adds that in Norway, 'education for all' received great recognition but the lack of in-service training impacted negatively on teachers' beliefs and understanding about 'education for all'. This gives yet another point to consider, namely that teacher preparation has an influence on their attitudes. This suggests that teacher competence is another important attribute that needs attention when teaching learners with impairment. Zhang, Admiraal and Saab (2021) share a similar sentiment that opportunities to learn for learners lie on the quality of teaching provided by teachers. Content knowledge from the teacher is as well an important determinant of learner achievement. Thus Majoko (2019) view pre-service and in-service training as requisite to provide teachers with the competence that enables them to make education accessible for all learners.
Being competent to s teach learners with impairment does not only mean being confident with the subject matter, but also how to address learners' needs is as well an important attribute in increasing their opportunities to learn. Ndhlovu and Matafwali's (2020) findings

depict that teachers were competent to teach Science to hearing-impaired learners but lacked special education skills. With this, one would conclude that teachers were inadequate when it came to teaching learners with impairments. This indicates that learners' special needs should be informing teachers about how to conduct their lessons.

As mentioned earlier EFA 'invited' to school learners with different disabilities, but this section will consider learners with sensory deficiencies thus visually impaired learners (VI) are considered. McLinden *et al.* (2020) show that (VI) are different and their learning needs limit their opportunities to learn as they cannot explore the environment or learn through imitating their counterparts. Since VIL have the same intellectual capacity as other learners (McLinden *et al.*, 2020), it is the teachers' responsibility to utilise other sense organs for VI to receive information in class. That is the sense of hearing and touch could be used for their best advantage when learning; so that they can achieve the same learning outcomes as their counterparts. However, Matobako and Jita (2022) posit that visually impaired learners choose what they regard as their opportunities to learn from what the teacher displays for them. That is even when teachers have decided to provide accommodative strategies, VI can still choose what they think could help them learn better. This suggests that teachers must present more opportunities for VI to access information.

The above point relates to the Van Leendert *et al.* (2019) finding that VIL experience problems with brail reading and participated differently in learning. This comes when brail is understood as addressing the challenge of reading for the VI. This says that what teachers regard as opportunities to learn may not always be inclined to learners' needs but the availability of learning opportunities is of utmost importance. This shows that VI is not a homogenous group and their needs have to be addressed as individuals. Hence, Terzi (2014) emphasises that initiatives intended to assist learners should be relevant to their needs. On a final note, it is understood that the provision of various learning opportunities widens hearing-impaired learners' opportunities to achieve.

However, it is worth noting that there are challenges teachers encounter when teaching learners with impairments. To address this, Messiou (2017) suggests that learners with impairments be given a lot of attention. In view of this, Atika *et al*. (2018) advise that effective teaching approaches for learners with diverse needs be informed by research. This, however, seems quite limited and results in unclear messages of 'education for all'. Hence it is important to explore teachers' experiences of teaching VI.

Fast and Wild (2018) are of the view that inquiry-based approaches enable VIL to access hands-on activities, which heighten their possibilities to investigate, explore, and solve problems. An inquiry-based approach includes the use of experiments when teaching Science to VI. Exploring the laboratory, with safety precautions, remains a hurdle to the VI, thus most of the times they are paired with their sighted peers (Reynaga-Peña, & López-Suero, 2020). Even though this arrangement may appear helpful, the VI may not have the opportunity to do experiments on their own and their capability to construct knowledge using the experiential processes may as well be compromised.

The provision of quality education is assessed on its capability to build an independent individual who can learn on their own and live without being in desperate need of support from others (Anna and Denys, 2019). It is using ICT skills that learners can learn on their own. This requires teachers who can integrate ICT in teaching and learning as this improves the performance of learners with impairments (Tohara, 2021). ICT presents a learning opportunity for learners to go through the instructional material several times until they have understood the concept under discussion, and this promotes learning (Khurshid & Bibi, 2020). An appropriate learning material for VI is any recorded audio that can be played many times through an ICT tool.

It is noteworthy to show that there are multimedia representations in ICT that teachers need to utilise to accommodate the diverse needs of their learners. There are instances when teachers may have to take cognisance of both verbal and visual learners in the classroom, and it is through ICT that this could easily be achieved. Ferguson *et al*. (2019) regards this as a universal design for learning (UDL), where learners with differing needs are accommodated.

It is difficult for teachers to teach learners with impairments when they have not received any kind of training. This suggests that they are only able to use UDL or choose appropriate accommodations when they have undergone continuous professional development (Baitanayeva *et al*., 2020). Thus Issaka (2018) advises that CPD be a policy issue and clearly outlines how training will be conducted. With this, policy reforms could be well implemented (Walia & Walia, 2022). The implication of this is that teachers' roles as agents of change and how they will be supported will be clearly articulated in policy guidelines. Mansour (2014) adds that it is important that teachers' views and concerns are considered as guiding tools on what to include in CPD, so that it responds to their needs. Besides CPD mentioned to be important when teaching learners with impairments, it is important to understand how HIL are taught in regular schools as it is the focus of this side.

2.1.6 Teaching learners with hearing impairments

As previously stated, education has opened doors for everyone including learners with hearing impairment (HIL). This initiative compels teachers to use teaching approaches that accommodate all learners with diverse educational needs, including HIL. It is worth noting that HIL are not homogeneous, and their needs are different (Silvestri & Hartman, 2022). It is therefore important to understand how teachers address this diversity in their classrooms for all learners to perform to their best potential (Broderick, 2018) This includes activities designed in consideration of individual's needs and interests which enable HIL to learn best (Dewi, Yawisah & Siregar, 2019). This is a learner-centred

approach and demands that teachers get to know their learners. However, this could be a challenge in an overcrowded classroom. With this, one would reason that the number of learners in a class with HIL should be manageable, so that teachers can easily identify and address the needs and interests of individuals.

Most HIL's needs are caused by language deficiency, and this includes the fact that they are mostly lagging behind their counterparts. It is indicated that a way that teachers could deal with this challenge is by giving them some extra work to do (Dewi & Dalumunthe, 2019). Another strategy that is encouraged when teaching HIL is to repeat the information communicated since they are slow (Hadi *et al*., 2019). These two strategies when used imply that HIL may need a lot of time to learn the stipulated learning outcomes. Therefore, time spent on concepts taught may predict their possibility of understanding the information communicated. This again says that time is an important variable for HIL 's opportunities to learn. However, when HIL are slow and given little work to do, one can see the challenge arising of not completing the syllabus. However, one could show that when ICT is used, as explained earlier, this challenge can be avoided when learners are also given ICT tools to assist them to learn on their own.

Another study, conducted in Indonesia by Ardianingsih, Rofiah and Ainin 2020 investigate how HIL learn in a diverse classroom. Their findings show that teachers must consider how they position HIL in the classroom, as this is an important attribute to consider when teaching them. HIL, regardless of the degree of hearing impairment, must be closer to the information source, this because the hard of hearing can only hear voices at a proximity. This is relevant to Kumatongo and Muzata's (2021) view that the classroom arrangement should be allowing HIL to use their residual hearing. There is also HIL who access information through lip-reading (Shanthi & Roy, 2023) and should also be closer to their teachers. Lastly, there is a group of HIL who use sign language and they need to be close enough to see the sign language interpreter. The use of sign language is regarded as a traditional way of teaching that can be replaced by ICT tools that convert voice to sign language (Shanthi & Roy, 2023). Even though the approaches are found to be effective, teachers are reported to still face challenges when teaching HIL.

The main challenge of HIL is language deficiency, which brings problems for teachers when teaching abstract concepts that need more clarity, normally provided using words (Rusyani *et al.*, 2021). As a result, HIL are hindered from performing like their counterparts (Basha, Engida & Tesfaye, 2020). This challenge places teachers in the position of trying other alternatives. These include the provision of notes that complement the information lost when verbal communication is used. While English is the medium of instruction for learners, sign language should be available to facilitate learning for HIL. Without the use of sign language, it becomes difficult for HIL and their teachers to communicate (Basha *et al.*, 2020). Consequently, this may result in social exclusion and poor performance. It is therefore important that teachers are prepared to communicate in sign language, as this can deal with a situation where teachers rely entirely on sign language interpreters who most of the time lack content knowledge (Lynn *et al*., 2020).

The proper implementation of EFA will as well depend on how teachers understand it. Bemiller (2019) conducted a study in the United States of America to explore teachers' understanding and reflections about education for all learners. The study found that some teachers understood EFA as placing all learners in a regular classroom while others stated that it is providing for the learning needs of all learners. Bemiller (2019) shows that these different understanding of EFA stems from teachers lack training and this could be reflected in their classroom practice. Thus, Engler and MacGregor (2018) show that CPD programmes are required to capacitate teachers and improve the quality of their teaching. Since this study is focused on Science teachers, it is imperative that how Science is taught to learners with impairments is under

2.1.7 Teaching Science to learners with impairments

The EFA emphasises that all learners should have access to quality education and Science is one of the subjects that should be available to every learner at school, including learners with visual impairments (Ediyanto & Kawai, 2019). It is believed that the use of teaching approaches relevant to VIL could bring change to their learning:

> Students with VI can learn Science well if there is a proper support tool for them to learn. If the teachers can apply the right learning model and are supported with good facilities such as orientation and movement, tactile and kinesthetic learning, auditory learning and accommodations, and assistive technology, it is possible that students with VI will be able to learn about Science very well (Ediyanto and Kawai, 2019:1).

The extract above gives encouragement that there is a possibility that VIL can achieve when appropriate teaching approaches are in place. With this, it appears imperative to explore teachers' experiences of teaching Science to learners with impairments. Maryanti and Nandiyanto (2021) conducted a study in a special school on the methodologies used when teaching Science to learners with the following impairments: learners with physical disability, learners with visual impairments, learners with hearing impairments and learners with intellectual disabilities. The results show that most of the teachers used a 'lecture and question and answer method', which resulted in poor learner performance. These are traditional teaching approaches where the teacher is in authority to transfer facts to learners (Jerrim, Oliver & Sims, 2022) and they do not appear to promote quality learning.

Danene and Tiffany (2018) show that teachers found teaching Science to learners with visual impairments as a challenge. The authors Danene and Tiffany (2018) found that visual representation is used predominantly for the understanding of concepts, yet VIL are deprived of sight. This says that the selection of teaching approaches was not aligned to what learners can do. Therefore, VIL's opportunities to learn were compromised. Reynaga-Peña and López-Suero (2020) indicate that the selection of teaching methods should always align to the characteristics of the learners, as well as their interests and needs and this is called user-centred design.

As indicated earlier, visually impaired learners are not cognitively disabled, but Science learning relies a lot on vision, as observations are made so that learners can think and

reflect on what they have seen (Kızılaslana, Zorluoglub & Sozbilir, 2020). This poses a challenge to VIL, as they cannot use any other senses except sight, therefore, it becomes the role of the teacher to explore alternative ways that VIL can use to access information in class (Kızılaslana *et al.*, 2020). It is also important to understand how Science is taught to HIL, the focus of this stud

2.1.8 Teaching Science to learners with hearing impairment

The teaching and learning of Science have been established as one of the priority areas needed to improve the provision of quality education for all learners across the globe. Science is a subject necessary to develop essential skills for the 21st century (Sabry, Darwis & Fathallah, 2020). Therefore, all learners, including HIL, need Science literacy to solve daily life issues and contribute positively to their communities. The authors showed that with appropriate teaching methodologies, HIL can also do well in Science and develop creative thinking skills.

This is congruent with Atika *et al.* (2018) that HIL are not cognitively challenged but are deprived of language skills needed to effectively access the curriculum content like their counterparts. Based on this description, it becomes apparent that all learners, regardless of their disability, should be competent in Sciences. This aligns with Ross, Yerrick and Pagano's (2020:1) view that, "[w]ith the goal of improving deaf and hard-of-hearing students' equitable access to quality Science education, strategies should be considered. in teaching approaches". However, it is noteworthy to mention that there is a gap in the literature because a limited number of studies investigate the teaching of Science to HIL. Instead, the dominating studies are conducted separately on the teaching of Science and on the teaching of HIL, this is elaborated below.

> Because no current framework exists for studying deaf learning in Science, we must draw on other education fields that face similar issues of culture and literacy. Science education has a rich and growing research base regarding English Learners (EL), and even, to some extent, students with special needs, but DHH students have not been a focus of

> these studies. Research into pedagogical advances in educating EL students and special needs students are varied but have relevance to improving DHH education for both teacher preparation and policy (Raven and Whitman, 2019:1010).

It is on this basis that the following paragraphs discuss in detail approaches to teaching Science to HIL, with reference to Science education studies for learners with special needs.

Parveen (2017) indicates that challenges exist when teaching Science to HIL, but that does not say that teachers cannot make an effort in teaching them. He conducted a study in Pakistan to assess the effectiveness of the inquiry-based instructional model. The study revealed that an inquiry-based model was more effective compared with a lecturing method. This indicates that with pedagogical shifts HIL can learn more easily, as the approaches mentioned are better for actively engaging learners in their learning. Such approaches include the use of mind-maps that have been observed to be more engaging and useful for the teaching and learning of Science for HIL (Rusyani *et al.,* 2021). The authors acknowledge that HIL have a problem with understanding abstract concepts but can do well when appropriate teaching methodologies are employed. They found that learners understood concepts better and were eager to learn when mind-mapping was used. The use of experiments is known to engage HIL in the Science classroom, as scientific processes are explored enabling acquisition of higher order skills (Dewi & Wardani, 2018). As learners engage directly with the scientific concepts under discussion, they tend to be motivated and be willing to learn more (Marchut & Gormally, 2019). The implication of this is that the use of experiments stimulates HIL's willingness to learn and promotes learning.

Learning is stimulated by the place in which learners are taught and teachers should opt for a space with learning resources. This is supported by Kumatongo and Muzata's (2021) assertion that environment stimulates how individuals learn. A Science laboratory is one of the learning spaces which allows learners to be taught scientific concepts that enables

them to understand concepts more easily (Kalyon, 2021). This is supported by Braun *et al*. (2018) who say that creating a welcoming environment is very important for HIL, as they are often regarded as cognitively challenged. Since HIL depend mostly on the sense of sight and touch, the teaching approaches opted for should mostly be visual and the exploration of a tangible object (Liu, 2020; Rodrigues *et al.*, 2022). It is in a situation where experiments are seen, creating a learning environment that engages these senses and consequently widening HIL's opportunities to learn. Lastly, Nandiyanto *et al.* (2018) maintain that teaching a difficult subject like Science requires a teacher who uses experiments and demonstration since these methods are cognisant of HILs' needs.

A study was conducted by Hidayat *et al*. (2020) to explore how best HIL could be taught the concepts of floating, hovering, and sinking using an egg for demonstration. A conventional method and a combination of a conventional method and an experiment/demonstration were used to assess the best teaching approach that promotes learners' understanding. It was found that the conventional teaching approach on its own was not that effective when compared to a combination of the two methods which was more effective in stimulating learners' understanding and interest of the concept. The study revealed that HIL acquire concepts easily when visual learning methods are utilized. In Indonesia, Rusyani *et al.* (2021) conducted a study in a special school to investigate the teaching approach used when HIL are taught Science. The findings show that HIL's understanding of concepts increased when an experiment was demonstrated.

Another approach that is helpful entails the use of ICT, which is widely used in the education sector to facilitate the teaching and learning of Science for HIL. Adigun (2020) conducted a study in Nigeria on the effectiveness of 'computer assisted learning' (CAL) and 'problem-based learning' for deaf learners in a biology classroom. The findings revealed that teachers considered CAL to be the best method when teaching Science to HIL. Another finding was that CAL is a learner-centred approach that allows learners to engage interactively in the Science classroom.

ICT is a tool predominantly used as an educational resource that compensates for different kinds of impairment, including hearing impairment. Zafar *et al.* (2021) reiterate that ICT improves on the special arrangements made to accommodate HIL. The use of ICT can include a situation where the interpreter in is replaced by assistive technological devises called Avatar. This device necessitates direct communication between the teacher and the HIL and writes English language in sign language. This appears to be an appropriate educational resource that has the potential to solve mistranslation and misconceptions experienced in the presence of an interpreter. Additionally, Ross *et al.* (2019) conducted a study in the United States of America and explored how a toolkit web resource could be useful, above some traditional pedagogical materials, for HIL to access climate Science topics. The study found that the use of the toolkit enabled HIL to actively engage with the content they had previously done in their classroom. The discussion above reveals the power of ICT in assisting in the active involvement of learners in learning and how it contributes to more meaningful learning.

It is necessary for the teacher to know the progress of the learners when teaching. Thus Tibbitt (2020) elucidates that assessment is part of effective teaching and learning. The author further shows that assessment is carried on throughout the whole lesson to allow the teacher to address misconceptions that have been identified. Balakrishnan (2018) reiterates that assessment is not a once-off activity, but an integral part of teaching and learning that informs both the teacher and learners of their objectives. However, Tibbitt (2020) laments that assessment is one of the educational tools underutilised to improve teaching and learning for HIL. This may lie on teachers' inability to assess HIL in line with their strengths or abilities; this is explained below:

> Although there is limited literature on the use of formative assessment among deaf and hard of hearing learners, a strong consensus exists that relying exclusively on standardized assessment offers limited benefits (Tibbitt, 2020:4).

The extract above indicates that when assessment is standardised, HIL may have minimal opportunities to learn due to the demands of linguistic skills they are deprived of. It also becomes evident that during teaching and learning, Learners are taught through sign language but when assessed are expected to write in standard English.

This is in agreement with Mandyata's (2018) observation that HIL learn through visual representations of sign language, and it becomes very difficult for them to express what they know in writing. Teachers' inability to use assessment that is relevant to the needs of HILs may emanate from their lack of capacity to communicate through sign language. Hence Balakrishnan (2018) argues that it is important for teachers to be equipped with the skills that can enable them to use assessment efficiently. This may as well provide teachers with alternative methods besides 'pen and paper' assessment. It is on this basis that Pizzo and Chilvers (2019) recommend that for assessment to be effective, it should always be matched with the needs of HIL. It is also emphasised that these accommodations in assessment should not give HIL an advantage of doing better than they deserve. This means that when initiatives are made for HIL to access assessment, they should not just be given correct answers. This again clarifies that the provision of opportunities to learn for HIL should not unfairly give them the privilege of doing better than others.

Teachers are at liberty to use assessment feedback for different purposes such as assisting learners who have not achieved the lesson objectives. This according to Rasul, Shahzad & Iqba (2019) is the main role of teachers, namely, to assist learners to construct knowledge. There is also remedial teaching where the performance of learners who cannot reach the expected learning objectives is improved. This may assist learners to equally access education regardless of their needs. For the initiative to be effective, accommodation strategies employed should assist learners to achieve the learning outcomes (Noprianto, 2019). This can only be achieved when opportunities to learn are customized for HIL and are useful to accelerate their learning.

Remedial teaching can come in different forms such as peer teaching where learners assist each other in understanding of the concepts (Wang & Gao, 2021). Another way could be through ability-grouping where learners with the same learning abilities are grouped together for the teacher to deal with homogeneous educational needs (Pozas *et al.*, 2020). While ability-grouping can as well be used advantageously to support both slow learners and high performers so that they can progress in their learning, it is also predicted to advocate for inequalities (Trinidad & King, 2022). This suggests that in other instances remedial teaching should be used to extend learners' knowledge. It is also of great importance to explain that the approaches cannot be effective on their own without the consideration of further issues elaborated below.

Planning the lesson for a HIL is a crucial step in the provision of accommodative strategies and enables them to remain active and directed in their task. Attaining this could be using a universal design for learning, as Iqbal, Siddiqie and Mazid (2021) show that a teacher can utilise time, resources, materials, and techniques effectively. These are the teaching resources, which when planned and allocated carefully can accommodate learners' educational needs and differing abilities. Neild, Taylor and Crecelius (2022) explain that learners in the United States of America face challenges in accessing quality education and with a UDL such problems can be solved. The authors Neild *et al.* (2022) explain that UDL comprises the following: engagement, representation, expression, and the use of technology for HIL to have access to quality education. With this said, UDL appears to be an effective tool that could increase HIL's opportunities to learn in a diverse classroom setting. Hence Dewi & Dalimunthe (2019) view UDL as not a 'one size fits all' but an opportunity to provide learners with the different characteristics required for a fair access to the curriculum content.

It is worth stressing that language plays a significant role in teaching and learning, as it helps enable learners to interact with their peers and the teacher. Therefore, sign language removes barriers to Science teaching and learning for HIL.

> A lack of access to the necessary communication skills can often cause Deaf students to feel dissatisfied or unable to study basic Science. Therefore, sign language is a solution to meet the verbal and communication needs of the deaf community as the many spoken languages meet communication needs of the hearing community. (Meghdari & Alemi, 2020: 47)

It is on this basis that a regular Science teacher conducts the lesson in collaboration with a sign language interpreter. The extract above suggests that using the language one understands enables individuals to engage effectively with the information communicated. Therefore, HIL need sign language interpreters to facilitate communication in class. It is on this basis that De Freitas, *et al.* (2017) consider the presence of interpreters in schools with HIL essential for them to access curriculum content. This may lie on Caselli, Wyatte and Henner's (2020) assertion that interpreters accommodate HIL's language needs. This is essential because it enables HIL to participate. This relates to Miles, Khairuddin & McCracken's (2018) argument that meaningful communication enables the HIL to participate in class. The argument laid out above sees language as a pivotal tool in making teaching and learning meaningful for HIL. However, the main concern is that with translation and learners deprived of language may not improve in their linguistic skills (Caselli *et al*., 2020).

In other instances, teachers resort to the use of learners' native language for the clarification of scientific concepts or questions asked in class (Kumar, Nukapangu & Hassan, 2021). This according to Alan and Idris (2018) is called code-switching and can be used for different instances while it promotes learning. This is explained further below:

> Code-switching took place in different situations in the teaching and learning. In explaining difficult concepts and in repeating instructions to those who had difficulty in understanding in the target language (Bhatti, Shamsudin & Said 2018 :100).

The extract above shows that teachers switch to home languages with the intention of making concepts clearer for the learners. In a similar vein, a class with HIL can be described as a multilingual class, where the teacher is bound to code-switch to meet the language needs of lip readers and the learners who have good hearing. It is worth noting that even though HILs depend on interpreters for communication they can also benefit from code-switching when interacting with their counterparts who have understood the concepts clearly. This is peer collaboration, which according to Marchut and Gormally (2019) promotes learning.

2.2 Challenges of teaching Science to hearing impaired learners

EFA advocates for quality education for everyone, but teaching HIL remains a global concern for most Science teachers. Challenges brought about by language deficiency continue to impede the effective teaching and learning of HIL even in the 21st century (Pimentel *et al.,* 2018; Meghdari & Alemi, 2020). One can see that HIL are seen in Science classrooms, but their performance is unsatisfactory due to the challenges the teachers are faced with. This shows that the physical presence of HIL in a Science classroom does not mean that HIL have acquired the knowledge. Hence, it is believed that with the appropriate teaching methods, HIL can perform adequately like their counterparts (Ross, Yerrick & Pagano, 2019).

It is even advised that HIL should be taught in a way that enables them to access Science content and achieve (Lynn *et al.*, 2020). This suggests that the choice of teaching approaches should be inclined to the capabilities of HILs or what they are able to do to have access to curriculum content. Raven and Whitman (2019) reiterate that challenges when teaching HIL come with pedagogies that disregard the repetition of concepts and the use of visual representation. This requires teachers to know how HIL learn by identifying their strengths and to teach accordingly.

Pedagogical barriers form part of the challenges teachers are confronted with when teaching Science to HIL. Vivian and Leonel (2021) conducted a study in Brazil to

investigate the challenges Physics teachers are faced with when teaching HIL. The study revealed that HILs have difficulty to access written language, and this is the basis of all other challenges. This is because reading and writing enables access to curriculum content and the inability to do these poses challenges for teachers. The authors Vivian and Leonel (2021) also believe that CPD for people engaged in teaching and learning of HIL is inevitable:

> The formation and training of bilingual teachers and Libras interpreters, investment in creating signs and bilingual visual teaching resources can significantly advance scientific knowledge in deaf education. When we think about educational equity and inclusion of deaf people in the educational, scientific and social environment, these are possible means to be strengthened.

The extract above indicates that teacher preparedness to teach HIL includes being well acquainted with sign language to enable communication in the classroom. Lynn *et al*. (2020) extrapolate that this kind of CPD may address the problem where regular teachers rely entirely on sign language interpreters for communication.

Involving interpreters in a classroom is a bilingual aspect intended to solve communication problems for HIL, but lack of vocabulary it is yet another challenge that needs attention (Raven & Whitman, 2019). This is similarly to Clark *et al's* (2021) view that with limited vocabulary in sign language, it is not easy to clarify scientific concepts. Besides this, Ngobeni, Maimane and Rankhumise (2020) conducted a study in South Africa and found that sign language interpreters are not that competent in the necessary sign language since there is no continuous professional development. This is reported to have compelled sign language interpreters to come up with their own signs, which is also a weakness that hinders HIL when communicating amongst themselves (Ntinda *et al*., 2019). With this, Science may fail to be universally taught, as it known to be.

Alasim (2018) conducted a study in Saudi Arabia that explores barriers to participation of HIL in a regular classroom. The study revealed that language deficiency deprived HIL from participating and interacting with their counterparts. Discussion is one of the effective teaching approaches that brings learners together when they are proficient in the language used as a medium of instruction, but with HIL, approaches that use verbal expression mostly may not be relevant to HIL's needs. This in the end reduces learner interactions and acts against Vygotsky's (1978) argument that learning is social. Not only does this minimise learners' opportunities to learn, but it also compromises the chance of sharing social skills.

Adigun (2020) is also of the view that the inability of HIL to understand spoken languages hinders their ability to interact and learn from others. The discussions were taken further by Adigun (2020) that the attitude of teachers can also hinder the HIL's ability to participate in class. This argument is made on the basis that what teachers think and feel about HIL is easily transferable to the other learners and thus affects their participation in class. With this said, a lack of language and teacher attitude are understood to impede teaching and learning for HIL. Thus, it is pertinent to understand the experiences of teachers and their challenges when teaching HIL.

Reporting on the context of South Africa, Kelly, McKinney and Swift (2022) investigated the educational needs of HIL and what hinders them when accessing scientific knowledge. Their findings also indicate that HIL experience communication difficulties when interacting with their teachers. This relates to an argument raised by Bamu *et al*. (2017), that most teachers are not familiar with sign language and lack adequate skills to address the educational needs of HIL. Another challenge that teachers face when teaching HIL is the unavailability of resources relevant to the learners' needs. A study conducted in the United States by Long and Kowalske (2021) aimed to investigate teachers' experiences and how they understand teaching Science to HIL. The findings show that teachers were not aware of HIL needs and were challenged with choosing appropriate teaching resources. The implication of this is that the misalignment of learning

resources to learners' needs may as well compromise their opportunities to learn. It also says that while some schools are challenged by the provision of resources for HIL, there are others that can be resourceful but fail to address the problems learners are confronted with when teaching and learning takes place.

It is also noteworthy to mention that there is diversity in the HIL community (Tiggs, 2021) tand HIL should never be treated as a homogeneous group even when they have different learning needs. Meghdari and Alemi (2020) agree that the degree of hearing differs amongst individuals and remind us that there are hard of hearing and deaf learners. Therefore, accommodation by teachers will as well differ according to the diverse needs of HIL. Ross, Yerrick and Pagano (2020) attest to this with an explanation that in America, diversity exists even for sign language users. This is based on the notion that HIL might rely on sign language as their first language while others rely on lip-reading. This says that while the one group of HIL rely on sign language interpreters, another relies on regular teachers. Therefore, opportunities in place should match learner capabilities.

Teachers are as well challenged by the inability of HIL to engage in critical thinking (Adeniyi & Kuku, 2018). It is explained further that language plays a vital role in knowledge acquisition of abstract scientific concepts (Zakia & Yamtinah, 2017). Therefore, HIL's delay in language acquisition affects them when they engage critically with the information at their disposal. Not only is language a tool that allows cognition to take place, it also allows collaborative learning. With this deficiency, learners may not be able to learn from their peers, which goes counter to Vigotsky (1978)'s argument that learning is social. Therefore, a lack of communication reduces learners' ability to interact with their peers. It may as well be difficult for teachers to teach such a diverse classroom and thus I found it intriguing to understand teachers' experiences of teaching Science to learners who cannot hear or speak the language that their counterparts and teachers understand.

2.3 Continuous Professional development

The above section stipulates that teaching HIL remains a challenge for most teachers, especially those who have not undergone adequate training. Most recommendations on how to deal with the aforesaid challenge are directed towards the provision of continuous professional development (CPD) for teachers (Hassanein *et al*., 2021; Issaka, 2018). This is based on the conception that the quality of teachers determines the possibility of the content being accessible to learners (Rubini, Ardianto & Hidayat, 2018). That is, having a competent teacher is a requirement for HIL to achieve a quality education, as stipulated by EFA prescriptions.

Additionally, Popova *et al*. (2022) show that in many countries, teachers lack the skills essential for effective teaching and learning. In response to this, continuous professional development (CPD) is globally considered important for improving their content knowledge and pedagogical practice (Mukan *et al*., 2019). Besides this, educational reforms compel more resources to be directed towards equipping teachers with the essential skills that make them relevant as teachers when it comes to current national trends. In a similar vein, education for all learners is a new initiative that has somehow changed teachers' roles. Therefore, with CPD, teachers are capacitated with what is expected of them and this indirectly leads to improved learner achievement (Baitanayeva *et al.*, 2020). It is on this basis that the following paragraphs discuss issues of CPD for teachers teaching Science to HIL.

There are different ways of defining CPD, but its goal is to increase the opportunities for learners to achieve (Bates & Morgan, 2018). CPD also keeps teachers up to date and enables them to make the changes required by policy reform. This is explained further by Khan, Grijalva and Enriquez-Gates (2019): "Professional development is essential in supporting teachers as agents of change to foster international educational reform". This shows that for teachers to be the best implementers of any curriculum reform, they should be professionally developed.

There are different types of professional development, and a few are mentioned: the content, support for collaboration, coaching and expert support (Bates and Morgan, 2018). With content CPD teachers are enabled to connect theory to practice. However, this kind of professional development alone has no direct impact on improving their classroom practice or learner achievement. With support for collaboration teachers can work together either in small groups or as a whole school to discuss the challenging issues they face with their instructional practice. With coaching and expert support teachers get assistance from an external expert. With different teaching approaches teachers can be actively engaged in learning. The only weakness with this approach is that teachers are taken out of a teaching context.

For a school that has HIL, not only do teachers need CPD on content but they also need special training on how to deal with HIL (Ndlovu and Matafwali, 2020). This considers the qualification of the teachers coupled with their knowledge of special education that is a requirement for teachers teaching learners with diverse needs. Chitiyo, *et al.* (2019) agree that special education is a requirement when teaching learners with educational needs. They explain:

> What countries are faced with in this regard is the shortage of qualified teachers with the requisite skills to provide an appropriate education for their children. This shortage can be addressed through provision of professional development for all in-service teachers in the area of special education (Chitiyo *et al.*, 2019:29)

The extract above indicates that quality education can be attained through well trained teachers. This says that teacher training is an important variable that needs to be considered in the provision of opportunities to learn for learners with special needs. It further elaborates on the kind of training teachers need to be relevant to a diverse classroom. It has also come to the author's awareness that teachers may not have received the special education training in their pre-service training, and this can be attained while they are already at work.

Raven and Whitman (2019) conducted a study to establish how Science is taught. The study revealed the challenges as follows: many teachers were not competent to teach Science, there was an inconsistent use of teaching approaches such as the drawing of pictures and the building of models. Lastly, pedagogical accommodations provided for learners had limited visual representations and repetition. Based on this, there must be an appropriate CPD to address the stated challenges. That is, a CPD that is focused on instructional practice and support for HIL. This indicates that CPD should be well planned and focused on teachers' needs for it to be meaning to fruitful for addressing learners' needs.

Another study was conducted by Adigun (2020) to investigate how computer and project-based learning approaches can be used to teach Biology to HIL in a manner that they can achieve. The study revealed that learners were doing well in Biology when computer and project-based learning methods were used. Adigun (2020) also encouraged teachers to use technologies that could be accessible at home. Further advice was that teachers should be adequately trained with the use of computer assisted instruction, as this seems to improve the performance of HIL. There is other evidence showing that CPD should be conducted based on either the needs of teachers or learners. When this is well done it may bring a CPD that increases opportunities for equitable access of quality education for all learners.

A study to explore the educational needs of HIL was conducted by Kelly *et al*. (2020) in South Africa. This was done with the understanding that quality education for HIL can only be attained when their teachers understand their educational needs. The study indicated that HIL encounter challenges when communicating with their teachers. This may lie on HIL's deficiency in language. Another finding is that teachers for HIL are not adequately trained to understand and address the needs of their learners. It is believed that when teachers receive training aligned to addressing HIL's needs in school, they can do well like their counterparts.

2.4 Theoretical Framework

This study presents the view that learners could do well when given support and appropriate teaching methods. It also contends that ‘education for all’ stems from the views of equity. With this, it is believed that learners could access education when learning resources are equally distributed and there is consideration of the diverse needs of learners. These views are explored through the guidance of the ‘opportunities to learn’ and the ‘capabilities framework’. These two theories agree that the welfare of individuals could be achieved with the availability of opportunities that have relevance for their needs. With respect to the education context, the theories suggest that for learners to show their best achievement, opportunities should be available and relevant for them.\

2.4.1 Opportunities to learn

Since the poor performance in Science is worrying, one must think carefully about opportunities provided by the education system for learners (Chabongora & Jita, 2014). This directly involves teachers who are believed to be mainly responsible for learner achievement (Kang & Martin, 2018). The discussion above shows that qualified teachers could provide the appropriate tools for learners to master the content. It is also noteworthy to show that giving learners with educational needs an opportunity to be in the Science classroom may not automatically translate into their access to quality education. What teachers do in preparation for instructional practice may be of the greatest concern and may as well contribute to ‘opportunities to learn’.

OTL has multiple definitions, but the term generally refers to the availability of factors that enhance learning. Cawthon *et al.* (2012) show that the opportunity-to-learn model is reflected by the interaction between instructional practices and abilities of learners. It is believed that the quality of teaching has a direct impact on learner achievement (Hammond, 2017) and classroom practice is a crucial factor when it comes to successful learner performance. Cawthon *et al*. (2012) indicate that there are several OTL variables,

which may not work independently to give the desired outcome, and these are: teacher preparation, teacher professional development, content, intensity of instruction and technology resources. Cawthon and colleagues found that these factors are very important for the effective teaching of learners with diverse needs. For this reason, they could be used to accommodate learner diversity. OTL takes in to account the following issues: who teaches, who is being taught and the availability of resources. Thus, the researchers found these key variables of OTL useful for teacher preparation, instructional resources, comprising of aspects such as attitudes and in-service professional development (Chabongora & Jita, 2014).

Trimble (2003) affirms that professional development may broaden opportunities to learn. What the teacher knows and takes to the class is of great importance since it tends to be reflected in the learning outcomes achieved. Knowledge and skills about teaching the subject in a classroom setting may not solely be acquired during teacher training, but in-service professional development could as well be useful to assist teachers with the new trends in teaching. During classroom practice teacher-preparedness could be assessed at different levels, either with qualifications, conceived attitudes, or classroom preparation. Professional development could as well be designed in line with the assessment levels. This argument is taken further by Goos (2014) that educators who prepare teachers are very important and should be considered as important initiators of CPD. That is, they have so much to learn to produce good teachers who are entrusted to teach and present many opportunities for a learner in the classroom.

Cawthon *et al*. (2013) takes the argument further that teacher preparation and professional development are guiding tools for the achievement of learning outcomes. They further show that content coverage progresses alongside the activities learners are engaged with, while the intensity of the instruction depends on the time given for learners to deal with this content. Activities in the classroom may be of a different sort, including the integration of information and communication technologies. The use of assistive tools may remove barriers that might prevent learners with differing needs from being able to

function at the same level as their peers (Ahmad, 2015); thus, opening opportunities for meaningful learning.

OTL is also found to be appropriate for interpreting teachers' stories and to enable an understanding of their experiences of teaching Science to HIL. Notably, resources for teaching is the main OTL variable considered when attempting to characterize how teachers teach Science to HIL in regular classrooms. OTL is used to examine teachers' views based on their experiences on how HIL should be taught, as to whether they create or hinder opportunities for HIL in regular classrooms (Tau, McCord & Ryndak, 2017). This variable considers teacher qualification, guidelines for 'education for all', the conditions under which teaching and learning take place and lastly the culture of teaching and learning in the classroom. OTL variables seem to enhance the concept of 'education for all'. Access to educational opportunities may improve achievement. In this regard, the stated variable seems to be appropriate for exploring learning opportunities availed for the teaching of Science to HIL.

However, it has come to Taub, McCord and Ryndak's (2017) realization that most learners with diverse educational needs do not get opportunities to learn, but when given such opportunities they can learn. This shows that when appropriate accommodations are provided for learners with diverse needs learning can take place. One question one would ask is how do teachers know when they have selected a relevant accommodation for learners with educational needs? This has been addressed by Matobako and Jita's (2022) finding that visually impaired learners choose from the pool of opportunities provided by the teacher the ways they found best for them to learn. This implies that teachers have to provide many opportunities, as much as they can to cater for the diverse needs of their learners. This also says that, with diverse educational needs, there is no one size fits all kind of accommodation. It is on this basis that the educational tools used would play a crucial role in providing a pool of opportunities to learn for different learners in a classroom.

2.4.2 Capabilities Framework

A capabilities approach, according to Sen (1992), is used to address well-being and the social issues surrounding individuals. This framework is also used outside the education system to assess the requirements of disabled people for disaster-oriented issues (Villeneuve, Abson, Pertiwi & Moss, 2021). In the education sector, the framework is commonly used when evaluating opportunities for effective learning. The framework also has the potential to assess the quality of education provided to learners with special educational needs (Florian, 2008). The author elaborated this further:

> The education of adults with difficulties in learning has been informed by[1] a series of discourses about disability, difference and social inclusion that determine and support different views of what constitutes well-being and quality of life (Florian, 2008: 1).

With the extract above, the wellbeing of an individual is given priority. With this conception, different ways on how an individual could access education are explored in accordance with their capability. Capabilities are defined as basic needs that one could not do without, such as human rights (Nussbaum, 2011). It is therefore crucial for capabilities to be secured for individuals' wellbeing, hence in education it is considered very important to include all learners regardless of any disability. According to Sen (1992) the focus is on what an individual can do to attain their wellbeing. In the context of this study, teachers in schools are entitled to know and apply different ways that enable HIL to access the information communicated in the classroom. Mitra (2006) reiterates that this instance is displayed when the disability is viewed through a capability's framework, which acknowledges that everyone can achieve when initiatives undertaken are informed by what they can do.

Even though the 'capability approach' does not resemble justice theory, the aspect concerning diversity constitutes the larger portion of it. Sen (1992) opposes the idea that

people could be equally influenced to achieve the same outcomes, instead opines that this could only happen when human diversity is considered. Similarly, ‘education for all’ could see the light of the day when learners’ diverse needs are taken into consideration. This includes teachers’ initiatives to introduce accommodative strategies that are informed by HIL’s needs. Sen’s work inspired many scholars, including educationalists such as Nussbaum and Terzi to adopt this theory, as it suited the context of ‘education for all’, that included learners with disability. Terzi (2010) asserts that people with impairments are not cognitively deficient but could contribute positively to society when given the opportunity to do so. This indicates that effective learning can be achieved by learners with impairments when their needs are addressed. Terzi (2014) and Tau, McCord & Ryndak (2017) reiterate that HIL could do well in school when the focus is not on what they can do instead the learning opportunities that are relevant to their needs. This shows that when appropriate opportunities are provided for HIL to learn, they can learn and achieve like their counterparts. It is on this basis that Robeyns show that everyone should be given a liberty to choose how they can achieve their well being. That is, there has to many opportunities presented for learners to choose how best they can learn and understand concepts. In this manner, learners’ diverse needs can be served.

For further clarification about diversity, Sen made an example of a pregnant woman. He shows that equity is equivalent to the food needed by a pregnant woman comparative to the one who is not pregnant. It is clarified that the food a pregnant woman needs may not be the same as that of a normal woman. Likewise, resources a normal being needs to perform a certain task may not be quantified similarly to that of a person with impairment. With Sen’s conceptualisation of equity, adjustments are made to compensate the one in need to achieve the set goal. This example features well in a diverse classroom setting and suggests that the provision of opportunities should consider individual differences and needs. Based on this, one would expect that teachers would provide different learning opportunities to accommodate the diverse needs of learners.

This argument is taken further by Nausbaum’s (2011) that individuals should not be pushed into such opportunities, instead be considered before any intervention is made.

This may be because the allocation of opportunities without consideration of learner needs may not promote learning as anticipated. Meda (2016) is of the same view that the special needs of learners are different and should be considered accordingly. Capabilities framework does not only consider the availability of resources but goes deeper into assessing whether resources are relevant to the person they are directed at. Taking this into an educational context, it may be said that consultations should be made whenever an intervention is made. For example, Ahmad (2016) shows that the choice of assistive technologies should be in line with learning needs and be accessible to learners.

2.5 Conclusion

Most studies show a need to shift from viewing disability as a deficit to embracing individual differences. This aligns with Article 24 of the CRPD, which depicts education as a right for everyone regardless of their disabilities. It also clarifies the idea that disabled learners need to learn alongside their able-bodied peers, to enhance the concept of diversity within the society. This is the 'education for all' initiative and is considered as an opportunity to attain equality and access to education. For a long time, this has been challenged by barriers, such as physical environment and attitudes within education systems.

Some studies are against the concept of 'education for all' with the view that regular classrooms are not sufficient to meet the educational needs of every learner. These studies propose the resuscitation of special schools with the view that some disabilities are too severe for regular teachers to handle. The proponents of 'education for all' accept this and suggest that it should be introduced with the good will of advancing the academic excellence of all learners. Of course, there are barriers that inhibit its successful implementation. These are a lack of knowledge and skills amongst teachers and a lack of resources. The amalgamation of these factors impacts on the attitudes of teachers who are the agents of change in schools. With the literature reviewed and the stipulated theoretical base, it is worth investigating what teachers understand as the teaching of Science to HIL.

Chapter three: Research design and methodology

3.1 Introduction

This chapter outlines and justifies the research design and methodology that was used to conduct this study on the experiences of Science teachers teaching learners with hearing impairment in secondary schools in Lesotho. The chapter covers the following: the paradigm of the study, research approach and design, the sampling adopted for the study data collection and analysis, credibility, trustworthiness, and ethical considerations. The main research question is: What are Science teachers' experiences of teaching learners with hearing impairment in Lesotho secondary schools? The subsidiary questions are:

a) What teaching approaches do Science teachers employ when teaching learners with hearing impairment in Lesotho secondary schools?
b) What professional development opportunities are available for Science teachers teaching learners with hearing impairment in Lesotho secondary schools?
c) What are the challenges of Science teachers in the teaching of learners with hearing impairment in Lesotho secondary schools?
d) How can teachers' experiences of teaching learners with hearing impairment in Lesotho secondary schools be understood and interpreted?

3.2 Research paradigm

Paradigms are ways that individuals make sense of the world around them and give the basis on which the research could be founded (Davies & Fisher, 2018). The paradigm that was used in this research is interpretivism, which according to Alharahsheh and Pius (2020) enables the researcher to go deeper into the phenomenon under investigation. In this study, teachers' views, and experiences are understood from the place where they happen. Interpretivism is subjective in nature, that is, their knowledge and what they believe is true is informed by their experiences (Ryan, 2018). Researchers also bring their

values and attitudes when trying to understand and interpret the responses of the participants in any phenomenon under discussion. With an intention of understanding the views held by participants and their challenges with the phenomena under discussion, the study was categorized in an interpretive paradigm.

According to Abdulkareem, Ismaila and Jumare (2017), in an interpretive paradigm, reality is not attributed to a single definition and is instead defined differently by different people. Similarly, in the present study, participants were expected to present different experiences on teaching Science to HIL. The same questions were asked but the experiences and challenges participants presented are different. The use of interpretivism is relevant to this study because it enables the experiences of teachers to be sought in their place of work, which is school. Leavy (2017) further reiterates that within this paradigm, realities of this world are socially constructed and are understood in their real-life context. This is consistent with what has been done in this study, since the researcher interviewed teachers at school, where teaching and learning of HIL occurs. The advantage of a real-life context is that it would be easy for a participant to provide evidence in support of their statements whenever the need arises (Wilson & Abibulayeva 2017). There is a reason therefore to believe that situations explained within a real-life context may be better understood, thus increasing the effectiveness of the data interpretation. It is on this basis that transcriptions of the interviews of four teachers are interpreted to understand the views and beliefs of different teachers about Science teaching to HIL.

3.3 Research approach

The study followed a qualitative approach to explore the research questions mentioned earlier this approach allows participants to verbally express their perspectives in relation to the research problem under investigation (Groenland & Dana, 2020). A qualitative approach can be used to study how human beings live and do things in real-life situations (Cleland, 2017). It is also highlighted that people have different interpretations influenced

by their experiences. Hence, a qualitative approach is considered suitable for this current study to come up with different views and beliefs of teachers who are influenced by the experience of teaching Science to HIL.

Groenland and Dana (2020) further indicate that a qualitative approach enables the researcher to be the primary instrument for the collection and interpretation of data. With this, the researcher interacts directly with participants and gives them an opportunity to understand better the concept under discussion. A qualitative research approach also enables data collection and analysis to happen at one time (Busetto, Wick & Gumbinger, 2020). With this, I was able to listen to teachers' stories after every interview and that enabled me to restructure my questions and make a follow-up on their responses. This allowed me to see areas that needed to be worked on, either unclear questions or to see when data saturation had been reached. This can also inform the researcher about making decision on the sample size used (Moser & Korstjens, 2018). Likewise, this enabled me to finally consider including four teachers in this study.

Creswell (2018) reiterates that aqualitative approach is relational and requires the researcher to meet participants in their natural setting. This tends to necessitate a good rapport between the researcher and the participant. This approach enables the researcher to get first - hand information that has not been manipulated by others (Taylor, Bogdan & DeVault, 2016) and for participants to freely divulge the kind of information required. Based on this, the approach used in this study has been found appropriate, to seek deeper into teachers' experiences of teaching Science to HIL. Therefore, trust is requisite for teachers to give honest opinions, views, and their experiences of teaching Science to HIL.

In a similar vein, I went to schools and conducted interviews with selected Science teachers. Interviews were guided by an interview protocol (see appendix A) and participants were further probed on the responses they had provided. The first interview session initiated a good rapport between the participant and the researcher. This enabled

the participant to feel free to provide the information required and to respond to the research questions stipulated. In addition to this, I listened to their responses every time after data collection, and this enabled me to restructure the questions that were not clear for the participants. This also allowed me to identify questions that were not clearly answered but were clarified further in the interview that followed.

On the other hand, a qualitative approach is commonly criticized as being prone to bias because the data is gathered and interpreted by the researcher (Mackieson, Shlonsky & Connolly, 2018). However, Mackieson *et al.* (2018) show that bias can be minimized through the collection of rich data and can be assured by selection of participants relevant to the purpose of the study. To this study, I selected teachers teaching Science to HIL at secondary level. I interviewed them and corroborated their statements with policy documents guiding teaching and learning in schools.

The use of different data sources was to assure trustworthiness of the research (Yin, 2017). This was done with the understanding that different data sources or the development of a research instrument considered the research questions, theoretical framework, and the literature review to assure quality (Yin, 2017). Consideration of this helped me to understand teacher experiences as narrated and to avoid bias. It is along this line that a qualitative approach was found appropriate for understanding and interpreting the experiences of Science teachers teaching hearing-impaired learners. It is on this basis that interviews were not solely used for data collection but were combined with document analysis for the collection of rich data.

3.4 Research design

According to Cohen *et al.* (2018) the research design gives a plan, which the study followed to get to valid findings. The authors Cohen *et al.* (2018) further clarify that the design establishes links between the research questions and how data is collected and analyzed. With this logical flow, the trustworthiness and credibility of the study may be

highly anticipated. Additionally, Yin (2018) is of the view that research design is determined by the nature of the questions and could either be in multiple or single case studies. The design suitable for this study is a case study design as the main research question explores the experiences of teachers teaching Science to HIL. The exploration of this research question demands participants to verbally express themselves and therefore this qualifies the study to be categorized as a case study.

Interview transcripts were gathered to interpret and understand participant experiences of teaching HIL. This was done based on Bearman (2019) clarification that logical interpretation is often attached to 'told' stories which are guided by generative questions. In a similar manner, participants were interviewed and responded verbally to questions that were asked. Their verbal expression was initiated by probing further into their responses thus providing the rich data that enabled the researcher to understand deeply their experiences when teaching Science to HIL. Their verbal expression was also key in data presentation and interpretation, as quotations were given in verbatim and minimized bias.

Case study design is widely used with a qualitative approach and the researcher is the primary interpreter of each case (Yin, 2018). In case studies, data is collected in depth from a real-life situation where participants interact with the researcher. Creswell (2019) adds that a case study enables the researcher to dig deeper into the issues pertaining to the research problem. This may enable the researcher to give a well-understood interpretation of the collected data, enlightened by what is predicted by the theory. The interpretation, however, should be honest and represent the voices of the participants and not of the researcher to attain trustworthiness in the study (Cohen *et al.*, 2018). A case study looks at a certain setting, particular participants, and a specific situation (Creswell, 2017). A case study is ideal for this study since it has one setting (secondary schools), a group of participants (Science teachers) and a specific situation, namely the teaching of Science. This design has been used to enable a deeper understanding of how Science teachers position themselves when teaching Science to HIL.

To take the justification for a case study further, Yin (2018) delineates that there are different case studies that could be used to explore a phenomenon, and these are single case and multiple case studies. A single case study gives in-depth information on one issue while a multiple case study comes about by studying different cases to understand a certain issue. This study is a single case study, as it discusses one case of teacher experience of teaching Science to the hearing-impaired. Therefore, there are four case studies that explain one phenomenon of teacher experiences of teaching Science to HIL. Without any bias I interpreted the experiences of the participants in line with the literature reviewed and the theoretical framework.

3.5 Sampling procedure

Sampling is an essential component in research that determines the credibility of the study (Bhardwaj, 2019). It is always made in line with the research questions and gives the researcher a direction of where data should be taken from (Leavy, 2017). The intention of sampling is to get a representation of the population under study (Leavy, 2017), that is a decision is made on who should take part in the study, including the sample size. This according to Cohen *et al*, (2018) is done with the intention of getting the relevant information that would respond to the stipulated questions. In qualitative studies, a limited number of participants is favoured, as it allows a deeper exploration and understanding of the subject under discussion (Ellis, 2021).

On the other hand, Vasileiou *et al*. (2018) warn that even though the sample size is justified to be small in qualitative sampling, it threatens the trustworthiness of the study and generalizations should not be made. For this study, four teachers were selected with the understanding that four is a good number to get deeper into exploring the subject under study. However, with this limited number, the study could not generalize the findings to all Science teachers teaching Science to HIL.

There are different sampling techniques employed when exploring a research problem including purposive sampling that considers the participants who can best provide rich data (Leavy, 2017). The sampling most often opted for in case studies is purposive sampling and it is done by the researcher before the data collection process to get insightful information in line with what is being investigated (Ellis, 2021). This is regarded as the most convincing sampling technique as the research question, aims and objectives of the study are always in the researcher's mind (Campbell *et al.*, 2020). This gives a good possibility of collecting relevant data and thus improves the trustworthiness of the study. It is therefore important that the characteristics of the participants represent the population under study (Edmonds & Kennedy, 2016).

Again, this kind of sampling provides a deeper understanding of the phenomenon under discussion, since the participants have direct experience of what is being studied (Flick, 2017). With purposive sampling, there are no generalizations but conclusions are only made from the limited choice of participants (Andrade, 2020). Based on the discussion above, I opted for purposive sampling and four Science teachers from four schools with teachers with experience of teaching HIL were selected. This is purposive sampling because participants had to be Science teachers in a secondary school, teaching HIL. These Science teachers have been purposively selected to give insightful information about their experiences of teaching HIL. The selection of four teachers was made on the basis that a qualitative study does not require a large sample size to reach data saturation but should rather provide rich data for deeper understanding of the phenomenon under discussion (Hennink & Kaiser, 2021).

In a similar way I conducted interviews and listened to the teachers' responses and found that data at some point was repeating itself and this was a sign that I had reached data saturation. The site was also selected based on Flick's (2018) elucidation that purposive sampling should provide opportunities for the provision of rich data. Therefore, the places of work (schools) of the participants were used as research sites and this enabled the validatation of information they were not accurate about. For instance, some participants brought the attendance register to give the exact number of HIL in their classroom. This

enabled me to come up with valid and rich data, as the participants were relaxed and responded to questions relevant to the place they were at.

3.6 Data collection process

In qualitative studies, data comes in the form of words and this attribute determines how data should be collected (Rich, Brians, Manheim & Willnat, 2018). Canals (2017) is also of the view that there are different ways to collect data and the appropriate data source is determined by the research question. The main data source used in this study was interviews because the research question aims to investigate the experiences of Science teachers' teaching HIL. Therefore, with the use of interviews, my interest was to have a deeper understanding of these experiences when teaching Science to HIL.

3.6.1 Interviews

The study engaged teachers so that they could tell their experiences of teaching Science to HIL. An interview instrument was chosen to capture their experiences in line with the aforesaid phenomena. According to Yin (2018) interviews are direct conversations intended to provide information on the subject under investigation. Moser and Korstjens (2018) are of the view that interviews enable participants to express themselves based on how they feel, think, and display their attitudes about any question under discussion. Lune and Berg (2017) further state that there are different types of interviews that could be used to collect data. The difference comes with their rigidity. That is, some interviews are closed while others are open, and these determine the kind of information needed to respond to the research questions under study. Semi-structured interviews were chosen to collect data in this study, and they are described in detail below.

3.6.2 Semi-structured interviews

Semi-structured interviews involve a person asking a question with the intention of gathering information without any predetermined answers (Leavy, 2017). They are carried out like a conversation, allowing participants to explain their issues of interest or the ones they feel are important (Roulston & Choi, 2018). That is, it is not a yes or no type of interview and instead participants are allowed to give their own answers. This allows the participant to explain in detail the issue under discussion. It also enables the researcher to probe further and engage in an in-depth discussion (Roulston & Choi, 2018). It is worth noting that even though probes are allowed in semi-structured interviews, questions are developed to enable the researcher to stay focused on the objectives of the study. Understanding the experiences of Science teachers requires a clear explanation about what teachers think it is like to teach Science to HIL. Therefore, with the guidance of an interview protocol (see appendix A) I asked questions and probed where necessary to dig deeper into the information I found relevant for responding to the research questions. Hence, the choice of a semi-structured interview. I recorded their voices as they responded to the questions asked and the audio recordings, as mentioned earlier, were transcribed immediately after the interviews. Interviews took about forty-five to sixty minutes per teacher.

Semi-structured interviews were used together with document analysis. The data from document analysis is basically intended to corroborate the teachers' experiences. The corroboration is done to gain greater insights about their experiences in line with the policy documents used in guiding teaching and learning in schools. This was also intended to understand how schools incorporated HIL in their lessons with consideration of the policies guiding educational practice. Yin (2018) postulates that information should come from different data sources for the study to be more convincing. The use of more than one research instrument is called triangulation and it is advantageous for credibility and trustworthiness of the study (Lune & Berg, 2017). With this explained, this study,

employed semi-structured interviews and document analysis to collect data. Detailed descriptions of the choice of these instruments are given below.

3.6.3 Document analysis

According to Creswell (2017), document analysis is the interpretation of information obtained from documents. The information articulated in documents is without the influence of the researcher and could be repeatedly reviewed to respond to the stipulated research questions (Frey, 2018). One of the advantages of document analysis is that the information presented is often well organized, unlike in situations that deal with raw data (Mackieson, Shlonsky & Connolly 2018). As a result of this, document analysis has shown the potential of improving the rigor of a study.

Sometimes document analysis can be single-handedly used while in other instances it could be coupled with other data collection methods (Frey, 2018). This study has used document analysis to corroborate the statements articulated during the interview session regarding the experiences of Science teachers when teaching HIL. This is in line with Creswell (2019) who states that document analysis could be used with other data collection methods to improve the accuracy of a study.

However, documents may include information that a researcher does not need and there can be a misinterpretation of the information, because the original intention of the messages presented is not known (Yin, 2018). This weakness does not refute the importance of using document analysis and I selected and looked carefully into the information that is relevant for answering the research question. The following are the documents reviewed: the junior secondary Science syllabus, the Curriculum and Assessment Policy (CAP), Lesotho Inclusive Education Policy (LIEP) and Lesotho Education Language Policy (LELP). The criterion for the selection is as follows: the first two documents guide the teaching and learning of Science and were used to corroborate

the views and beliefs of teachers about teaching Science to HIL. The other two documents were helpful in identifying how teachers created learning opportunities for HIL. Analysis was done in the form of a 'thick description' where the aims and objectives, the suggested teaching approaches and the assessment of learners are identified and understood.

3.6.4 Data analysis processes

There is a simultaneous operation between data collection and data analysis, that means continuing with data collection while also transcribing (Edmonds & Kennedy, 2016). The researcher goes through the data collected and gradually makes sense of it, followed by a continuous analysis and interpretation of the data (Cleland, 2017). This process is considered pertinent for the refinement of the interview questions with the purpose of gathering 'rich and thick' data. I listened to participant's responses every time after the interview and transcribed them. This enabled me to restructure questions for the second interview.

In this study content analysis has been used to analyze the data collected. Roller (2019) defines content analysis as an analytical method that can be used in a qualitative study to interpret data with reference to the context. According to Rich *et al*. (2018), content analysis is used by researchers to respond to research questions by working on common data sources, which include texts and written documents. This method provides new insight into the phenomena under study.

There are two types of content analysis that are established based on the development of themes. The first one is inductive content analysis that entails the use of themes in the data which is reduced and categorized to respond to the questions of the study (Kyngäs, 2020). This method relies more on the data; hence the researcher must frequently go back to the original data to ensure that it is similar to newly developed inductive codes (Johnson & Christensen, 2014). This may control the possible bias by the researcher, since categories are solely derived from the perspectives of the participants, thereby

increasing the validity of the study. In a similar way, I went through the transcriptions of the interviews and categorized the data in line with the stipulated research questions. Inductive analysis was done in a manner where the researcher first listened to an interview to become familiar with the data collected. This enabled the researcher to evaluate how effective were the questions that were asked, to elicit 'rich and thick' data that might be relevant to the research questions. The researcher transcribed what was on the tape, read through data, coded the text, grouped data into codes and lastly interpreted the codes that were constructed. This procedure aligns to Busetto *et al.'s* (2020) explanation that analysis starts from transcribing verbatim the recorded data that may come through either interviews or focus groups for coding.

The second kind of analysis I used was deductive analysis, which according to Creswell and Poth (2017) refers to the situation where themes are formed and checked against the raw data. Similarly, I developed themes in accordance with the research questions and checked them in line with the raw data. The literature review was used to understand the experiences of the teachers and how they opened opportunities to learn for HIL while teaching Science to all the learners. The study employed these two types of content analysis for a better understanding of how teachers experience the teaching of Science to HIL. This, according to Cohen *et al.*, (2018) is called an inductive-deductive approach.

3.7 Trustworthiness of the study

According to Creswell (2019) the quality of the study can be determined by the steps undertaken to assure it's trustworthiness. There are different ways to account for the trustworthiness of a study and these include the use of relevant literature to support the justification for the methodological orientation followed in the study (Noble & Heale, 2019). In this study, trustworthiness was ensured by triangulation, member checking and memos.

3.7.1 Triangulation

Triangulation is one of the ways of improving trustworthiness and is enacted by using various data sources or theories with the intention of obtaining credibility (Creswell, 2019). This includes the use of several data collection methods, which may include observations and interviews. The use of different data collection methods tends to provide richer information for a better understanding and the corroboration of the interpretations, and this controls any possible bias by the researcher (Bans-Akutey & Tiimub, 2021). Another way that the validity could be ensured is using theories that can be used to analyze, interpret, and validate the findings of the study (Noble & Healer, 2019). This study employed a triangulation method whereby teacher interviews and document analysis were used. As previously mentioned, document analysis was not the main data collection method, but was used to corroborate the statements Science teachers made.

3.7.2 Member checking

With member checking, data or results are taken back to participants for verification or validation (Creswell & Poth, 2017). Member checking may reduce any bias in the study since the researcher is both the data collector and the analyst. This may also give participants a chance to clarify or enrich the information they have given. In some cases, participants may even delete information that they initially provided, meaning that this process enables participants to reassess and modify their statements. Ultimately, member checking may improve the credibility and trustworthiness of the data and thereby initiate effective interpretation of the results (Creswell, 2019). In this study, interview transcripts were given back to participants for modification and confirmation. This enabled participants to clarify unclear concepts and to elaborate on issues found not to be clear. Apart from this, I found member checks important for validating the points made by the participants that were found not convincing enough to write about. When participants repeated these ideas and clarified them it gave consistency and made me realise that the idea expressed was not a mistake.

3.7.3 Memos

Making memos, according to Edmonds and Kennedy (2016), is the writing of notes by the researcher about what is learnt in the field and helps with how the data is conveyed during the analysis. This act assists the researcher to remember important ideas that could be useful in data interpretation or how ideas connect. When interviewing teachers, I also had a pen and paper to write down points that I found important. I found the ideas useful when transcribing and they made data more meaningful. Also in analysis, I went through the all the data and jotted down ideas and concerns that I found intriguing. The notes were important for reminding me of the contextual realities and kept me focused on what the data said to me.

3.7.4 Ethical considerations

Most case studies involve human beings, and it is appropriate for ethical issues to be considered and to protect participants from any form of harm (Yin, 2018). In a similar vein, in this study, teachers were the main research participants and protecting their identity is important and so pseudonyms were used. The researcher sought ethical clearance from the University of the Free State to grant permission for conducting research involving teachers. The researcher sought ethical clearance from the University of the Free State to grant permission for conducting research involving human beings. The researcher as well asked for permission from relevant authorities including Regional Inspectors (see appendix C), school principals (see appendix D) and Science teachers at the targeted schools (see appendix E). In the letters, the participants were made aware that taking part in this study is voluntary and they can withdraw at any time. The participants filled in consent forms as an agreement to take part in this study. The researcher informed the participants that the information gathered through interviews would only be used for research purposes and would remain confidential.

Chapter four: Data presentation, analysis, and interpretation of the findings

4.1 Introduction

This chapter presents the analysis of the data collected to seek answers to the main research question that investigates Science teachers' experiences of teaching learners with hearing impairment in Lesotho secondary schools. What are the experiences of Science teachers when they teach learners with hearing-impairment in Lesotho secondary schools? The subsidiary questions are:

a) What teaching approaches do Science teachers employ when teaching learners with impairment in Lesotho secondary schools?
b) What professional development opportunities are available for Science teachers, teaching learners with hearing impairment in Lesotho secondary schools?
c) What are the challenges of Science teachers in the teaching of learners with hearing impairment in Lesotho secondary schools?
d) How can teachers' experiences of teaching learners with hearing impairment in Lesotho secondary schools be understood and interpreted?

The teachers are named using pseudonyms to ensure anonymity and to protect them. The main data sources are the stories of four Science teachers. These stories are corroborated by documents that guide the teaching and learning of Science to all learners, including learners with hearing impairment (HIL). Data is analysed using content analysis. The data presentation is in two sections, the first one focuses on documents and the last one is on teacher interviews.

4.2 Section A - Document Analysis

This section provides an analysis of the policy guidelines regulating teaching and learning in the Lesotho education system. These documents are the junior secondary Science

syllabus, Curriculum and Assessment Policy (CAP), Lesotho Inclusive Education Policy (LIEP) and Lesotho Education Language Policy (LELP). The criterion for selecting these documents is as follows: the first two documents guide the teaching and learning of Science and since this study focuses on how teachers experience the teaching of Science to HIL, the other documents were helpful to understand how teachers create learning opportunities for these learners. Analysis is done in the form of a 'thick description' where a clear articulation of how the aims and objectives, the suggested teaching approaches and assessment stipulated are seen and understood.

4.2.1 Aims and objectives of the documents.

The Curriculum and Assessment Policy (CAP) of 2009 was developed after the realisation that the focus of Lesotho's education system was to enable access by increasing the enrolment of learners. Other important factors, such as how learners access knowledge, were not taken into consideration. This led to the favouring of intellectually capable learners. The challenge is captured in CAP as follows:

> …[T]he issue of access has often been limited to the presence of learners in large numbers in schools forgetting other aspects such as access to educational content, thereby catering for only those few that are intellectually capable (MoET, 2009: i).

This implies that some learners were left behind, yet the provision of quality and the relevant education is a need for all Basotho people (MoET, 2009). To address this challenge, CAP redefined the issue of access and considered access to content as pertinent to define quality, relevance, and equity. Here is how it is explained in the policy: "This policy therefore takes all these issues further by defining the concepts of quality, relevance, equity and access in relation to education content" (MoET, 2009: i).

Equity and access are two important aspects relevant to the problem statement of this study, which argues that HIL aren't well represented in Science related careers, yet Science is for all learners. This may be because of problems in the pedagogy,

assessment and how HIL are taught. In the same notion, CAP finds a connection between curriculum and assessment needed to improve the quality of teaching and learning in schools. CAP also considers the development of relevant competences can enable a learner to deal with existing challenges. Learners are expected to develop core competences at different levels of education which include: “scientific, technological and creative skills”, “effective and functional communication”, “collaboration and co-operation”, “problem solving and critical thinking” (MoET, 2009: 20). These competences are essential to enable learners to contribute positively to the development of their country.

4.2.1 Aims and objectives of the syllabus.

The syllabus provides detailed information about how learners can develop Science related competences. The Science syllabus seems to have similar aims and objectives to CAP, as it states:

> The purpose of the Science curriculum is to enable learners to acquire knowledge, skills and attitudes in Science and technology that would enhance permanent and functional literacy and numeracy for continuous learning and effective participation in social issues and activities (Ministry of Education, 2002: 1).

The above extract implies that Science-literate learners should be able to contribute towards problem solving in the community. It also shows that it is not content alone that is essential in Science learning. Values and attitudes are considered equally important, and they are required to develop scientific and technological competence amongst learners. Clearly, having access to this competence can enable learners to actively participate in social issues and to contribute positively towards the economic growth of the country.

The junior secondary syllabus is designed in such a way that it can provide learners with basic scientific skills that cater for their diverse needs in terms of their different aspirations. The syllabus considers that there are “learners who will be leaving school after Form C,

as well as those who will be proceeding to senior secondary education, either specialising in Science or not" (MoE, 2002). It also empowers those who intend to pursue Science related careers. This document considers the diverse needs of learners, but only to a limited extent, as it only talks about their choices after completion of form C and does not focus on different ways of learning concerning their capabilities.

The Lesotho Inclusive Education Policy (LIEP) (MoET, 2009; 2018) seems to bridge the existing gap. LIEP's mandate is to ensure an enabling environment for increased participation of learners with special educational needs (LSEN) in the education system (MoET, 2018). The extract below gives a clear description:

> The policy is aimed at ensuring that all LSEN shall participate in the Lesotho school system that prepares them to function and live independently in the society and contribute in both social and economic development (p. 6).

The policy is cognisant that access to quality education is not only achieved by opening doors for learners with special needs, but the environment should as well allow for LSEN to participate fully in school activities. With this, it is believed that LSEN can live their lives to their full potential; being able to contribute to solving both economic and societal problems.

LIEP indicates that the placement of learners with special educational needs (LSEN) in schools without provision of learning opportunities compromises their access to education. In response to this, LIEP aimed at establishing an appropriate teaching and learning environment that caters for LSEN.

> Operationalisation of LIEP requires a conducive teaching and learning environment that can allow learners to access quality education, as such MoET shall [amongst others] establish guidelines for the provision of reasonable accommodation for learners (p. 13).

It is also realised that LSEN should learn along with their counterparts so that they can acquire the social skills required for active participation in the community (MoET, 2018). It states “LIEP outlines guidelines geared towards the provision of high-quality education to LSEN in a common learning environment with their peers”. Achievement of this may contribute to the attainment of a collaboration and cooperation competence, observed as one of the core competences outlined in the CAP (MoET, 2009). Effective and functional communication is the requirement for the development of collaboration and cooperation competence. This can be facilitated through the language understood by learners with diverse needs, including those with hearing impairment.

The development of collaboration and cooperation competence depends on whether learners acquired an effective and functional communication skill. Language diversity is yet another factor that hinders access to quality education. Lesotho Education Language Policy (LELP) takes consideration of language as a medium of instruction. LELP provides policy direction “for the treatment of language issues in the Lesotho education context in order to improve language and literacy competencies” (MoET, 2019: 20). The main purpose of improving language policy is also to promote access to education. LELP also “aims at equal access to education for all Basotho […] in order that they acquire the knowledge and relevant skills to promote sustainable development”. Where a HIL is involved, sign language can be an appropriate mode of communication that can enhance access to knowledge and relevant skills. When effectively used, it has the potential to meet HIL’s language needs (MoET, 2019).

Similarly, the Science syllabus finds it prudent for learners to develop “skills and attitudes in Science that would enhance permanent and functional literacy” (MoET, 2001: 1). Science has its own universal language that requires a mode of communication between the teacher and learners or amongst learners themselves. This indicates that language is required for the communication and the effective teaching of scientific concepts. Having discussed the objectives of the documents above, it is now essential to focus on how these documents propose ways of helping learners develop scientific skills and acquire the content knowledge.

4.2.2 Teaching approaches suggested in the documents.

Both CAP and the Science syllabus encourage the use of a learner-centred approach. Learner-centeredness explained in CAP says: “Learners should assume greater responsibility for their own learning process” (MoET, 2009: viii). This approach seems to call for responsible learners who own their work and do not entirely rely on their teachers for learning. With this approach, learners should be able to identify and solve problems. CAP further states:

> The new trend should be a move from teaching to facilitating learning; from transfer of facts to student construction of knowledge; from memorization of information to analysis, synthesis, evaluation and application of information; from knowledge acquisition to development of knowledge, skills, values and attitudes; from categorized knowledge (traditional subjects) to integrated knowledge (broader learning areas) from didactic teaching to participatory activity-centred and interactive methodologies. (MoET, 2009: viii)

CAP appears to discourage rote learning but rather appreciates knowledge construction with the assistance of the teacher. This approach seems to advocate for the active involvement of the learner. It is extended in this way: “Pedagogy must shift more towards methods that can develop creativity, independence and survival skills of learners” (MoET, 2009: Viii). Acquisition of life changing skills to solve real-life issues seems to enrich the justification for the use of this approach. Creativity is one of the skills essential in the 21st century and this goes along with developing the skills and attitudes of the learners. This acknowledges the importance of three cognitive domains of learning that contribute to a holistic development of learners.

On the other hand, the syllabus indicates that learner-centred teaching approaches should include hands-on activities and the building of new concepts in existing knowledge. It is also shown that practical work is essential for effective teaching and

learning of Science in school. The suggested approaches to the teaching of the syllabus is explained below:

> It is intended that in teaching this syllabus, learner-centred approaches and methods should be used. These include among others: practical through experiments, inquiry through investigations, projects involving analysis. It is also important to realise that students come to school with a certain knowledge of Science, which should not be ignored but improved upon. (MoET, 2002).

This syllabus seems to be inclined towards constructivism that claims that knowledge is constructed in the minds of the learner, hence the syllabus considers it important to engage learners in learning. That is learners should not be considered as passive receivers of information in a classroom. It also considers that learners are not empty vessels to be filled by the knowledge communicated by teachers in schools, therefore what they know must be established. This says that what a learner knows should be considered as something that promotes learning (Kitta & Tilya, 2018).

The Lesotho Inclusive Education Policy (LIEP) is also of the same view that teaching approaches should be improved in line with learners' abilities. LIEP advocates for the modification of curricula, as well as teaching strategies, by engaging theories of learning that support learner-centred, Universal Design for Learning and differentiated approaches giving priority to the use of an Individualised Educational Programme (IEP). It further highlights that effective inclusion can only be realised "when all learners have access to curricula content conveyed in an appropriate mode of instruction" (MoET, 2018: 15). It also considers the provision of instructional resources in accessible formats to achieve effective teaching and learning. This is how these are stipulated in the objectives:

> MoET shall: ensure adaptation and modification of the curriculum and teaching approaches to cater for diverse educational needs of learners at all levels of learning; […] provide appropriate instructional material and

> learning resources in accessible formats depending on individual needs in order to ensure effective inclusion (MoET, 2018:).

The above extract implies that when learners are taught, their opportunities to learn may be widened by the provision of learning aids that are based on their needs. It becomes apparent that effective teaching should as well consider the use of teaching aids. LELP highlights the issue of instructional and learning modes as follows: “LELP shall offer a variety of instructional and learning modes relevant to learner needs” (MoET, 2019: 21). This indicates that learning styles should be customised to learner needs, thus increase access to education as stated below:

> Openness of access to education and freedom of selection or choice of language of study by all Basotho youth inclusive of those from minority language backgrounds through inclusion of Sign language as their mother tongue and additional choice for them in the curriculum (MoET, 2019:).

Unlike the conditions that prevailed when data was collected in schools, the policy intends to remove communication barriers hindering access to education especially for learners with hearing-impairment. It considers Sesotho as not a mother tongue for all learners including HIL who are the focus of this study. The policy also directs that Sign language might be the best learning mode addressing their needs.

4.2.3 Assessment

CAP clarifies that “assessment should be used to improve teaching and learning” (MoET, 2009). That is assessment should benefit both the teacher and the learner through informing them how and where to improve. Not only is continuous assessment (CASS) intended to follow a learner’s progress, but it will be used to inform the teacher about remedial efforts.

> Formative assessment, continuous assessment (CASS) will be used in schools at all levels of education to check the learning progress. It will be used by teachers for a diagnostic of learning difficulties to identify areas requiring attention. […] assessment will be in the form of examinations that are used for selection of learners for higher education levels […] both group and subject examinations will be available for candidates of different abilities and circumstances (MoET, 2009:23).

Summative assessment is proposed to be in pen and paper examinations that identify learner readiness for institutions of higher learning. This indicates that assessment will be used for a selection of learners who seem to be ready for tertiary learning. This is an important aspect of teaching and learning that identifies the depth of knowledge amongst learners. Hence it is indicated that it should be done in a manner that accommodates learners with diverse abilities.

The syllabus briefly indicates that assessment should be daily. It also shows that summative assessment should be carried out at the end of the Grade. This is how it is presented:

> In addition to assessment techniques employed daily throughout the course, the main ones to be used at the end of each level (year) and at the end of the course will be paper and pencil examinations. Techniques to be employed should cater for knowledge and skills at different levels of cognition (MoET, 2002).

The above extract seems to give the teacher the liberty to employ different assessment strategies daily but confines the end of level examination to a ‘paper and pencil’ examination. LIEP is cognisant that assessment modes are standardised and are generally administered traditionally, which limits the participation of some LSEN (MoET, 2018). Even though this policy acknowledges some provisions made during national examinations, for example, sign language interpreters, it still contends that assessment should be modified to cater for the needs of learners with disabilities. It states, “it shall

modify assessment criteria by appropriate representations to meet individual learners' needs". This suggests the provision of support materials essential for learners with special education needs. LELP is of the same view that assessment should consider learners' needs and that "it shall enable provisions for assessment strategies that are sensitive of students with disabilities and children in vulnerable situations." This indicates that assessment should be customised to learners' capabilities.

4.2.4 Summary of document analysis

Access to education is the focus of all the documents reviewed. Teaching approach appears to be imperative when considering widening learner opportunities and should be inclined towards learner-centeredness. Assessment is also intended to track progress and modified when the need arises. One would believe that understanding what these guiding documents entail may assist the researcher in interpreting the teachers' experiences. Teaching learners with diverse needs depends on professional development opportunities provided for teachers. However, this issue is silent in both the Science syllabus and CAP while it is explicitly explained in LIEP and LELP. It is indicated that teachers should be empowered so that they can be able to handle the educational needs of learners with disabilities. The table below gives a summary of how the analysis of the documents has been carried out.

Table 4.1 Summary of documents analysis

Document	Aims and objectives	Teaching approaches	ICT	Assessment	Professional development
Curriculum and assessment Policy	Improve access to quality education. Learners should acquire scientific concepts	Learner-centred. English as medium of instruction	The acquisition and understanding of scientific and technological concepts, principles and processes for socio-economic development.	Formative assessment to check the learning progress	Not mentioned
Syllabus	Learners should acquire scientific knowledge, skills and attitudes to solve problems and interact with the environment	Learner-centred	Learners identify and interpret the influence of technology on socio-economic aspects of life.	Paper and pencil examination	Not mentioned
Lesotho Inclusive education policy	Improve teaching and learning of LSEN	Learner-centred. Use appropriate mode of instruction.	The use of ICT in inclusive education is key to effective and efficient implementation of the policy.	Modified assessment	Teachers should be empowered with requisite skills to help them identify learners' needs and accommodate them.
Language Policy	Gives direction on how sign language could be used in both teaching and learning.	Instructional and learning modes relevant to learner needs.	Not mentioned	Assessment relevant to learner needs.	In-service and pre-service training are recommended.

4.3 Section B - Teachers' experiences

This section presents data gathered from teachers in the form of structured interviews. There are four cases analysed in this section. The data is presented in themes that are intended to answer the three sub-questions. This is summarised in the table below.

Table 4.2 A summary of themes

Research Questions	Themes
a) What teaching approaches do Science teachers employ when teaching learners with impairment in Lesotho secondary schools	Personal background
	Teaching of Science to HIL
	Teaching approaches to Science teaching
b) What are the challenges of Science teachers in the teaching of learners with hearing-impairment in Lesotho secondary schools?	Challenges of teaching HIL
c) What professional development opportunities are available for Science teachers teaching learners with hearing impairment in Lesotho secondary schools?	Teacher professional opportunities

4.3.1 Case study 1: Mr. Thuto

4.3.1.1 Personal background

At the time of data collection, Mr Thuto was teaching at one of the government schools located in Maseru. This is the same school where he obtained his Cambridge O-level Secondary Certificate (High school certificate). Thuto had ten-years of teaching experience. He was responsible for teaching Science; particularly Physics, as well as Mathematics in all the five grades (A, B, C, D and E). It is worth noting that Physics is a contributory subject to integrated Science at secondary level. When Thuto was first employed in this school, he held a Bachelor of Science majoring in Physics and Computer Science. He further pursued a Post Graduate Diploma in Education (PGDE), which he obtained a few years later. When asked about his experience, he explained:

> I did my BSc general and completed in 2009 […] majored with Physics and Computer Science. Later on, in the same year, I was hired here to teach Science because they had a shortage of Science teachers. A few years later, I went on to do PGDE while still teaching. […] I have been teaching in this school for ten years. Here I teach Science and Maths.

It is evident that Thuto was not a qualified teacher in his first appointment since he had only studied Physics and Computer Science. However, the shortage of Science teachers compelled the school to employ him as one of their teaching staff. His enrolment into PGDE incited my curiosity and the wish to understand what influenced him to join the teaching profession. He stated that the enjoyment he had while teaching and assisting learners struggling with Mathematics triggered him to join the teaching profession. He clarified:

> The moment I started teaching, there were a few things I found enjoyable in helping students. There are so many problems that students encounter. […] Since I am good at Mathematics and Science, I found it nice to help children that struggle in those subjects. So, I thought, why not study further and be a qualified teacher?

Mr Thuto continued and highlighted that Mathematics and Science were his favourite subjects in high school and he also performed well in them. He said:

> Mathematics and Physics were my favourite subjects while I was at high school level because they were the ones, I had the best grades in. I enjoyed doing Science and Maths.

It was evident that Science is one of the challenging subjects in this school and Thuto seemed to be willing to improve learners' performance in the subject. It appears that assisting struggling learners in these subjects made Thuto see teaching as an exciting profession to pursue. When he decided to pursue PGDE, Thuto realised that he lacked the requisite teaching skills that would enable learners to learn Science more effectively. Thuto's story portrays him as not only a qualified teacher but also having good intentions of bringing change to learner performance, with the optimistic objective of teaching Science.

4.3.1.2 Teaching of Science

It was important to first understand teacher's experiences of the teaching of Science in general before I could narrow down the discussion and get their experiences of teaching this subject to hearing-impaired learners. I asked Thuto to explain how Science is taught in his class. He revealed that the teaching of Science demands the use of experiments, as it provides an opportunity for learners to see what is being discussed, thus enhancing their understanding. He clarified:

> Helping students with Science, you have to use experiments. […] I found that it is easier for them to grasp the concepts when they see things happening as opposed to when they listen. Hence, I have to prepare many experiments for such lessons.

Mr Thuto's teaching goal is for every learner to understand scientific concepts, thus he considered the use of experiments as effective for everyone. He also regarded the use of experiments appropriate to link scientific facts with real-life situations. This is how he explains:

> Because I really need to deliver content to learners and make sure that they understand what they have been taught, I use practicals and relate what learners have been taught to real-life situations.

It is evident that Mr Thuto taught Science in a manner that learners could establish a link between scientific facts and real-life situations. Mr Thuto's approach of teaching is congruent with the Science syllabus prescription that a learner-centred approach through experiments should be used when teaching Science. With this approach, learners engage their observation skills to understand a scientific concept. Besides this, it is an inquiry-approach highly encouraged to equip learners with higher order thinking skills essential for good achievement in Science.

Mr Thuto further indicated how he is impressed with the way the learners interact and ask questions, as this assists with understanding the issues being taught. He elaborated this point further and noted that in the teaching of Science, learners' understanding of questions raised in class is very important. He stated:

> Normally, if a learner asks a question, I want another learner to understand what has been said. I will try and rephrase and use simple English. So I will say it in the way the learner is trying to ask the question but in simple English, or even try to translate it into Sesotho.

It is evident that Mr Thuto gives his lessons in English as CAP 2009 directs that English should be used as the medium of instruction; except in lower Grades (MoET, 2009). The above extract also indicates that learners often ask questions, which owing to language difficulties may not be well understood by others in the class. Mr Thuto seems to have realised that language could be a barrier for learning and responded positively to learner language needs using Sesotho and simpler English to clarify the questions. This was not surprising as LELP states that language plays a vital role in accommodating learners in the classroom (MoET, 2019). Thuto further reaffirmed that he used code-switching for the learners to understand.

> You see, while it is important that we teach and use those terms in English language, I also notice that my learners sometimes struggle to understand me, so I …I then combine with Sesotho here and there so that learners can understand exactly what I am trying to say.

The extract above reiterates Mr Thuto's initiative to code-switch so that all learners can understand what he is saying in the classroom. Apparently, the use of code-switching in Mr Thuto classroom is to maximise the opportunities to learn.

4.3.1.3 Teaching Science to hearing-impaired learners

The focus of this study was to explore, in detail, the experiences of Science teachers when teaching learners with HIL. It was therefore important to listen to the views of the participating teachers and how they understand teaching Science to learners with learning impediments. First, I wanted to find out if Thuto had any general contact with hearing-impaired individuals. He, however, explained that he had not previously been in contact with hearing-impaired individuals: “Not at any point had I ever met people with a disability; particularly hearing-impaired … such as some of my learners. Not at all do I remember meeting such people.” This quotation indicates that it was Mr Thuto’s first time to meet a hearing-impaired individual in his Science classroom. This suggests that he might not be familiar with how he could assist hearing-impaired individuals. According to Thuto, the hearing-impaired condition of a learner in his class is that of being hard of hearing. The total number of learners in his class is forty-five. Mr Thuto enlightens:

> This student has a hard of hearing impairment and is in a class of about 45 other learners. The tool they use is meant to assist them with hearing. The problem is that despite the hearing aid tools he still struggles to hear and cannot speak at all.

In the conversation with Thuto, I wanted to understand his experience of teaching Science to a HIL who cannot talk at all even though CAP and LELP show that language is a medium of instruction.

> In the beginning, to be honest, it was very difficult because I had to think deeply about how I am going to help these learners so that they can get the same understanding as others even though they have a hearing impediment… I therefore find ways to bring in different teaching strategies that would accommodate all the learners including the one with hearing impairment.

The extract above reveals Mr Thuto's view that teaching HIL was not an easy task, but he seemed to have explored different ways of helping these learners to develop the same understanding as other learners without impairments. This agrees with the LIEP statement that notes that different teaching approaches should be employed to accommodate learners with special needs (MoET, 2018). Mr Thuto's willingness to explore different ways to help the HIL understand the content is aligned with a CAP 2009 aspiration that education should be accessible to all learners. I was further interested in finding out specifically how he does this and what approaches he uses in ensuring that even that a learner with a hearing impediment is not left behind in the teaching and learning of Science. Mr Thuto continued and showed that the engagement of HIL in learning should start from the lesson plan. This is how he explained it:

> If you have a learner in the class who cannot hear or talk, you should be able to incorporate such a learner in your preparation… You must make sure that in your lesson plan you consider such a learner. So, you don't only include him when you teach, it's important that you make plan on how to accommodate him.

Mr Thuto seems to believe that a HIL can adequately access Science concepts when lesson plans are prepared in a way that includes them. This is supported by LIEP that a universal design for learning should be used where information is presented in different formats that accommodate learners with diverse needs. Mr Thuto' s practices seem to be in line with the above principle that all the learners should not only be accommodated in the teaching and learning, but also at the planning stage. Thuto took the discussion further and indicated that amongst the many strategies he uses are experiments. He further shows that experiments enabled the HIL to comprehend the Physics concepts. He provided the following explanation:

> With experiments, it becomes easier for these learners to understand as they can see and touch. Even when you give them a test, a quiz or classwork, you will find that they perform better in the task when we had done experiments.

From the conversation with Mr Thuto, assessment feedback has proven to him that the HIL performed satisfactorily in the concepts taught through experiments. This implies that Mr Thuto considered the use of experiments as relatively effective for teaching HIL. It also becomes evident that Thuto uses formative assessment to diagnose learners' understanding, as stipulated by CAP that it should be a tool used to identify learners who needs assistance. Even though the use of experiments seemed to be helpful for HIL, Thuto postulated that they are often time consuming.

> You may find that, to be honest, doing a lot of experiments requires a lot of time. When I prepare for an experiment for the students especially those who are in the same class with the learner with hearing impairment, I really need so much time to prepare. This just means you really have to go the extra mile; you have to do a lot of preparation in terms of how you are going to deliver that content so that such learners are fully accommodated.

The extract above reveals that there is a difference in terms of the time and effort Mr Thuto needs when teaching a class that includes HIL. He stated that teaching a class with a HIL needs a lot of time for preparation. The implication of this is that even though experiments promote learning, they cannot be used daily due to limited time for curriculum coverage. He took the discussion further and indicated that HIL also take a longer time to understand the concepts.

> Sometimes as I explain other terms, scientific terms for example, explaining curriculum content, you may find that they take a longer time to understand compared to others due to their hearing-impairment.

It was evident that, according to Mr Thuto, the HIL is slow when compared to his classmates. This agrees with M'mbijiwe *et al*. (2018) observation that HIL are present at school but lag behind their counterparts. I was also interested in finding out what other approaches Thuto uses to teach HIL. Thuto indicated that he makes use of peer teaching. He does this by relying on students who sit next to a HIL in the classroom to

clarify the concepts for them. Mr Thuto said: “I also benefited from this set up”, as he clarified:

> One other strategy is to make use of the other learners with no hearing-impairment. I use them … these students to explain some of the things for this HIL, you see, I observed that besides the fact that they sit next to each other, they play, socialise and they end up knowing and understanding them better. Hence in the class, I decided that they sit next to him. I normally wait for them to explain while I am there, so that they communicate what I wanted to communicate. So I try to get from these students, ‘when he is saying this, what does it mean to you?’ So they tell me, ‘he does not understand you when saying this and that’.

The extract above shows that Mr Thuto created an environment that would facilitate communication for effective learning. This is peer-assisted learning and seems to work best for Thuto when dealing with the HIL’s inability to speak. Besides this, they benefit from assisting him as they teach in the presence of their teacher and can be corrected before communicating incorrect information to Tsebo. It is somehow an indirect assessment of what they have understood in class. Again, allowing learners to work together harnesses the collaboration and cooperation skill that is postulated by CAP as the competence that should be instilled in learners so that they can be able to solve real-life challenges. Mr Thuto realised that HIL need special attention for them to understand Science concepts. In his class, he also attends to and puts more focus on these students while the rest of the learners continue to work in groups. Sometimes the assistance would be extended into break sessions to clarify concepts that might have been missed in class. He stated:

> I normally put more focus on them individually to talk about what we did especially when the rest of the students are busy working in groups. This I do simply because I noticed that they need special attention…you know, sometimes I just need to help them during break time or even a few minutes of their lunch time.

Mr Thuto seems to practice differentiated support, where a learner is attended to on his/her own, given remedial classes and taught according to his/her pace. This is, as well, in line with aspects of the capability's framework, which state that when an intervention is made, the diverse needs of individuals should be taken into consideration. This also agrees with the LIEP prescription that learners with educational needs should be supported in different ways including differentiated teaching approaches that allow learners to learn according to their pace.

In the conversation with Thuto, I wanted to find out his beliefs about HIL. Thuto concluded that even HIL could study Science and find a career in Science, regardless of their impediments. He clarified:

> I think hearing-impaired learners can still be teachers, work in the laboratory and help other students with similar disabilities; even those who don't have such disabilities. They can literally become whoever they want to be as long as they are provided with relevant and necessary support.

We see that Mr Thuto's belief is that HIL can do anything any normal learner can do. This is congruent with Atika *et al.* (2018) view that it is not that HIL are cognitively incapable of acquiring scientific concepts, but ineffective teaching approaches can contribute massively to their learning problems. Thuto's intentions are also in agreement with the curriculum and assessment policy, which states that all learners should access knowledge at school regardless of their disabilities.

4.3.1.4 Challenges of teaching Science to hearing-impaired learners

If it is so difficult for normal learners to do well in the Sciences, how much more difficult must it be for HIL? With this predicament in mind, it was rather intrigued to find out from the participating teachers the challenges they encounter in the teaching and learning of HIL. Mr Thuto mentioned limited time for teaching and communication as a barrier and two of the main challenges he encountered when teaching HIL. He posited that it takes a

lot of time to cover the syllabus in a class with HIL compared to any other class. He affirmed that a lot of time is needed in classes with HIL, yet time allocation for lessons is the same for all classes.

> You may find that in classes with HIL, I am a little bit behind comparatively in terms of the coverage of syllabus materials. But it is not possible to help during the lesson because we are allocated the same period as the other classes. So you will find that the same experiment I have to do takes double the time in a class with HIL compared to what I did in the rest of the classes. So it takes time.

From this assertion, it is clear that, with the teaching of a HIL content coverage takes a lot of time, as even the experiments must be done twice compared to another class with no HIL. This may result in learners not being able to complete the syllabus. Thuto further alluded to the fact that a HIL's inability to speak and hear creates a communication barrier. It became difficult for Mr Thuto to identify concepts that were not clearly understood by this learner, as he explained:

> Sometimes when I ask a question, you may find that I don't get clearly what he is trying to say. So, when that happens, I am not really sure whether he understands or not. This is really a huge challenge for me.

It becomes evident from this extract that Mr Thuto assesses learners while teaching, as indicated by CAP that the progress of learners must be diagnosed while teaching to inform the teacher about learner achievement. However, due to a HIL's inability to speak, Thuto seems not to benefit much from assessment. With this challenge, Mr Thuto may not be able to tell what the HIL has or has not understood. Additionally, Mr Thuto clarified that hearing-impairment affected teaching and learning as HIL acquire concepts slowly compared to their counterparts:

> Sometimes as I explain scientific terms and other curriculum content, you may find that they do not understand as quickly as others due to their

> hearing-impairment. Look, he has a disability, I try all I can to avoid asking him questions that would make him explain certain things to the whole class. I noticed that if I ask him a question in class, it doesn't sit well with him and he looks embarrassed or shy.

The HIL's inability to speak compels Thuto to avoid asking questions that require an explanation. Such a decision was made to avoid putting this learner in the spotlight, as well as to protect him from any form of embarrassment. Mr Thuto raised a concern that, with this decision to protect HIL, other learners in class are denied the opportunity to learn from them. This emerged when he stated:

> If this HIL cannot ask questions or answer the questions in the class, it just means the other learners cannot learn from him. This is because if one learner asks a question in class, you may find that the problem was not only for that particular learner. Other learners might have similar problems or questions.

His concern warns us that the inability of HIL to actively participate in the classroom may compromise a potentially symbiotic learning environment. This is also against the assessment guiding document showing that learners should be in dialogue with a teacher for effective learning to take place (Assessment strategy, 2012). Mr Thuto understands asking questions in class is a crucial aspect of learning, but the situation often meant that he did not make this opportunity available to the HIL.

4.3.1.5 Teacher professional development opportunities

Teaching a class of learners with diverse needs does not only require content knowledge, but also requires appropriate teaching methods to accommodate learners' needs (Navaro e*t al*., 2016). In this regard, the need for professional development, especially for regular teachers cannot be overemphasized. It was at this point that I found it important to find out what professional development programmes Thuto had participated in to prepare him to teach Science to learners with a hearing-impairment. Even though Mr Thuto indicated

the different approaches he uses in the teaching and learning of HIL, he confirmed that he had not received any form of training to enable him to include or teach HIL. This is a professional development opportunity identified by LIEP as the empowerment needed by teachers to be able to effectively teach learners with diverse needs. I was rather shocked and wanted to find out more about how Thuto was able to teach these students despite his lack of training and support. He clarified that he gathers information on effective ways of teaching the HIL from the internet. The following quotation provides evidence of this.

> […] I do not remember any time we were ever prepared or trained to teach Science to hearing-impaired learners. I just go through the internet and research and try to find out how best I can teach learners with HI … What are the activities? So researching the internet on how HIL are assisted in general. That is how I am trying to get those skills and trying to apply them in the same class.

The quotation indicates that Mr Thuto did not get any form of training or support from the Ministry of Education to equip him with the requisite skills essential for accommodating a HIL in his class. Instead, he conducted self-empowerment using the internet, to gain the skills essential to incorporate HIL in his lessons. The absence of professional development support for teachers needing to teach HIL made no sense, as LELP does not only require that the teachers accommodate these learners, but it also reiterates that these teachers should be provided with the necessary support to enable them to accommodate and teach learners with hearing impairments.

Hearing about the lack of professional development support from the Ministry of Education, I was curious to find out if this kind of support is provided during their pre-service training. This is because one of the objectives of the Lesotho Inclusive Education Policy stipulates that institutions of higher learning should equip teachers with the relevant knowledge required to accommodate learners with impediments. Mr Thuto, however, confirmed that while he was taught theoretically on how to write lesson plans incorporating learners with diverse needs, none of these skills prepared him to tackle these issues when he got to the real world of teaching. He clarified:

> At tertiary courses we did in education, we learned about lesson plans and others theoretically. We never had a situation where we practically had to develop a lesson plan to incorporate these kinds of learners. You see, the problem here is that we do too much theory that most of the time does not go together with what we must do practically in the classroom. Such theory does not prepare us to handle real issues on the ground.

The above quotation suggests that the pre-service training that Mr Thuto went through did not help him deal with classroom realities where HIL were involved. He also clarified that theory is far different from practice, as what they deal with in the classroom is far different from what they have been taught during their pre-service training.

Even though Thuto appears not to have been prepared to teach HIL, he considered cooperation with his colleagues as an opportunity to assist in the teaching of HIL. Mr Thuto mentioned that he received assistance from his colleagues who have experience of teaching HIL;

> I have to ask my colleagues, talk to them, not only Science teachers but other subject teachers how they deal with certain situations with learners with certain disabilities and how they handle that situation. This is because you may find that what learners do is common across the subjects … you can apply to any other subject.

The extract above shows that Thuto receives assistance from his colleagues on how to teach HIL. This could be based on his understanding that what learners do cuts across the subjects. I was interested in finding out exactly how he works together with the other teachers. He said:

> We normally hold meetings regularly and share and talk about the students in different classes as well as the problems they encounter and

> how teachers handle such problems. So you are able to get something from other teachers, and this is quite helpful.

This seems to suggest that in the absence of any professional development support, teachers come together to share their experiences and challenges of teaching learners with impediments. These regular meetings provide teachers with the opportunity to share the problems they encounter, to develop strategies of how best HIL could be taught.

4.3.1.6 Summary

Thuto seemed to believe that assisting struggling learners in Science and Mathematics made him see teaching as an exciting profession to pursue. He also showed that the use of experiments is the best way of teaching Science. He enlightened me that alternatively ICT could be used in the absence of reagents in the laboratory. He also alluded that experiments take a longer time to prepare. With this, learners are at risk of not completing the syllabus within the stipulated time. He realised that HIL are slow to understand concepts and express themselves in class. It was for these reasons that HIL were not given a chance to speak in class. It also appeared that in a class with diverse needs there may be conflicting learning opportunities. This occurred in cases where the learning opportunities for a HIL was a barrier for his counterparts.

Thuto also indicated that his teacher training institution did not prepare him to teach HIL. He identified that in the absence of professional development, teaching Science to HIL is a tall order as they are not equipped with appropriate skills and knowledge to handle the aforesaid challenge. However, he explored different alternatives that he thought could assist the HIL comprehend Science concepts. These were the development of his own teaching through research and consultation with his colleagues. He revealed that being taught how to teach a learner with a disability is different from dealing with this in a real situation.

4.3.2 Case study 2: Mrs. Mpho

4.3.2.1 Personal background

The evidence shows that Mrs. Mpho had always been passionate about Science and Mathematics and her performance in these subjects was satisfactory. She told me: “I like them [Sciences and Mathematics] and in Form E, I managed to pass them”. This seems to have influenced her career choice. At the time of the data collection, her highest qualification was a Bachelor of Science with Education (BSc. Ed.) and she majored in Physics and Mathematics. She had had ten years of experience teaching Physics. When she first joined the teaching fraternity, she held a diploma in Science education and she later decided to further her studies. She talked about her academic journey as follows: “I started teaching in 2008, I went to school in 2009 and came back in 2012.” She explained further: “I went back to school for a BSc. Ed. so that I could be equipped with the essential skills required for effective teaching”. This implies that Mrs. Mpho realised that she initially lacked some skills that could improve her pedagogical practice.

Data revealed that when Mpho arrived at the school, it was her first experience of interacting with HIL. She clarified: “It was my first time to communicate with deaf learners … when I arrived at this school”. Mpho’s view about HIL is that they are different. According to her this affects their attitude towards their studies. This is how she presented her views: “Hearing-impaired learners are different. It takes time for them to believe that they can do well at school … just like the ‘hearing-persons’.” This suggest that Mrs. Mpho realised that HILs’ self-esteem in terms of their school work is quite low. Nonetheless she tries to motivate them so that they can do well like their counterparts, even though to achieve this takes a long time.

It is also imperative to understand the context in which Mrs. Mpho was teaching, so that her views and beliefs about teaching Science to HIL can be meaningful to the reader. Patlong High school is located 73 km north of the capital of Lesotho, Maseru. The school

accommodates HIL, most of whom reside at the boarding facility of a nearby special school for the deaf. In that school they are provided training with sign language and also social skills. Patlong High school has sign language interpreters to facilitate communication in the class. Mrs. Mpho explained: “There is always an interpreter in the class”. Mrs. Mpho explained further about the credentials of the sign language interpreters:

> They are qualified teachers who are specialised in special education and are able to communicate with sign language. They are just teachers and not qualified to teach Science.

The fact that sign language interpreters lack subject knowledge might raise a concern that authentic Science messages might fall between the cracks for the HIL. She explained the significance of sign language interpreters in class as follows:

> It is very important to have the interpreter in a class. This is because, if there is no interpreter deaf learners cannot get the message. Again, eh eh…. knowing a little bit of sign language is very important because I can understand what deaf learners are saying even in the absence of the interpreter.

Mrs. Mpho noticed that the absence of the interpreter could be detrimental towards directing the communication between a teacher and the HIL. However, she stated that she understands the basics of sign language and that this allows her to communicate directly with the HIL. This shows that when teachers have a basic knowledge of sign language, they will be able to communicate directly with the learners. This could be advantageous for the facilitation of teaching and learning, especially when there are no interpreters. This is highlighted in LELP that when teaching HIL sign language should be the medium of instruction to facilitate effective teaching and learning. She continued and described the calibre of the learners she was teaching:

> There are around eight hearing-impaired learners. […] Some cannot hear even though they can make some sounds. Others are hard of hearing and can relate the movement of lips with what they already know.

Mrs Mpho's class has deaf learners and hard of hearing learners. The implication is that deaf learners communicate with sign language, while hard of hearing learners can get information through lip-reading as indicated by the extract. However, she seemed not to be in support of an overreliance on lip-reading and she explained as follows:

> Hard of hearing learners should as well know sign language so that they do not lose the information. When they lip-read, sometimes they do not get me as the teacher on what I am trying to say. […] the learner may assume I am saying a particular word; yet I am not saying that.

The extract above articulates Mpho's view that sign language may increase the opportunities to learn for HIL, as this should compliment lip-reading. This gives the impression that the two modes of communication are essential for improving accuracy when accessing information. Nonetheless she mentioned the challenge encountered by hard of hearing learners coming from regular schools: "They do not know sign language because there were no interpreters in those schools." Even though she viewed the need for hard of hearing learners to learn sign language, she revealed yet another challenge for these learners to learn sign language as a mode of communication: "Another problem is that there are no sign language lessons in this school and they have to learn by looking at the interpreters." It is evident that the issue of effective communication remains an unresolved probelm in the school, especially for learners who lack a strong foundation in sign language. The LELP pronouncement articulates that sign language should be taught in schools to give HIL a proper foundation for their language of communication. Having discussed Mpho's background and the context where she is teaching, it is now essential to understand how she experienced the teaching of Science.

4.3.2.1 The teaching of Science

How teachers view the best practices for teaching Science may contribute massively to their classroom practice. It was found necessary to explore Mrs. Mpho ‘s experiences of teaching Science. Mpho indicated that she prepares herself before going to class by writing a lesson plan and it must have either an experiment or demonstration. She explained: “I write a lesson plan knowing that there has to be a demonstration or an experiment for a physics lesson”. The evidence suggests that Mpho’s understanding of teaching Science concepts goes along with proper lesson planning. Thus, a lesson plan is considered a priority and she further explained how this feature when conducting her Science lessons: “We do a recap on what we have done in the previous lesson.

We start with the known and move to the unknown.” Mrs. Mpho’s belief about teaching Science aligns with the syllabus pronouncement that prior knowledge should always be taken into consideration when teaching Science (MoET, 2002). It also emerged that the teaching approaches that she preferred for teaching Physics concepts are demonstrations and the use of experiments. Mpho elaborated further.

> For Science you need to demonstrate. There are some things that you have to do experimentally. […] they become clear when experiments are made, as compared to Sesotho which has no experiments for learners to understand Sesotho concepts.

Mrs. Mpho appeared to believe that scientific concepts become clearer when experiments are done, and this is an aspect that makes it different from other subjects like Sesotho. Mpho elaborated the process of conducting experiments as follows:

> First you have to hypothesise on what could happen after the experiments. They should also know how to handle the equipment.

Her emphasis is that learners should first know how to handle the equipment, and this suggests that she teaches Science as a process where learners conduct experiments

themselves. Mpho's belief about teaching Science seemed to be inclined towards scientific processes where demonstrations and experiments are prioritised. It is noteworthy that Mpho felt that learning occurs more readily when learners are actively engaged in conducting experiments themselves. It is also important to understand what Mpho believes this to be the appropriate way of teaching Science to HIL and this is explained in the following subsection.

4.3.2.2 Teaching Science to hearing-impaired learners

This section gives an insight as to how Mpho views the teaching of Science to HIL. Considering that listening is the essential communication skill required in teaching and learning (Spataro & Bloch, 2018), it is found imperative to understand teachers' critical reflections on the appropriate way of teaching Science to HIL. Mpho indicated that the placement of HIL is critical to consider so that they are not blocked off from the interpreter. She explained:

> We normally arrange them in the first two columns, so that all of them could see the interpreter. The purpose is also to allow us to move because when you teach you cannot always stand still, the arrangement is for us to stand without shading the hearing-impaired learners, there is never a time I can come in front of the interpreter. We were advised by the inspector to arrange learners in a horse-shoe but because they are many, we did not manage to do that when teaching.

The evidence above indicates that HIL are not randomly placed in the classroom, as that could hinder their opportunities to learn. It also shows that teachers were advised by the Ministry of Education to adopt a horse-shoe arrangement, which however did not work for them due to the large number of learners in the class. This shows how powerful the context can be and what is communicated in policy prescriptions may not always be implementable in the the classsroom. This reveals that context can influence practice. Mpho described the process of preparing her Science lessons for the benefit of HIL, as follows:

> When you introduce the topic, you have to explain the meaning of the whole topic for the interpreter to understand. When the interpreter understands what you are saying, learners will also understand.

The extract above shows that Mpho found that it is important to thoroughly explain Science concepts to sign language interpreters. This may lie on the realization that sign language interpreters are not qualified Science teachers. Therefore, it appears compelling that Mpho had to explain concepts to them before going to class. This also seems to be Mpho's belief, namely that interpreters' understanding of Science concepts may have a direct influence on the accuracy of messages relayed to the learners. This suggests that HIL's effective acquisition of content is dependent on the understanding of the relevant scientific concepts by the sign language interpreters The evidence shows Mpho's resounding trust and dependence on interpreters for translating what she says to the HIL. This agrees with Lucas *et al.'s* (2018) view that most subject teachers lack sign language and rely on interpreters who notably lack knowledge of Science content.

Mpho explained that she preferred using different approaches for teaching Science to HILs. She stated that she commences her lessons by identifying the scientific terms her teaching and learning would be based on. She elucidated:

> When you introduce the topic, you have to write most of the words you are going to talk about on the board. Those words are explained as we continue with the topic. If you are talking about the atom, start with what the learner knows.

The extract shows that Mpho understood that writing the new words on the board is a way of increasing opportunities to learn for the HIL. This gives the impression that words displayed on the board can compliment the information translated by an interpreter from speech into sign language.

Another point is that a HIL should be familiar with how scientific concepts are written in standard English. The extract also refers to the point indicated by the Science syllabus that teachers should start from what the learner knows. This shows the importance of learners' prior knowledge for learning. Mpho explained another approach of teaching Science to HIL like this:

> When teaching a deaf learner, you have to repeat yourself several times. I know that they cannot get the message theoretically like the hearing learners. For that reason, I repeat several times.

This quotation demonstrates that repetition is one of the important approaches for teaching Science concepts to HIL. I was curious to know whether the repetition of concepts might negatively impact on the other learners, and this is how she responded:

> We also have slow-hearing learners who benefit when repetition is done for learners with hearing-impairment. I also advise slow learners to listen and add to what they have learnt while the interpreter explains to the HIL.

This extract shows that Mpho believes that repetition works to a large extent to the advantage of a HIL, but she also acknowledged that slow-hearing learners also benefit. Dostal, Gabriel and Weir *et al*. (2017) maintain that as 'opportunities to learn' are maximised for HILs, all other learners should as well benefit. Mpho continued and noted that when teaching a HIL she has to stand in one position. She clarified:

> When teaching HIL you have to stand in one position… you don't have to move and talk when you are writing. I talk and when I have finished I go to the board. This is made so as to allow hard of hearing learners to lip-read and you have to face them. If you want to move, sometimes we make a lot of confusion because learners will not see the interpreter.

It is evident that she considered staying in one position as an accommodative strategy for the HIL. It seems Mpho realised that moving around might deny the HIL access to

information either through lip-reading or sign-language interpretation. Mpho's practice is congruent with the capabilities framework principle that any intervention made should be informed by an individual's needs.

Mpho showed that her teaching of Science also involves giving notes to learners. She said: "I prefer giving those notes and describe here and there without saying much." Note taking may assist HIL to read and understand the concepts at their own pace in the absence of a teacher. This prepares them to learn independently and become responsible for their own work.

Mpho reiterated the use of experiments as an effective strategy for teaching Science to HIL. She further explained:

> As for Science, some of the things could be done experimentally. Deaf learners should actually see them happening. For some experiments, we might not have the equipment to use since deaf learners learn by seeing, you may demonstrate such experiments through a projector or computer.

Mpho also identified HIL as visual learners and believed that in the absence of laboratory equipment projectors or computers can be used to demonstrate experiments. Mpho seems to see the importance of technology only in the absence of laboratory equipment. From the extract above, it becomes apparent that HILs' opportunities to learn are widened when visual representations are used. She continued by saying that contextualisation of Science ideas could assist HIL to easily comprehend what is being taught. She said: "When teaching deaf learners again we have to localise everything for them to understand what we are talking about." This suggests that connecting what is being familiar with what is taught may enable learners to construct knowledge easily in their minds (Iqbal *et al*., 2021). In this manner, learning objectives are more easily achieved when concepts taught are linked to real-life situations.

The discussion above shows how Mpho prepared Science lessons for teaching HIL. It also covered different teaching approaches that are beneficial for HIL, including writing new words on the board, repetition of concepts, note taking, staying in one position and the use of experiments. The following sub-section explores the challenges that Mpho encountered when teaching Science to HIL.

4.3.2.3 Challenges of teaching Science to hearing-impaired learners

Teaching integrated Science has been an ongoing challenge for most teachers for different reasons including a lack of teaching skills (Rubini *et al*., 2018). In this section, I discuss challenges that Mpho encountered when teaching Science to HIL. Even though Mpho considered going slowly and repeating concepts essential accommodative strategies when teaching HIL, she also acknowledged that they are time consuming. This is how she explained this:

> The best way to teach deaf learners is to be slow, repeat whatever you are saying several times and have more activities for them to understand but this takes a lot of time. Apart from that, you will find that some hearing learners are no longer listening because they have long time understood what is being repeated. At the same time, you cannot pass to the next topic.

Mpho seemed to be aware that being slow and repeating information is time consuming. Apart from that, repeating concepts negatively affects some of the other learners as they lose interest at some point because the situation compels them to listen to what they already understood. The fact that Mpho cannot proceed to the next topic unless the HIL learners understood what was being taught could compromise learning opportunities for most of the learners. This gives the impression that there is a challenge when providing equal opportunities to learn in a diverse classroom.

Mpho also explained the dilemma she was confronted with as she tried to create opportunities to learn for HIL: “It is true that we are trying to push the syllabus, but it does

not benefit the learner when we hurriedly go through the syllabus." Evidently, Mpho was under pressure to complete the syllabus, but she was aware that if she succumbed to such a pressure, learners would suffer. This shows that completing the syllabus was Mpho's goal but for HIL understanding of concepts was also her priority.

When dealing with the aforesaid challenge, Mpho explained that she conducted remedial teaching. She explained as follows:

> For learners who are about to sit for examinations, we normally come before seven o'clock before we go for assembly, and we also come on Saturdays. We are not forced to finish the syllabus but that is what we have to do and this is only done for external classes.

It becomes evident from the extract above that this arrangement is intended to prepare learners for examinations. However, it targeted external classes only, meaning that the problem of an incomplete syllabus is not dealt with in internal Grades. The implication is that she would have a high backlog of content to be covered within a limited time. Again, learners may proceed to the next classes without a proper foundation.

Even though Mpho realised the importance of notetaking to benefit HIL, she explained a challenge associated with this as follows: "It is also very difficult to teach Science to deaf learners because you cannot teach and write notes". Mpho found not being able to use a 'chalk and talk' approach as a challenge for her. This provides evidence that Mpho had to get out of her comfort zone to accommodate HIL. Mpho explained further that it is difficult to teach some topics through experiments. She clarified:

> I sometimes use a teacher-centred approach when teaching an unfamiliar topic such as 'sound' to HIL since they cannot add any information. They as well cannot hear sound and there is no experiment that could help them understand.

Even though Mpho stated earlier that experiments are effective for teaching HIL, she is also of the view that not all topics can be taught using experiments. In such cases she resorted to using a teacher-centred approach. The implication of this is that context is powerful in directing Mpho on which methods to use. Parsons *et al*. (2018), refer to this as adaptive teaching, when teaching approaches are chosen in line with learner needs. Mpho shows that when conducting experiments, HIL must observe processes and look at the interpreter, but it becomes difficult for them to concentrate. To deal with this challenge, Mpho arranged with the sign language interpreter that they should not talk while the demonstration process is happening. She explained:

> If you do experiments, the interpreter is there to interpret, and it is not easy to look at the experiment and the interpreter at the same time. We agreed that when I demonstrate, the interpreter stops signing. But I cannot demonstrate keeping quiet, I will also talk but while learners focus on what I am doing. It is after demonstration that deaf learners are given the chance to ask questions.

This indicates that HIL are not part of the discussion when demonstrations are carried out because they use the sense of sight to get the information from activities. Therefore, Mpho found it preferable for the explanation to come after the demonstration. With this, learners who can hear properly have a better opportunity to understand concepts delivered through experiments - way better than their HIL counterparts. It becomes evident that HILs' inability to ask questions during the lesson may hamper their learning. Mpho acknowledged that she encountered a challenge when teaching HIL if the sign language interpreter was absent. She described the situation in this manner:

> When there is no interpreter in the class and you are trying to teach them, you will see that these people do not understand. Hmmm…you will see that they are trying to ask a question and you as well do not understand what they are trying to say. I then realized that knowing a little bit of sign language is necessary. When one

> knows sign language one can continue teaching in the absence of the interpreter.

Mpho warned that relying fully on the interpreter without understanding a little bit of sign language could reduce opportunities to learn for HIL. Mpho had the advantage of understanding the basics of sign language. This is based on her explanation that knowing a little bit of sign language allowed her to identify misconceptions, she stated:

> Sometimes, you will find that the message the interpreter is conveying is not what you said. This is observable when you ask questions, you will see that the way learners get answers wrong, is because of the information they got. Not that they did not understand the concept. You will see that misconceptions come right away from the interpreter.

Having the basics of sign language helped Mpho to identify areas where sign language interpreters show weakness. It is evident that at times learners cannot receive accurate information from the sign language interpreter. It therefore reveals that the content knowledge of the interpreters may not be rich enough for teaching Science to HIL, yet they play a central role in the teaching and learning of HIL in the Science classroom. Mpho showed that interpreters are not only challenged by their content knowledge, but they are also challenged by a limited sign language vocabulary. She clarified:

> Sign language interpreters encounter problems when teaching Science due to the limited sign language vocabulary. This compels interpreters and HIL to come up with their own signs. The sign depends on how they understand the word and they make a picture of that like the wave. For instance, signing the wave with the hand, always when we talk about the wave they make that picture. The only problem with this arrangement is that you will find that interpreters have not agreed on invented signs across all classes, consequently learners sign words differently.

Based on the extract above, limited vocabulary makes it difficult for interpreters to convey Science messages accurately. Mpho reported that in response to this challenge interpreters, in collaboration with HIL, invent their own signs but the disadvantage of this arrangement was the lack of uniformity which may lead to a language barrier for HIL. Again, the arrangement seems to localise scientific terms to the classroom level. With this, HIL may not be able to learn from each other since language is the tool for learning.

This agrees with Vygotsky's (1978) assertion that learning is social, and learners' interactions are initiated by language. With these challenges, one can see the importance of teaching sign language as a subject in schools, as prescribed by language policy. Another challenge that Mpho mentioned is that even when the subject teacher knows sign language, it is not easy to sign and teach at the same time. This is how she shared her experience.

> Even though I can sign some words, I cannot teach and sign at the same time as that will consume a lot of time. You will find that within 40 minutes you have just conveyed a short message to them. Having an interpreter in class saves time and if they had a chance of knowing what we are going to teach then teaching will be more effective. I have realized that in the presence of the interpreter there is communication and learners understand what I am saying. If deaf learners do not understand, they ask the question back to me through the interpreter so that I can explain more.

Even though Mpho had the basics of sign language, it would be very difficult for her to teach using signs because this has implications for the time factor. Hence, this gives evidence that there should always be an interpreter during Science lessons in order to save time.

Mpho also reported that learners are challenged with written assessments that demand the use of Standard English. She explained:

> When the interpreter is not there, you will see that this person [deaf learner] does not understand the question when written down. Besides that, so many words confuse deaf learners as they end up not knowing what the question wants and fail to get it correct. When the interpreter explains the question, deaf learners tend to understand. You will also find that learners know the answer, but the problem comes when they have to write it down.

The extract above reveals the adversities HIL encounter in assessments due to limited language skills such as reading and writing. Mpho reported that assessment seems to be a challenge for HIL in her class, especially in the absence of the interpreter. The evidence reveals the challenge presented by misalignment between assessment and teaching. That is when learners are taught through sign language but are assessed through Standard English. This practice seems to compromise HIL opportunities to learn, since their reading and writing skills of Standard English are not that sharp. Therefore, they cannot write what they have understood.

The fact that both oral and written assessment are conducted in English poses a challenge for HIL. Mpho proposed that sign language be used in assessment. She clarified:

> To deal with this, each question should be written in sign language grammar as they may not identify the question in Standard English … later their answers could be converted into English grammar.

Mpho attested that sign language is somehow necessary for HIL to acquire scientific concepts. However, she seemed to be agitated using English in assessment as she reported that it hinders HIL ability to show what they have understood. She then suggested that assessment should be given in sign language grammar and HIL should be allowed to use the same grammar when answering questions. She further recommends that HIL answers should later be converted into Standard English so that regular teachers can easily mark their work.

HIL attitude is another challenge that can hinder their ability to learn. Mpho indicated that HIL can't appreciate being taught about the 'sound' topic because they cannot hear. She clarified that when the word 'hear' is used in her class, HIL often get offended. She warned:

> When treating some topics like 'sound' do not use the verb 'hear'. Once you write 'sound', deaf learners become offended and say we do not want to do that because we don't hear. Since HIL do not see the need for learning about sound, I found it working when explaining to them the importance of sound before teaching the concept. It is important to learn that topic because you might also be a teacher and you have to be confident with teaching that topic.

Mpho outlined HIL's negative attitude towards the topic of 'sound' to be caused by their impairment that denies them access to learn through a sense of hearing. She emphasised that it is important for HIL to learn about the topic as they could also become teachers. This again shows that Mpho believes that HIL, like their counterparts, have a potential to further their studies. She also found that explaining the importance of the topic to HIL as a working strategy for them to be willing to learn about the topic. This indicates that learners' inability to learn some topics may lie on the fact that what is taught is not relevant to their lives. However, Mpho cautioned against assessment that mostly focuses on inaccessible topics for HIL. She emphasised: "It is also unfair for deaf learners to answer more questions on sound, yet it is the topic that demands a sense of hearing to be well understood." One more challenge Mpho identified is that HIL are always lagging behind their counterparts in Science lessons. She explained:

> HIL are not dumb learners but being unable to hear makes them to always be behind their classmates. Deaf learners' performance depends on their intelligence as individuals. This is because you might find that this HIL is totally deaf but could do well in all subjects except Sesotho.

Mpho showed that there should always be an expectation that HIL could lag due to language deficiency and not that they are incapable of learning Science concepts. The discussion revealed different challenges that Mpho had to overcome when teaching HIL, including the limited time needed to cover the curriculum content when using teaching methods that accommodate hearing-impaired learners. She also indicated that not being familiar with sign language to be a challenge even though she cannot teach and sign at the same time. She showed that moving around in class and not talking and writing on the board challenged her when teaching. Mpho put forward her experiences on the factors that hampered her effective teaching of Science to HIL. It is therefore important to understand how she reflected on the professional opportunities needed to deal with these aforesaid challenges.

4.3.2.4 Teacher professional development opportunities

In many countries teachers do not have the essential skills required for effective teaching (Popova *et al.*, 2022). Thus, continuous professional development (CPD) is globally considered a cornerstone for improving teachers' competences in different areas identified as challenging (Mukan *et al.*, 2019). Mpho also reflected on issues of CPD and mentioned that she went for capacity building training in Zambia and provided the following explanation on its purpose:

> In Zambia we were analysing the textbook and the syllabus. What they emphasised is that the book should be localised, every time you are in class consider what a learner is familiar with. And that should be based on the general objectives of the syllabus. When you teach deaf children again, we have to localise everything for them to understand what we are talking about.

Mpho described the training she received in Zambia as relevant to her even though it was not directly focused on teaching Science to HIL. The training gave her exposure on how textbooks should be aligned to the syllabus objectives and should prioritise local context. She held a view that the training helped her to realise that it would be important to

consider localising Science content for HIL to facilitate their learning. This is congruent with Morris's (2020) idea that learning becomes meaningful when the new content is situated and aligned to real-life issues. Mpho pointed to one occasion where teachers and sign language interpreters shared ideas on ways of supporting HIL in the school. She clarified:

> There was a time we had a workshop as teachers and the interpreters. We tried to explain how deaf learners behave, how we should approach and teach them. The resolution reached was that each individual teacher is free to use the teaching method of her choice. The individual teacher or the individual interpreter, but we do not know whether we are doing it right or wrong because there is no training for such.

She pointed out that they did not receive any form of training from the Ministry of Education and Training. She narrated: "We do not have any training from the Ministry. We do not know how to handle HIL. We learn by ourselves that these learners are like this, and these learners are like that." Mpho seemed to be aware that she needs more capacity building on how to teach Science to HIL. She clarified further:

> We need training to teach deaf learners Science. The trainers are the ones who can help us with appropriate signs for Science. So, we need this training. The training will also help us deal with deaf learners.

Mpho seems to believe that this training will as well assist them to learn sign language appropriate for Science teaching. Mpho also believes that there should be signs designed for teaching Science. This suggests that the day-to-day sign language for communication has gaps and cannot always facilitate the teaching and learning of Science concepts. This is in line with Ndlovu and Matafwali (2020) who say that for the effective teaching of Science, continuous professional development is needed. This point was elaborated further:

> [a] focus on Continuous Professional Development (CPD) on Sign Language related symbols in Science would enhance knowledge and skills of teachers to effectively deliver lessons and respond to the diverse needs of learners with Hearing-Impairment (Ndlovu & Matafwali, 2020: 88).

Mpho explained that they did not receive any form of a training workshop. However, that did not stop them from capacitating themselves to enable them to teach HIL. In her discussion, she believed that CPD is essential to improve both pedagogical practice and sign language. This aligns with the LIEP pronouncement that teachers should be prepared to teach learners with special needs.

4.3.2.5 Summary

Mpho is a qualified Science teacher and believes that the proper preparation of the lesson plan for Science teaching should be through an experiment or demonstration. She seemed to believe that prior knowledge plays a vital role in assisting learners to acquire new concepts. For that reason, she preferred using locally available materials to make learning relevant to learners' experiences, which emerge as prior knowledge for them when being taught. Mpho showed that HIL rely on sign language as a medium of instruction. Therefore, interpreters are always in her class to facilitate teaching and learning. She reveals that she knew a little bit of sign language, which assisted her to capture misconceptions communicated by the sign language interpreters. With this, one would find it important for teachers to learn sign language and do away with sign language interpreters. However, Mpho says that she would still need interpreters since one cannot sign and teach at the same time.

She said that when teaching HIL she had to explain concepts to the interpreter before the class started. Mrs. Mpho took this explanation further and explained that the teaching of Science to HIL involves giving notes to the learners. She explained that she starts her lessons by identifying and explaining the scientific terms to be used. She continued and

noted that when teaching HIL she has to stand in one position. She also warned that a limited vocabulary makes it difficult for interpreters to teach Science.

Mpho acknowledged that teaching HIL is a challenge because HIL are slow to understand concepts. She indicated that going slowly and having to repeat concepts when teaching works against the stipulated time for curriculum coverage. Mrs. Mpho reported that assessment seems to be a challenge for HIL, especially in the absence of the interpreter. She lamented that learners are taught with sign language but are expected to be able to respond and write in standard English in the assessment. She indicated that sign language has its own language structure where learners start with the object, and this challenges HIL when presenting their work in a written format.

Mpho indicated that they have never been prepared for teaching HIL both at pre- and in-service training and all that they relied on was to capacitate themselves. Therefore, teaching HIL remains a challenge. She emphasised that there is a need to be trained in sign language for the effective teaching of Science concepts. This comes because of the current situation where sign language lacks the vocabulary to effectively explain scientific concepts.

4.3.3 Case study 3: Mr. Tsolo

4.3.3.1 Personal background

Mr Tsolo is a young teacher with a diploma in Science Education. He was trained to teach Biology and Chemistry at the Lesotho College of Education. When asked about his experience and qualifications, Tsolo explained:

> I fell in love with the specialization after we were given career guidance on different career choices. Apart from that, I was doing my best in those subjects.

From the extract above Tsolo explains that he is not only passionate about Biology and Chemistry but also competent in these subjects. He justified his interest in these subjects by stating that despite being admitted into the Faculty of Agriculture at one tertiary institution, teaching remained his first career choice. With this, he seemed to believe that the teaching profession was a calling for him. He explained:

> I think when something is a calling it just happens. I found the teaching profession as the best career to follow. I got admitted at university doing agriculture but it is not my thing. I found teaching the best profession and went to the College of Education to study for a diploma in education.

Even though Mr Tsolo qualified for other courses in the university, he chose a teaching career over the other opportunities. This shows how passionate he was about the teaching profession. Tsolo explained his academic journey as follows:

> I have a Diploma in Education and majored in Biology and Chemistry. I started teaching in 2016 as a private teacher at Qai [Not a real name] secondary school. I then came to this school which gave me the experience of teaching hearing-impaired learners.

His academic credentials show that he is a qualified Science teacher. However, at the time of the data collection, Tsolo was an inexperienced teacher with only three years of teaching experience. Even though Tsolo had never taught HIL before, his competence with the subject matter is of great importance for teaching and learning. Shulman (1989) is also of the view that what the teacher knows is very important and forms the basis for teaching. That is a qualification can be considered as an important determinant of learners' opportunities to learn.

4.3.3.2 Teaching of Science

Globally, Science Education is given priority, as it enables one to use scientific content for rational decisions, which impacts positively on individuals and society (Kalyon, 2021). It is noteworthy to mention that to achieve the aforesaid benefits, 'how to teach' should play a pivotal role in the delivery of Science Education. Thus, it is intriguing to find how Tsolo identified effective ways of teaching Science.

Tsolo explained that teaching Science to learners with different learning needs is a hurdle, but the use of technology can make things better. This agrees with Nawzad, Rahim and Wakil's (2018) view that technology use increases willingness to learn and improves Science performance. He indicated that experiential learning keeps learners focused on the task and promotes learning. With experiments, observations are made, and different senses are engaged with, including the manipulation of objects. This suggests that a sense of hearing may be compensated for with the other senses so that active learning can take place. Mr Tsolo was further probed on how he conducts his experiments and he explained:

> When we go to the laboratory to conduct an experiment such as a food test, we give learners apparatus and steps to follow. This is done so that they can see and clearly understand the procedures on how to test for different types of food. After the experiment they write the lab report. With this, I can see if they have understood what they have done and follow up with questions. I have also realised that learners do not understand the food test topic theoretically … compared to after an experiment is done.

The use of experiments appears to be another way of actively engaging learners in learning, especially when they engage in practical work. As previously stated, this is a suggested teaching approach that widens learners' opportunities to learn and improves learners' skills, values, and attitudes as they experience scientific processes. Besides this, it enables learners to see what is being discussed and allows these individuals to

follow scientific procedures. The extract above shows how Tsolo conducts experiments, and this seems to follow and confirm an inquiry-based approach. This is an approach where learners are given procedures of how to carry out an experiment and continue until they get to the expected results. Assessment through report writing is part of these experiments. This is how learners' understanding of the concepts taught through experimentation is checked. This practice aligns with the role of assessment as stipulated in CAP (2009) and the Science syllabus (2002), namely that it should be used to check the progress of the learners.

4.3.3.3 Teaching Science to hearing-impaired learners

Teaching Science to learners with diverse needs demands a flexible teacher who employs the appropriate teaching methods to accommodate all the learners (Pujaningsih, 2021). This section focuses on what Tsolo considered to be effective approaches for teaching Science to HIL. Tsolo showed that formative assessment is very important when teaching HIL, since it provides feedback that informs teaching and learning. He clarified:

> I ask questions based on what they have done and then will see if there is progress. If there is none, it says that I must reteach to make them understand. I don't pass to the next concepts before ensuring that the one I taught earlier has been understood before going any further. This is to avoid a situation whereby you may see after a week that on that topic there was a challenge … so you will be compelled to repeat the whole topic.

Tsolo believed that the repetition of concepts is one of the best approaches to be used for teaching Science to HIL, especially when concepts were not well understood. It is evident that Tsolo uses assessment feedback as a yardstick to determine whether it is necessary to repeat concepts. He showed that HIL can learn Science by 'doing' since it is a practical subject by design. He was also of the view that the needs of learners should be considered from the inception of the planning of a lesson. This is how he explained his views:

> Deaf learners lack literacy skills, but they can learn Science because it is actually a practical subject. This subject doesn't need them to explain themselves more. So…then they do things by themselves, it becomes easier for them to understand. I usually plan my lesson in accordance with learners' needs. I also make sure that there must be something that they "do" for them to understand.

Tsolo seemed to be aware that an effective approach for teaching Science to HIL is through practical work because they lack literacy skills. He also believed that HIL having direct engagement in practical work could enhance their understanding of the Science concepts. Furthermore, Tsolo considered the importance of planning a lesson in such a way that individual learners' needs are catered for. He prioritised 'activity learning' from the planning stage of a lesson and he viewed that it could maximise opportunities to learn, especially for HIL. It also becomes apparent from the extract above that any activity that engages learners in learning is planned in the lesson plan, that is teachers do not randomly choose activities in class, but they are planned in line with the needs of their learners.

Tsolo considered the use of experiments as an appropriate method of teaching Science to HIL. He explained:

> I first had to explore the best ways of teaching Science to learners with different abilities and found that the most effective method is the use of experiments. When doing experiments, they become fully engaged and you may find that they have that interest of making something and learning becomes more successful. Experiments should be used where learners explore, see things outside, manipulate, see, touch, or feel whatever we will be teaching. Using experiments improves learners' understanding. I checked them when teaching irrigation, gave them the test and they passed. That showed me that the more they see the more they understand.

The extract above indicates that Tsolo was not conversant with appropriate ways of teaching HIL. Through exploring different ways of teaching, he found that the use of experiments provided HIL with meaningful learning experiences. Through their good performance in tests, Tsolo concluded that the use of experiments promotes learning.

Tsolo regarded ICT as another approach that could be used when teaching Science to HIL. He became aware that the use of technology devices facilitates the effective teaching of Science to HIL, as seeing things improves the understanding of concepts. He emphasised:

> Most of the time I use the projector which they watch. The projector gives a clear image of what you are talking about in class. When things are being interpreted, learners may not understand concepts the way they would if they see what one is talking about. At certain times I ask them to come with their mobile phones so that I can share with them whatever I have downloaded with my phone. I would monitor the progress and ask questions based on what they have written. I send it to them so that when talking about it in the class they could see it on their phones. I sometimes form groups in class when some learners do not have phones.

Tsolo indicated further that he also uses mobile phones when teaching. When asked how phones are used in the class, he indicated that learners come with their phones, and he would share downloaded videos with them. He also clarified that group work becomes another option when learners have not brought their phones. Based on the extract above, Tsolo used ICT for distributing notes and other learning materials in class. ICT in this instance is used as a tool when teaching. This is in line with Hrast and Savec's (2018) view that ICT could be used to search for information and for presentation. This strategy enables learning materials, including notes that are copied from one learner to the other within a short period of time, unlike writing notes on the board where HIL are bound to need extra time for copying. Again, the provision of learning materials allows learners to access curriculum content at their own pace. This also suggests that Tsolo avoids the

use of ‘chalk and talk’, as he cannot look too often at the board while teaching or writing notes as this compromises learners’ opportunities to learn.

Lastly, Tsolo indicated that learner’s progress was assessed to see if they understood the concepts under discussion. He seemed to practise continuous assessment as per the CAP (2009) pronouncement that teachers should assess learners’ progress. With continuous assessment, Tsolo was able to assess any need for remedial teaching. Tsolo also considered using other learning resources as an effective way of teaching Science to HIL. He stated:

> I also use textbooks, charts or sometimes download pictures so that they can see what we are talking about. This is because when you have taught them with a picture or something they have seen, they are able to answer each question. Eh…it also becomes easier when you ask the question with a diagram. Most of the time or in fact always we should use things that learners can see and allow them to manipulate real objects.

It is evident that on top of the textbooks that learners have, Tsolo used other additional resources that contain pictures to increase the opportunities to learn for HIL. As mentioned earlier, he prioritised the active engagement of HIL through the manipulation of real objects. He seemed to consider this as an effective approach for HIL that supports the learning of Science concepts. This may lie behind the fact that Science is an abstract subject and ‘doing’ can enhance learning for HIL, because they lack language skills. Tsolo is also of the view that the way HIL are taught should align with how they are being assessed. That is, when they are taught through pictures or diagrams, questions and responses should as well be presented with diagrams. It is also evident that Tsolo understood the use of sight and touch as the senses that fully engage HIL in learning. On a final note, Tsolo’s belief is that visual representations and manipulation are essential for teaching Science to HIL. This agrees with the Science syllabus pronouncement that the teaching of Science should consider hands-on activities (MoET, 2002).

Tsolo considered teaching HIL in the following ways: he used diagnostic assessment which allowed him to assess learners' understanding. He also valued the use of experiments and practical work where learners are actively engaged in learning. He also used ICT to facilitate learning. He considered the use of books as effective for teaching HIL, which he complimented with the use of diagrams. He also advised that visual representation should be used in assessment.

4.3.3.4 Challenges of teaching Science to Hearing impaired learners

International protocols advocate for the education of all learners regardless of their disabilities but recognize that there are many challenges HIL are faced with despite their willingness to learn (Csizer & Kontra, 2020). Teaching learners with diverse needs has never been an easy task, especially for teachers who have not been prepared to accommodate such learners. In this section, the focus will be on the challenges that Tsolo encountered when teaching Science to the HIL.

Tsolo was teaching Science with the assistance of a language interpreter and indicated that in their absence, it becomes a challenge to clarify concepts for HIL. He explained:

> I still need to learn sign language because anytime deaf learners come to me to ask questions, it becomes a challenge when there is no interpreter. This is because I do not know sign language and cannot communicate with deaf learners without the help of the interpreter. Another point is, it is not easy for interpreters to go as fast as us because deaf learners need a lot of time to understand. With this comes the problem where I teach faster and forget that the interpreter is there and have to go slow for deaf learners. We go faster!

Tsolo showed that not being conversant with sign language was a challenge for him when trying to teach Science to HIL. It was apparent that Tsolo creates opportunities for all learners including HIL to consult him after class. However, he was faced with the challenge of communicating directly with them, as he lacked basic knowledge of sign

language. For this reason, he was unable to give them support even when he had time to do so. Tsolo showed a need to learn sign language so that he would be able to assist HIL in the absence of the interpreter. Another factor that necessitates Tsolo to learn sign language is the fact that he noticed that sign language interpreters were not competent to assist HIL to effectively acquire scientific concepts. He explained:

> I also realised that these interpreters explain concepts even when they do not have a deeper understanding of what you are saying. However, you would find that deaf learners have understood what has been said and assist the interpreter on concepts that are not clear to them.

The extract above shows that there are mistakes that interpreters make when interpreting due to a lack of understanding of scientific concepts but are often assisted by HIL. This suggests that not being conversant with sign language hindered Tsolo's ability to notice mistakes made by the sign language interpreters and as a result he was unable to intervene accordingly.

Another issue that Tsolo considered as a challenge was forgetting to regulate his pace during the lesson, in alignment with that of the sign language interpreter. Tsolo's remark that "we go faster" gives the impression that he acknowledged that he is not the only one who falls into the trap of unintentionally moving faster and leaving behind the HIL. This gives the impression that HIL might be at risk of not effectively acquiring Science concepts and Tsolo would then be compelled to remediate, which could affect the time factor. One would expect that slowing down the pace would correct this challenge, but Tsolo mentioned yet another challenge. He explained:

> It is not easy to do the whole syllabus within the year because from the beginning we have to go slower for deaf learners to understand everything in the syllabus. However, with videos and charts the pace increases. The other thing that could be done is to reduce the syllabus since it is too much to be done within the year.

Tsolo seemed to be in a dilemma about covering the syllabus and accommodate HIL by slowing down the pace. HIL seem to struggle to cover the content, hence he recommended different ways of dealing with this, such as the use of videos and charts or to reduce the content outlined in the syllabus.

Another challenge Tsolo was faced with was to adapt to what the context required of him. It seemed that there was a misalignment between how he had been trained and the actual context that he had to deal with in the classroom. He elucidated his experience:

> The other problem is that at training college, we were encouraged to move around the class to keep learners attentive in class. However, in my class I had to do things differently, stand in one position because any movement I make, I 'shade' deaf learners who depend mostly on interpreters.

It becomes evident from the extract above that context is a determining factor on what should be done in class. This comes with the result that what he has to do is guided by what is available on the ground, regardless of what pre-service training had prepared him to do. This shows that context is powerful in influencing policy implementation since it is teachers' role to do their best for all learners to access the curriculum content. This also highlights an important factor that is lacking in the policy documents that were reviewed. Teachers are capacitated with skills and knowledge and the context where they are working should also be taken into consideration.

Additionally, Tsolo was challenged when working in an unfamiliar environment. He revealed how the situation frustrated him in this way:

> It was a great challenge to work with children you don't know. Eh… I also found it somehow destructive since it was my first time to see learners using their hands to communicate. The presence of sign language interpreters was irritating and frustrating, but I ended up understanding

> that that's how they learn. Lately, I enjoy working with disabled learners because I have seen that they are children like others. I also realised that they feel more comfortable with us here at school than at home because their siblings and parents do not know sign language.

According to the extract above, Tsolo was challenged when teaching HIL and disturbed by the presence of the interpreter in the class. However, after some time he got used to them and acknowledged the importance of the interpreter in his class. This reveals that he was never orientated on how teaching and learning occurs in the class until he realised by himself that he cannot do anything without sign language interpreters. He indicated that school is the refuge for HIL since they communicate well with others, learn, and socialise with their peers. However, being unable to communicate with people at home may imply that HIL may not get any assistance at home. Therefore, this suggests that for parental involvement to see the light of the day, knowledge of sign language should not only be situated at school. This can only be possible when all learners are taught sign language like other official languages as pronounced by LIEP.

4.3.3.5 Teacher professional development opportunities

Teachers need continuous professional development for growth, as this entails the acquisition of skills and knowledge required for quality education (Shibankova *et al.,* 2019). Tsolo had been through training in special education at the College of Education. He explained:

> I think we were not given enough content … it is true that there was that course on special education. However, things like sign language were just there as theory. For instance, we were taught how we can teach a certain learner with disability. We were just told that you should use sign language when teaching HIL. But we were never taught sign language. Eh…eh…I can say we were not prepared or equipped that much to teach learners with a certain disability.

Tsolo indicated that the pre-service training he went through did not prepare him adequately enough to teach Science effectively to learners with special needs. In Tsolo's view, teaching the HIL involves the use of sign language, but the course did not equip him with this important skill. He expanded on the disadvantage of not knowing sign language in this way:

> Being unable to sign also makes us make assumptions that deaf learners may have understood but realise later that they did not. This somehow affects learners' performance and I find it important to learn sign language.

He explained the lack of sign language as limiting him from identifying whether HIL have understood what was being taught. As a result, the level of the learners' understanding would only be realised at a later stage when they are assessed.

Tsolo shows that his lack of competence in teaching HIL is another contributing factor to them being slow when learning. He also views a knowledge of sign language as very important in enabling one to communicate directly with HIL. Tsolo shows that with this skill he would not have to make assumptions about whether learners have understood concepts when they have not. Knowledge of sign language is reflected in the following incidence by Tsolo as an essential accommodative strategy. He explained:

> When teaching, the interpreter is always coming after me, but I am not always aware when deaf learners are left behind. I think teachers being equipped with sign language interpreting skills may do better when teaching deaf learners. That would enable us to communicate with these children without the interpreter's assistance.

The extract above indicates Tsolo's belief that addressing HILs' needs depends on communicating well with them. He seems not to be content with the fact that he relies on interpreters when teaching HIL, as he mentioned earlier that he cannot assist them alone even at break time due to the language barrier.

Tsolo indicated that together with Science teachers from schools in close proximity, they work collaboratively in preparing the scheme of work for the coming week. He viewed collaborative planning as empowering him to do his work better. With the scheme of work, the content is selected logically for learners to understand the concepts to be taught. He clarified:

> I work with teachers from other schools on how to teach Science. We meet on Fridays after school and prepare topics to deal with the following week. We also look at these topics on how we are going to teach them, and my work becomes simpler in that way. Actually, you will find that I have a problem with some topics and that is the time I organise with those teachers. I tell them that I have a problem within a certain topic remembering that I have students with hearing impairment. They give me basics and when I come to class, I come prepared.

The extract above gives evidence that whenever Tsolo is confronted with challenges in terms of content, he gets support from other teachers. This shows that teachers work together sharing knowledge and skills on how to deal with any challenges they are faced with.

Tsolo acknowledged that at times they get opportunities to conduct study tours to learn from other schools who with HIL in regular classrooms. He clarified: “We only went to another school in SA to learn how they work with learners with hearing-impairment.” This is a ‘communities of practice’ example that enables the transfer of skills between people working in a common field (Glaze-Crampes, 2020). Nonetheless, Tsolo pointed out that these forms of teacher empowerment were not enough to equip him with the knowledge and skills he needed to handle HIL in his class. He elucidated: “We are not trained, and we lack skills on how to teach deaf learners and that makes us teach at a slower rate.” The aforesaid quotation gives evidence of what Tsolo understood as the root cause of the dilemma he mentioned earlier, namely of regulating the pace of the lesson and content coverage - the lack of skills due to the absence of in-service training. It is on this basis

that LIEP emphasises that teachers be engaged in continuous professional development (CPD) that prepares them to address the diverse needs of the learners.

4.3.3.6 Summary

Tsolo is an inexperienced teacher who is passionate about teaching as a profession. He indicated that he always starts his Science lessons by first preparing the scheme of work with the assistance of teachers from other schools close to his. He also showed that most Science topics are practical and are effectively taught when learners are engaged in activities.

Tsolo found teaching HIL as very challenging, but that motivated him to explore different ways that he could engage them in learning. He believed that HIL could learn Science like other learners when certain issues are taken into consideration. He seemed to believe that being capacitated in technology could help him avoid repetitions and increase HIL's pace of learning. Tsolo indicated that in the beginning the presence of the interpreter did not make him feel at ease, but he later realised that he could not do without them. He also showed that for a teacher knowledge of sign language is very important when teaching HIL, as this would allow him to assist HIL anytime, they needed his assistance. He also showed that the use of technological teaching aids such as a projector, when coupled with the presence of the interpreter promotes learning.

Tsolo stated that the use of experiments and the manipulation of objects helped learners understand and hold information for a longer time. He made an emphasis that HIL learn better when concepts are repeated, and the teacher is teaching slowly. He also showed that when teaching HIL, one should not be too quick as this will not help them to understand. He also clarified that as much as these accommodative strategies helped his learners understand concepts better, they are time consuming, and learners cannot complete the syllabus. He also found that messages communicated at pre-service training contradict the real classroom situation. For instance, he realised that when teaching HIL, he has to stand in one position so that they can see the interpreter. This

indicated that context has a big influence on the choice of pedagogical practice and that he created opportunities to learn in line with the calibre of learners he was dealing with. This shows his cognisance that what works for one group of learners may not work for everyone. Tsolo believed that HIL can learn Science like any other learners when issues such as being conversant with sign language are taken into consideration. He seems to believe that being capacitated with technology could avoid repetitions and increase HIL pace of learning. Tsolo concluded that he was not competent to teach HIL and that this could have contributed to delays and HIL being slow to grasp the content.

4.3.4 Case 4: Mr. Nare

4.3.4.1 Personal Background

Mr Nare is a certified Physics and Mathematics teacher holding a diploma in education. During the time of data collection, he had two years of teaching experience. Nare described: “I have a diploma in secondary education, and I am a Physics and Maths teacher. I have been teaching for two years in this school.” It becomes apparent from the extract above that Nare was really a novice teacher with only a two-year teaching experience. It was also his first time to teach in a class with a hearing-impaired learner. When asked why he majored with Mathematics and Physics, Mr Nare indicated that those are his favourite subjects from primary school, and he explained that he liked those subjects. He clarified:

> Since my primary level, I was one of the best performing learners in Science … so I like it. I developed that from primary level, then after writing Form E I decided to major in Physics because it is my favourite subject.

Mr Nare’s choice of being a Science teacher as a profession emanated from his passion and good performance in those subjects in early grades. One would believe that Nare’s competence coupled with his interest in the subject may have leveraged his willingness

to teach. Thus, it is intriguing to explore what he understood as good practice when teaching Science to HIL.

Nare worked at a school located in a Northern district about 46 km from the capital town of Lesotho. He explained the context of his class in the following manner:

> It was my first time experience teaching a learner with partial hearing-impairment. I am teaching fifty-two learners including one with a hearing problem. He can hear only when you are close to him, and he talks with a loud voice.

The evidence shows that it was the first encounter for Nare to teach in a class with a HIL. He also realised that this learner could access information only at a close range. It seemed that his class was also overcrowded, and he stated that there were fifty-two learners. Having discussed Nare's background and the context of where he was teaching it was imperative to find out how he experienced the teaching of Science.

4.3.4.2 The teaching of Science

The teaching of Science is one of the areas given attention globally since it fosters the development of 21st century skills (Fairuz, 2019). These skills are essential for dealing with a myriad of challenges in this world. One of the contributing factors for learner achievement in Sciences is how they are taught; hence it is important to understand what Nare believed to be the best ways of teaching Science. He indicated that the first thing that he does is to prepare for the lesson by drawing a lesson plan. Nare noted that his lesson plan is not formally prepared, but he considers learners' differences in understanding of concepts. He explained.

> I prepare a normal lesson plan and consider learners' different intelligence and difficulties. I sit down to prepare a lesson with the syllabus and the textbook. This writing the formal lesson plan is not helping. This is because you write down things that you may not do in

> front of the learners. I only write things I consider important. Firstly, a lesson focuses on the lesson objective and strategies only.

Nare showed that teaching Science entails lesson preparation even though he didn't consider a formal lesson plan to be helpful. He regarded lesson objectives and teacher approaches as key issues that should appear in his lesson plan. He seemed to plan his lessons in such a way that he would consider different levels of cognitive ability. It is also clear that Nare's pre-service training prepared him to develop a lesson plan, but he always opted for what he considered useful for him. Nare justified his practice in that he avoided writing down things that he may not end up doing in class. Hence, he excluded what he found irrelevant when making the lesson plan.

Another strategy that Nare found effective when teaching Science can be likened to 'inquiry-based learning' where learners find information by themselves (Laksana, 2017), as suggested by this remark:

> The most appropriate method is this one you give learners a problem and allow them to work on it so that at the end you allow them to hypothesise. At the end of the session, you go on and identify some mistakes they made. It is easy for them to identify their mistakes.

The evidence shows that this strategy allowed Nare to give learners an opportunity to take responsibility for their learning. It also gave learners the liberty to notice their mistakes and correct themselves. This suggests that Nare doesn't always need to provide solutions for learners, but only intervened where necessary. This gives the impression that Nare's role was to guide learners and monitor their progress. This is in line with the earliest definition of a learner-centred approach by Estes (2004) where the teacher uses learners' experiences to facilitate the lesson.

The use of experiments is one effective way of teaching Science that Nare mentioned. He stated that after giving learners an activity to work on, he allows them to conduct experiments by themselves. This is how he clarified his views:

> The learner should be allowed to work and discover for himself. I give them an activity before the laboratory experiment and allow them to work and come to their conclusion and solution.

Nare believed that giving learners an opportunity to explore the topic under discussion prior to carrying out experiments as being very important for their learning. After conducting experiments learners are expected to draw conclusions. This implies that he considers this process as essential for learners to develop an understanding of the topic being taught.

One more strategy that Nare used, is grouping learners according to their cognitive abilities, based on how fast they understand concepts. He clarified:

> I make sure that I always classify these learners in groups about their pace of learning, so that I deal with the same problem in each group. If it is a group of slow learners, I give them simple things to do, while fast learners I give them more challenging tasks.

Nare seemed to have understood this strategy to be effective for increasing learners' opportunities to learn. He believed that this enabled him to support learners in their different areas of need depending on their level of understanding.

4.3.4.3 Teaching Science to hearing impaired learners.

Teaching difficult subjects such as Science is possible but depends on how it is done (Nandiyanto *et al.,* 2018). This section outlines Nare's explanation of the best approaches for teaching HIL. The first strategy that Nare noticed to be effective when teaching Science to HIL is the discovery method. This is how he explicated benefits and disadvantages of this method:

> I said discovery method is suitable for teaching hearing-impaired learners but with this hard of hearing learner, it is slow. He takes a lot of time to

> hear and understand concepts especially when you are not allowing him to work on his own with close supervision.

The discovery teaching approach has an element of independent learning, but Nare shows that with HIL the progress is too slow without close supervision. That is, HIL cannot do their work without the assistance of the teacher, because it takes time for them to understand. It seems that the purpose of Nare's presence near a HIL is to speed up his ability to grasp content. Nare seems to have modified the discovery teaching approach for the HIL to be on par with his counterparts.

Nare mentioned experiments as an effective way of teaching Science to HIL. He explained:

> That boy who cannot hear is at his best when we do experiments. But concepts such as kinetic theory of matter do not allow us to conduct experiments, that is … we only talk and explain concepts to him but it becomes difficult for him to understand since it needs a listening skill.

According to Nare the ideal strategy for teaching Science to HIL is the use of experiments because they can bring desirable outcomes. This may be due to that fact that the use of experiments entails the manipulation of concrete objects and can create the opportunity for learners to see what is being taught. To compliment experiments Nare used a discussion method and the extract below manifests this:

> We discuss during the experimentation, and it is not easy to include this hard of hearing learner. I prefer to exclude him during the discussion because he has a problem of hearing and some students do not cater for him. For instance, he has to read-lip facing learners but some of the learners are not cooperative and do not face in his direction. So I always exclude him and take him one on one after the class discussion.

The evidence above shows that Nare preferred to use discussion to serve the majority of learners in his class but HIL did not benefit from this. Hence Nare decided to exclude him when having a discussion. Even though Nare indicated that he provides support to the HIL through one-on-one sessions, it is quite clear that this learner did not have an opportunity to learn from his colleagues during classroom discussions.

Another strategy that Nare used is a lecturing method which appears to be an alternative when experiments could not easily be conducted. This suggests that Nare viewed the nature of the topic as a determining factor when choosing the teaching approaches to be used in class. Nonetheless, a lecturing method could compromise the HIL's learning opportunities, as it requires a listening ability they do not have. This strategy could also be ineffective in Nare's context, as there are no sign language interpreters in his school. Nevertheless, Nare clarified his accommodative strategy for HIL in this way: "I place the HIL in the front seat of the classroom so that he could hear me clearly." In this case the choice of a teaching approach is justified with learner placement.

Another teaching strategy that Nare used when teaching the HIL is the provision of extra work. This was only arranged for the HIL so that Nare could explain the concepts that may not have been clearly understood in the classroom. "Sometimes we give this partially deaf learner extra work so that he consults me in his own time, I give him something like extra classes." This indicates that unlike other learners, Nare found it important to give remedial teaching to this learner so that he/she could catch up and be on par with the others. The discussion was mainly based on Nare's approaches to teaching Science to HIL. It is now necessary to find out what he elaborated as challenges.

4.3.4.4 Challenges of teaching Science to hearing-impaired learners

HIL are studying Science, yet they have a language deficiency that denies them the ability to communicate effectively with either their teachers or other learners (Rusyani, 2021). It is therefore important to understand the challenges Nare encountered when teaching HIL.

He acknowledged that he often encountered difficulties when teaching Science to HIL. He provided a detailed explanation as follows:

> It is hard to cater for the needs of HIL, I sometimes forget that I am preparing the lesson for a class with HIL and focus on learners without any disability who are doing well in Physics. Hmm… to be honest I sometimes plan the lesson without the consideration of this learner.

From the extract above, it seems that Nare encountered challenges when planning the lesson that caters for the needs of the HIL. The fact that he, at times, forgot to plan for a HIL gives the impression that it is likely that the opportunities to learn for HIL could be minimised. Nevertheless, his acknowledgement of this shortfall could suggest that Nare was willing to improve. This can be justified by his remark that, "[w]hen encountering the problems that's when you become stronger." This suggests the difficulty he experienced when teaching a HIL helped him to grow professionally. This is evident in the extract below as he explained another challenge he came across when teaching HIL:

> It is challenging to teach a learner who does not hear but it improves some teachers' individual intelligence and skill of teaching. You may find that I like this teaching approach, but it is not suitable for achieving the objective for this learner, so I try a different teaching approach.

This extract seems to suggest that Nare considered these problems as an opportunity for him to develop new teaching skills and become more competent and responsive to learners' needs. This also gives clarification that Nare was able to see when the teaching approach did not work for his learners, and he would try another approach. It shows the efforts that Nare made for the class to be accommodative for a HIL, even though this might go against his personal preferences. He further clarified this issue in the following manner:

> Teaching a deaf learner is challenging but improves my level of thinking, creativity, and patience. With these I develop a strategical approach to

> come up with a variety of learning methods. You would find that in my lesson plan I prepared to use a certain teaching approach but find that it is not suitable for achieving my objectives. So, you would try a different teaching approach.

The extract above reveals that sometimes classroom realities compelled Nare to deviate from his plan. He seemed to change his intended teaching approach when the need arose. This agrees with Emiliasari and Jubaedah's (2019) assertion that even when the lesson has been prepared, teaching and learning goes beyond that. It becomes apparent that Nare was observant of the classroom realities and did all in his power to accommodate HIL. Nare seemed to be creative and flexible with changing plans towards providing opportunities for HIL to have access to scientific concepts. He kept on preparing the lesson plan even when he knew that many teaching approaches are liable to be changed as per the learners' need. Nare found it challenging to teach abstract concepts to someone with hearing-impairment when they need listening skills. This is how he clarified this problem:

> It becomes difficult to teach concepts that need listening skills such as for kinetic theory. This theory is abstract, and we cannot use concrete materials to describe them or use experiments. The most challenging part when teaching kinetic theory through a lecturing method is it wastes time. You will always refer to him and say did you hear? But find that he did not hear anything […]. This teaching approach is not suitable for achieving the objective because we don't see or do an experiment. It also becomes difficult for this hard of hearing learner to understand.

Nare explained that teaching abstract concepts is challenging especially when experiments cannot be used. Evidently, Nare resorted to use lecturing, which most definitely requires a listening skill. According to him using this strategy for a HIL is a complete waste of time. He reiterated similar concerns when talking about the relationship between Physics and Mathematics concepts. He elucidated:

> The learner can do better in Physics when he is good in Mathematics, but you may find that Maths is always a problem to many learners. Again, Physics concepts are abstract, and it is not easy for hearing-impaired learners to link those concepts to Mathematics.

Nare believes that a clear understanding of Mathematics concepts is fundamental for learning Physics. This implies that learners capable in Mathematics stand a better chance to do well in Physics. This also explains that the effective learning of Science for a HIL is hindered by the inability to establish links between concepts in these two subjects. Nare's understanding of teaching Physics agrees with Li and Schoenfeld (2021) that Mathematics should be connected to the teaching of Science for a better understanding of scientific concepts. Another problem Nare pointed out is the overcrowded classroom. He lamented:

> Another challenging experience is I am teaching a class of fifty-two learners, and I have to make sure that all learners understand the concept and do hands-on activities. Hmmm…I have to reach all learners' capabilities and it is indeed not easy.

The quotation gives the impression that Nare was overwhelmed to teach in a crowded classroom. He seemed to understand what is expected of him, but he acknowledged that it is not an easy task to ensure that every learner in such conditions understands what is being taught. The greatest challenge that Nare discovered in his practice was to engage a HIL during discussions. The extract below shows the negative consequences of using a discussion method in the presence of HIL in class:

> Another challenging part of the discussion method is that it wastes time. This is because before moving to the next concept, I get back to him and ask, did you hear? And then he says "yes", and if I ask him to tell me what I said, I always find that he did not hear anything. With that, I always have to go back and start afresh.

Nare's belief is that a discussion method does not create opportunities to learn for the HIL, as it requires a listening skill. Evidently, Nare was often compelled to reteach what might have been discussed in class, after realising that this learner did not understand the concepts that had been taught. Hence, he considered this method as a waste of time for the HIL. Again, the extract above provides evidence that Nare checks on HIL progress before moving to the next topic. This is assessment for learning and is regarded by CAP as the best practice when teaching, as it helps the teacher check on learners' progress. However, Nare complained that every time he checks on this learner's progress, he finds that this HIL has not understood anything. It is based on this incident that Nare finds a discussion method as not effective for teaching a HIL, instead he finds it time consuming, as he always must start afresh when finding out that the learner did not understand anything.

This section demonstrates that Nare was faced with several challenges when teaching Science in the presence of a HIL, but he believed that these struggles contributed to his professional growth. The evidence for this is shown by his efforts when he tried different teaching approaches to help HIL to understand the Science concepts. This also implied that Nare strived to achieve education for all.

4.3.4.5 Teacher professional development opportunities

There is a global concern that most teachers lack the appropriate skills for teaching and so professional development is used by different countries as a strategy to improve their skills (Popova *et al*., 2022). Teaching learners with disabilities is a current reform that requires professional development so that teachers can do what is expected of them in schools. It is therefore important to explore and understand the kind of professional development Nare had undergone for teaching Science to HIL. When asked how he had been prepared to teach HIL in his pre-service training, Nare explained:

> We were somehow prepared through special education, which however was not a subject but a highlight on how learners with different disability

> could be taught. We did not go deep into teaching deaf learners. We were given some skills on how to capture learners' interest through our voice, we were taught of when to change the loudness of the voice.

The extract above indicates that Nare did get a special education module in pre-service training. Surprisingly he referred to the training he went through as inadequate since it did not assist him to teach Science to HIL. He clarified that it only introduced him as to how to teach learners with different disabilities, without specifically focusing on how Science should be taught to HIL.

Nare showed that there are limited opportunities in terms of the provision of in-service training. He elaborated:

> We don't have accurate or sufficient material that guides us to teach. What I need is the support from the Department of Education to be able to teach deaf learners effectively. The ministry can support us with expertise on how to teach HIL. We need to attend workshops because some of us have about ten years since tertiary and a lot is changing in our education.

This quotation shows that there is a scarcity of continuous teacher professional development. Nare seems to believe that through training workshops he can do better. He also acknowledged that he has been in the teaching service for a long time with many reforms happening and teachers need to be upskilled in order to be relevant. This challenge is well captured in LIEP, as it indicates the importance of teacher preparation when teaching learners with diverse educational needs.

4.3.4.6 Summary

Mr Nare is a qualified Physics and Mathematics teacher with a diploma in education. He is a teacher with only two years of teaching experience. It was also his first time to teach HIL. Nares choice of the teaching profession stemmed from his passion and good

performance in his subjects at early grades. His interest and competence in these subjects seemed to have leveraged his willingness to teach.

Nare indicated that he viewed drawing up a lesson plan as the appropriate way of preparing to teach Science. He stated that he does not develop a full lesson plan but looks carefully at what and how to teach. More attention is given to the objectives of the lesson and the teaching methods. Even though Nare received pre-service training that prepared him to develop a formal lesson plan, he seemed to believe that the objectives and teaching methods are the important components of a lesson plan. Nare further explained that he starts his lesson by giving a problem to learners for them to hypothesise and work on. This is a learner-centred approach where learners are given the chance to learn on their own where the teacher appears as the facilitator.

Additionally, Nare indicated that the use of experiments is an effective way of teaching Science. Nare revealed that teaching HIL helped him to grow professionally, because he had to explore different teaching approaches to accommodate the needs of HIL. This explains that even though Nare did not prepare a proper lesson plan, he was cognisant of HIL needs. Nare continued and mentioned that the use of an experiment is an effective way of teaching Science to HIL since they are engaged in learning. This teaching method widened HIL opportunities to learn through their active senses of touch and sight. Nare complied with ‘opportunities to learn’ which states that the capabilities of individuals should be a determining factor for the type of assistance they need. The focus should not be on what disabled individuals cannot do.

Nare also indicated that discussions were always coupled with experiments for learners to understand what was expected of them. He however made it clear that he had to exclude HIL from any discussion because owing to his or her impairment, it took a longer time for them to understand what was discussed. Nare chose to come closer to HIL after class discussion and explain what was discussed. He stated that this strategy assisted him to move faster. Nare also conducted remedial teaching in the form of extra work for HIL and this allowed him to be one-on-one with the learner. Nare considered grouping

learners according to their abilities and this was effective for him to move faster from one topic to another. This is what is called ability-grouping and Nare customised the activities or classwork given to his learners. This is to say that learners are given activities based on their understanding of the concepts.

Teaching HIL seemed not to have been an easy task for Nare as he indicated that he sometimes forgot to include HIL in his lessons. This indicates that teaching approaches planned by Nare left HIL behind. He also seemed not to be that accommodative from the inception of his lesson plan. He also indicated that the inability of HIL to establish a link between Mathematics and Physics made teaching HIL difficult. Another problem Nare pointed out was the overcrowded classroom, which made it difficult for him to address the diverse needs of the learners. He also showed that not all topics can be well presented through experiments and that he resorts to lecturing when teaching these topics. Nare acknowledged that he was not thoroughly prepared to teach HIL and was only introduced ‘a little bit’ as to how to teach learners with different disabilities. He indicated that teaching HIL challenged him and with the absence of training workshops and the guiding materials, the situation was only made worse.

Chapter five: Summary of Findings, Discussion, Conclusion and Recommendations

5.1 Introduction

In the previous chapter (chapter 4) I presented data generated from interviews with teachers and documents analysis. Themes were generated from their stories teaching Science to HIL and the educational documents guiding teaching and learning in schools. The interview questions and formulation of themes in the document analysis were informed by theories of 'opportunities to learn' and; 'capabilities framework'.

This chapter concludes the study and seeks to address the main research question. Firstly, there is a discussion guided by the literature and theoretical frameworks underpinning this study, giving an account of teachers' experiences of teaching learners with hearing-impairment in Lesotho secondary schools. Secondly, a conclusion is drawn about what teachers regard as their experience of teaching Science to HIL. Lastly, recommendations are made on what should be done in future research. Classroom practice and policy recommendations for relevant education stakeholders are also presented.

5.2 Summary of the study

This study sought to investigate teachers' experiences of teaching Science to HIL in secondary schools. The study showed that there are effective teaching approaches when teaching Science to HIL. It also revealed teachers' views on challenges of teaching Science to HIL and their reflections on the availability of professional development opportunities or lack thereof and how this affects their teaching. What triggered the existence of this study were the increasing clarion calls for every member of society, regardless of their abilities or disabilities, to contribute positively towards the economic development of their countries (Khan *et al*., 2019). It is worth noting that scientific literacy

equips individuals with skills essential in solving the ever-changing challenges of this world (Akben, 2018). Hence Science is compulsory at secondary level and is taught to all learners including HIL to prepare them to be problem solvers. Even though Science is hailed as playing a significant role in economic development, Petrus (2018) argues that for different reasons it continues to be poorly performed by students around the globe. While this is a problem even to learners without any form of impairment, one would want to think about what it is like to teach HIL. Considering that HIL allegedly lag behind their counterparts (Meghdari & Alemi, 2020) I was curious about what teachers experienced as effective approaches for teaching Science to this group of learners.

The literature shows that language is a very important tool to facilitate teaching and learning (Merecraite, 2022). This aligns to Adeniyi and Kuku's (2018) conception that language plays a powerful role in individuals' cognitive abilities and has a significant influence on one's critical thinking. This suggests that without language, effective learning cannot happen, since it involves communication. BIrinci and Saricoban (2019) enlighten us that HIL are as well cognitively capable even though they lack verbal communication. This indicates that HIL can do better when their language inability is compensated with appropriate learning strategies. Therefore, it becomes teachers' responsibility to use teaching approaches that address diversity in their Science lessons.

'Science for all' opened doors to most learners, including learners with impairments. However, research shows that the HIL tend to struggle in understanding abstract concepts due to limited language proficiency (Atika *et al.*, 2018). While one would think that sign language would effectively facilitate the teaching and learning of Science to HIL, Raven and Whitman (2019) argue that the lack of available vocabulary is a challenge that has to be given serious attention. It is also believed that creativity among Science teachers could solve a myriad of challenges inhibiting HIL to actively participate in teaching and learning activities (Adigun & Nzima, 2021). With these aforesaid views, my study intends to provide evidence-based findings on how teachers view effective approaches for teaching Science to HIL in Lesotho secondary schools.

This study employs a qualitative approach, which enables participants to verbally present their views and experiences; therefore, data generated is in words not numbers. This approach appeared to be appropriate for the study because it allows participants to be engaged at their working places to give insightful information on their experiences. Interviews and document analysis were used to gather data responding to the main research question, which is: What are Science teachers' experiences of teaching learners with hearing impairment? The subsidiary questions are:

a) What teaching approaches do Science teachers employ when teaching learners with hearing-impairment in Lesotho secondary schools?
b) What professional development opportunities are available for Science teachers teaching learners with hearing-impairment in Lesotho secondary schools?
c) What are the challenges of Science teachers in the teaching of learners with hearing-impairment in Lesotho secondary schools?
d) How can teachers' experiences of teaching learners with hearing impairment in Lesotho secondary schools be understood and interpreted?

5.3 Key findings and their implications

This section presents the main findings of this study as follows: a) Placement of HIL in a classroom, b) effective approaches of teaching Science to HIL, c) lack of content knowledge amongst interpreters, d) language as a barrier when teaching Science to HIL and e) lack of teacher professional development that is key when teaching HIL.

5.3.1 Placement of hearing-impaired learners in the classroom

One of the key findings is that teachers have realised that placement of HIL in front is a contextual factor that increases their opportunities to acquire information communicated in class. Nare explained: "He is able to hear, more especially when you are closer to him, and I make sure that this deaf learner sits in the front seat." This shows that it is the teacher who decides where the HIL should sit to increase their chances to hear what is

communicated in class. It also shows that often the learner is not completely deaf and placing them in front gives them an opportunity to use their residual hearing. Similar to this, Mpho indicated that they arranged learners in the first two columns so that they could see the interpreter. She indicated that it allowed them to move without blocking HIL from being able to see the interpreters. She further showed that due to limited space, they could not use the idea of the education officers that a horseshoe arrangement could be good seating position for HIL to access information in class.

Kumatongo and Muzata's (2021) also view the classroom environment as important to enable HIL to utilise their residual hearing. That is, HIL should always be closer to the information source which most of the time is the teacher who stands in front. Braun *et al*. (2018) point out that seating in a large circle could be a good arrangement that is appropriate for HIL, as it does not impede them from accessing the information. Harahap *et al*. (2020) add that the seating arrangement should always enable the HIL to see lip movements and facial expressions of both the teacher and the interpreter. This indicates that with HIL, a bigger space is more convenient for them while their placement in front should always be a priority. Iqbal *et al.* (2021) also show that the seating arrangement of the learner should be considered from the planning phase of the lesson. The intention of this is to align learner placement with classroom activities and the preferred teaching approaches from the inception of the lesson.

The discussion above shows that access to a Science lesson is not only guaranteed by HIL's presence in class, but by also about being mindful of their placement. It is on this basis that participants regarded placement of the learner as an accommodative strategy that enables HIL to access content. Zafar *et al*. (2021) are also of the view that the classroom setting should be arranged in a manner that allows HIL to see interpreters' gestures. This is in line with Robeyns's (2006) idea that accommodative strategies should be informed by individual's needs. That is, opportunities presented for learning should always align with individuals' abilities. It is noteworthy mentioning that this could be done in different ways but Ardianingsih *et al.* (2020) show that when teaching HIL, the placement of HIL should be considered as playing a significant role in providing them with

a learning opportunity. This study reveals that teachers are fully responsible for choosing opportunities to learn for HIL and are informed by their capabilities.

5.3.1 Effective teaching approaches for teaching Science to hearing-impaired learners

Out of many teaching approaches outlined in the literature review, participants identified that the active involvement of learners through experiments is the most effective way of teaching Science to HIL. Thuto explained:

> helping students with Science … you have to do experiments […] even when you give them a test, a quiz or classwork, you will see that the one that he has done experiments … he is doing it better.

The extract above shows that the effectiveness of experiments was evidenced by HIL's high marks attained when assessed. Thuto further showed that experiments connect Science knowledge to daily life issues and learners are given an opportunity to see what is being discussed and their understanding is enhanced. This agrees with the syllabus and curriculum policy prescriptions that show that a learner-centred approach using experiments should be used when teaching Science.

Tsolo explained further that experiments are effective for engaging learners in learning especially HIL who do not have literacy skills. He also stated that engagement of HIL in experiments increases their opportunities to learn as they understand concepts more easily. Tsolo also had the view that most Science topics are practical and are more effectively taught when learners are engaged in experiential activities. He explained further that the use of experiments with the manipulation of objects helps HIL to hold information for a longer time. Similarly, Mpho believed that using experiments and

demonstrations allowed learners to use their sense of sight and be able to understand scientific concepts better.

According to Rodrigues *et al.* (2022) a sense of sight is optimally utilized by HIL when learning. Hence participants consider the use of experiments as an effective approach when teaching HIL. There are different ways of conducting experiments as explained in chapter 2, and Nare viewed the use of experiments differently from his counterparts. He believed that learners learn better when experiments are conducted by themselves. This according to Margunayasa *et al.* (2019) is guided-inquiry and this promotes learning. 'Where' learners are taught is a crucial aspect one must consider when teaching Science, as Kumatongo and Muzata (2021) show that the environment has to be considered all the time so as to stimulate the learning process.

Kalyon (2021) adds that the learning environment could be in different places, such as the laboratory where experiments are conducted to effectively convey the subject matter to learners. It is noteworthy to indicate that with experiments, not only are learners provided with cognitive knowledge, but they are also prepared to be problem solvers. Therefore, the capability of the learners to solve problems is aligned with their deeper understanding of concepts. The provision of cognitive knowledge when using experiments is reflected by learners' ability to construct sound scientific arguments (Najami *et al.*, 2020). This says that when experiments are appropriately used, learners are engaged in real Science processes, and this promotes meaningful learning.

The use of experiments reflects an inquiry-based approach where learners are not only engaged in active learning but are also motivated to learn Science (Marchut & Gormally, 2019). This is also an approach which according to Wilcox and Lewandowski (2017) prepares learners to engage in scientific processes. It also enables learners to be exposed to experiential-learning and thus develops high order skills (HOS). Such skills include critical thinking and analytical skills, which enable individuals to solve real-life problems. The use of experiments enables learners to apply and link scientific concepts

to their individual daily life experiences. This can be linked with experiential-learning, whereby what is learnt is directed at the individual's life experiences (Kolb, 2014). With this approach, learners might be capable of solving rapidly changing social problems (Zain & Jamdi, 2018).

Again, with experiments learners engage all their senses to construct knowledge about Science processes and this according to Shambare (2022) promotes learning. That is, teachers do not only provide learners with an opportunity to write about the phenomenon under discussion, but there is also direct contact with what is being discussed. This enables learners to be taught according to their learning styles and be equipped with scientific processing skills. In this, the role of the teacher is to pose questions and allow for discussions (Margunayasa *et al*., 2018). However, the data presented showed that participants are challenged when it comes to including HIL in discussions. Nare explained: "We engage in discussions during the experimentation, but it is not easy to include a deaf learner. I exclude him from the discussion and take him later one-on-one". Experience has given teachers a clear direction on how to modify their teaching approaches in a manner that meet HIL's needs.

The use of discussions seems to have left HIL behind, but this teacher devised a strategy that would accommodate them. This indicates that in a diverse classroom, not all opportunities to learn could be accessed by every learner unless they are differentiated to accommodate their needs. That is, in a diverse classroom the teacher is bound to use different modalities of content delivery, while in the end all learners are expected to achieve the stipulated learning outcomes. This aligns with the principles of the capability framework which accepts that individuals are different, but education is a necessity for their well-being and should be accessed equally by everyone (Terzi, 2007).

It is worth noting that visual representations and the touching of concrete objects play an important role in HIL's learning (Liu, 2020) and this is the learning opportunity presented by experiment. Xohua-Chacón *et al*. (2022) share a similar sentiment that education for HIL yields good results when aligned with the ways learners access information. This also

relates to Broderick's (2018) conception that there has to be a response to human diversity in education, to allow individuals to participate equally and reach their potential. 'Participation for all' is what teachers identified as an outstanding benefit of using experiments in their diverse classrooms.

Additionally, teachers' willingness to explore different teaching approaches made them aware that the use of laboratory experiments allows learners to manipulate objects. Rusyani (2021) alludes that experiments create an opportunity for learners to learn through the touching of concrete materials and enables HIL to understand abstract concepts. According to Cheng and Lee (2022) manipulation does not only enable learners to understand concepts easily but it also develops positive attitudes towards learning. Therefore, concrete materials seem to compensate for the sense of hearing that is deficient in HIL, as they utilise their active senses of touch and sight to construct knowledge in their minds.

Teachers' focus is not on what HIL cannot do as they opted for other functional sense organs that can enable them to access the scientific information. This agrees with Mitra's (2006) view that access to opportunities should be enabled by matching learners' abilities or characteristics with resources. In this case, HIL's inability to hear is compensated by their sense of sight and touch that can enable them to access the curriculum content. Teachers seem not to interpret learners' disability by what they cannot do, instead by what learners have and could do. Participants are enlightened that impairments need to be taken into consideration when teaching HIL. Therefore, teachers realised that the use of experiments is a teaching approach that could be used for HIL to access scientific content. The descriptions given reveal teachers' understanding of disability as an attribute that emerges when teaching approaches do not align to learners' capabilities. This aligns with Sen's (1992) explanation that for individuals to achieve well-being, the focus should not be on what they cannot do; instead look to what they can do. This also agrees with Terzi's (2014) conception what learners cannot do should not be the central point of

teaching and learning, rather they should be assisted to acquire information using their capabilities.

Another approach regarded as effective is the integration of ICT when teaching Science to HIL. Mpho's experience made her realise that in the absence of laboratory equipment, projectors or computers could be used for the demonstration of experiments. She enlightened:

> I don't know… but for some experiments we might not have the equipment to use but since they learn by seeing, if you can have a projector or computers, whatever we want to have we can just project.

This agrees with Rodrigues *et al.*'s (2022) view that HIL learn better when engaging their sense of sight. Therefore, integrating visual representation in their teaching and learning should increase their opportunities to access information. The extract also explains that ICT can also be used to fill gaps in instances when a lack of laboratory equipment restricts teachers from conducting experiments. Such include the use of videos to explain a certain concept. Tsolo also explained his experiences:

> I used to teach deaf learners with mobile phones, smart phones, send them notes and ask questions based on that and then will see if there is a progress. Sometimes when I cannot do experiments, I just download videos and make them watch them to understand more.

The extract above shows that Tsolo shares instructional materials through ICT that can be read by learners in their own time and at their own pace to deepen their understanding. This compliments information attained from the sign language interpreter during the lesson. Khurshid and Bibi (2020) allude that using ICT, even slow learners can go through learning materials many times until their learning is improved. Tsolo further showed that not everyone in his class had a mobile phone and in such a situation he opted for group work. This shows that even when teachers are confronted by a lack of resources

modifications to the same approach could be opted to accommodate all learners. This mimics UDL as explained by Neild *et al*. (2022) that most of the time the choice of teaching methodologies should align to learners' needs to broaden their opportunities to learn.

Integration of ICT for effective facilitation of scientific concepts is not unique to those who participanted and described their experiences but was also identified in the document analysis. The documents revealed the importance of learners' understanding of scientific and technological concepts, principles, and processes for them to contribute positively towards socio-economic development. It is through the integration of ICT in teaching and learning that learners might acquire the skills. Chatwirakom (2018) takes the discussion further that the same integration of ICT in teaching and learning of Science improves both learner attitudes and performance. Again, with ICT, there is an optimum provision of visual representations that enable HIL to access information. This according to Adigun (2019) removes barriers to teaching and learning while supporting HIL to learn independently at their own pace. This brings in a shift from the teacher-centredness way of teaching to learner-centredness, which allows learners to take responsibility for their learning.

Apart from this, technology presents learning opportunities for learners with different learning abilities (Fadzil, 2018). This relies on the fact that information is communicated in a multimedia format and accommodates learners with their different learning styles. The use of ICT in teaching also exposes learners to the world of technology, a 21st century skill required for solving the ever-changing problems of this world (Chai *et al.,* 2020). Again, learners get motivated to learn, as they interact with information presented in different formats (Pradipta *et al.,* 2020). This implies that when teachers use ICT learners' willingness to learn increases.

Participants also viewed the use of text and the repetition of concepts effective when teaching HIL. Mpho explained: "When you introduce the topic, you have to write most of the words you are going to talk about on the board". Mpho believes that the use of text enables HIL to understand concepts better. This may lie on the fact that HIL rely mostly

on a sense of sight to access the information. Therefore, the use of texts appears to be a meaningful form of their communication. Besides this, Mpho indicated that she writes notes on the board without talking and briefly explains the issues that need to be clarified.

Participants seem to be aware that there are multiple ways of teaching HIL and should be used to meaningfully address learners' needs without being restrictive. It is on this basis that Miles *et al*. (2018) assert that meaningful communication should always be considered when teaching HIL as this enables them to participate in class. Provision of notes to HIL presents information in an accessible form for learners and this could be categorized as an accommodative strategy. In a similar manner Kisanga (2019) acknowledges that the provision of notes for HIL is essential for them to understand concepts better. Written texts are visual representations and when used appropriately actively engage HIL in learning (Liu, 2020). Even when Mpho used the chalkboard, she was cognizant of the ways HIL access information and thus avoided 'chalk and talk'.

Hadi *et al*. (2019) show that teaching HIL demands repetition for their better understanding of concepts. This implies that even though HIL are slow and lag behind their counterparts, they can still do well in Science when concepts are communicated slowly and repeated. This came through participants' explanation that not rushing through the concepts assists HIL to effectively understand the concepts. It is on this basis that Atika *et al*. (2018) reassure that HIL are not cognitively challenged and can perform better when appropriate teaching approaches are used. It is also indicated that even though repetition of concepts targeted HIL, this also extended to improving learning for slow learners. This aligns with Dostal *et al*.'s (2017) assertion that when 'opportunities to learn' are optimised, other learners should as well benefit. With this approach, learners' different needs could at once be met. Raven and Whitman (2019) are also of the same view that repetition is one of the requirements for HIL to have access to curriculum content.

There were instances when all approaches would be used, but learners could still not acquire the information, in this case remedial teaching was inevitable. That is, it is through remedial teaching that teachers compensated HIL on the information they had missed in class. Remedial teaching was understood differently by all the participants. Thuto used other learners to facilitate the communication between the HIL and himself during remedial lessons. With the cognizance that the HIL was able to communicate with his friends, Thuto took that opportunity and placed those peers near the HIL. Mpho believed that with extra classes on weekends HIL would improve their performance. Tsolo allocated time for HIL to ask questions either during break time or in the afternoon. On the other hand, Nare opted for one-on-one discussions with HIL. He also provided more work for these learners to improve when they had challenges in class.

Participants used remedial teaching in different ways to put HIL on the same level as their counterparts. Noprianto (2019) agrees that remedial teaching corrects inequalities in a diverse classroom, as it is difficult for learners with different abilities to achieve the learning objectives at the same time. With reference to diagnostic results, remedial teaching is used to assist learners who are left behind (Ren *et al.*, 2021). This according to Smale-Jacobse *et al* (2019) is differentiated-learning where learners are grouped and taught in accordance with their abilities. Ren *et al.* (2021) explain further that the role of differentiated instruction is to promote equity amongst learners. With differentiated learning, the intention is for all learners to achieve the stipulated learning outcomes. Similarly, Nare's experience made him believe that the use of different remedial teaching approaches should be employed for HIL to understand scientific concepts. This resembles the capabilities framework that declares that for everyone to attain wellbeing, intervention should be customized to his or her needs (Sen, 1999). This idea when contextualized into 'education for all', suggests that initiatives undertaken to improve learners' opportunities to learn should be aligned to their capabilities.

Unlike Mpho's scenario where fast learners had to learn at the same pace as HIL, Nare opted for ability-grouping with the intention of increasing the chance of curriculum coverage. He applauded ability-grouping as effective when learners are given activities

in line with their understanding of the concepts. Pozas (2020) considers this to be homogeneous ability-grouping, which enables the teacher to assist learners at the same cognitive level. With this grouping, no learner is held back by the pace of others since their cognitive abilities are the same. However, Trinidad and King (2022) refute the idea of ability-grouping in that it does not provide equal access of education for learners. This practice does not align with the objectives of EFA which states that learners with disability should learn alongside their counterparts. Due to the lack of the requisite knowledge to teach a diverse classroom participants opted for ability-grouping to address learners' differences. This shows that there is a need for teachers to be equipped with skills on how to teach a diverse classroom, so that without any discrimination all learners can achieve. Kang & Martin (2018) are of the same view that qualified teachers contribute positively to learner performance. With this I consider teachers with appropriate content and the correct pedagogy as being the resources required for opportunities to learn, particularly for learners with diverse learning needs.

The use of different representations is an indication that the participants understand that learners are different and can access information in different ways. This lies on the fact that HIL have different educational needs due to their differing degree of hearing, which determines their mode of communication (Silvestri & Hartman, 2022). When the diversity of learners is considered, there is a good chance that all learners attain opportunities to learn. This relates to the UDL principle, which stipulates that different representations and engagement are essential to accommodate learners' needs (Neild *et al*. 2022). It is gathered from the interviews that participants are aware that information should be shared in different formats in a class.

5.2.3 Lack of content knowledge amongst interpreters

It was also found that teachers viewed the explanation of concepts to sign language interpreters as efficient for preparing the lesson for HIL. Mpho believed that explaining scientific concepts to sign language interpreters prior to a Science lesson would increase the opportunities to learn for HIL. She elucidated:

> When you introduce the topic you have to explain the meaning of the whole topic for the interpreter to understand. When the interpreter understands what you are saying, learners will also understand.

The above extract gives evidence that Mpho believed that interpreters have a direct influence on the accuracy of messages relayed to learners, hence she considered explanation of concepts to the sign language interpreters an important part of the lesson preparation. This presents a need for an opportunity to learn for sign language interpreters who are entrusted to make information accessible to HIL in the Science classroom.

Teaching and learning require language as a medium of instruction, hence interpreters are essential in classrooms that have HIL. Nandiyanto *et al.* (2018) also show that a classroom that practices a bilingual method is effective for teaching Science to HIL. This is similar to De Freitas *et al*.'s (2017) argument that interpreters are mediators for effective communication when teachingHIL. However, this study reveals that it is important that interpreters are confident with the subject matter knowledge. Therefore, they should understand scientific concepts since they are directly responsible for HIL's academic performance.

That is, when interpreters understand concepts well; it gives HIL an opportunity to understand the concepts better. Caselli *et al,* (2020) maintain that preparation including interpreters is the best accommodation HIL ever need. The authors Caselli *et al. (*2020) also highlight that interpretation does not only harness the academic performance of HIL but also improves their social skills. This indicates that when teaching HIL, the mastery of sign language is not enough, and both the interpreter and the regular teacher should be proficient with the subject matter.

On the other hand, Thuto did not have an interpreter in the class, but was assisted with communication by HIL's classmate. He clarified:

> Sometimes when I ask a question you may find that I don't get clearly what he is trying to say. So I try to hear from those other students. I say is there any better way you can explain to him what I am saying? I wait for them to explain while I am there so that I can hear if what they say to him is what I wanted him to know.

The extract above displays how peer teaching is utilized to promote learning for HIL in the classroom. The involvement of peers to facilitate learning agrees with Wang and Gao's (2021) view that peers with similar educational levels and background can help each other to develop effective understanding of concepts and ideas. This conception started from the earliest work of Piaget who established that learning is social, and learners learn better when they interact with their peers (Lisi & Golbeck, 1999). The authors Lisi and Golbeck (1999) also show that interacting with peers sharpens the cooperative skill essential in day-to-day life activities. This indicates that there are factors that should be considered when peer assisted learning is conducted in class and includes learners' interests, abilities, needs and characteristics (Kubat, 2019). It is on this account that one would realize that opportunities to learn for HIL are not only assessed by the availability of tangible resources, but on how such are converted to address their educational needs (Barnett, 2021).

5.2.4 Language as a barrier to teaching Science to HIL

Another key finding in this study is that HIL's ability to do well in Science is compromised by their language deficiency. Language is a powerful tool in education, as it could either enable or hinder learners from accessing curriculum content (Infant & Licona, 2021). The authors also indicate that globally, English is the dominant language used in teaching and

learning. In a similar manner, CAP 2009 stipulates that English should be used as the medium of instruction, except in lower Grades (1 to 3) (MoET, 2009). English being a second language for most learners in the class makes it harder for them to acquire the concepts. In a similar manner teachers and learners who can hear, but who have incompetence in sign language seem to create problems when teaching HIL.

This challenge impacts negatively on the approaches stipulated as effective in facilitating HIL's teaching and learning. For this reason, interpreters are engaged to facilitate teaching. Enderle *et al*. (2019) reiterate this and explain that HIL are confronted by multiple language negotiations in the classroom, and such include academic Science vocabulary, written English and spoken American language. Based on this, schools with HIL engage sign language interpreters to facilitate teaching and learning. That is, regular the Science teacher in collaboration with the interpreter use both spoken and sign language to facilitate communication in the classroom. This according to Nandiyanto *et al*. (2018) is called a bilingual method.

Tsolo and Mpho's experiences made them realise that even although this arrangement helps in communicating scientific concepts, it falls short when interpreters lack content knowledge. This is because interpreters are described as facilitators in teaching and learning for HIL in which their lack of scientific knowledge results in inadequate Science teaching. Participants captured this as a challenge, since misconceptions are passed to HIL without the regular teacher being aware and this compromises their opportunities to learn. Shulman (1986) states that the subject matter knowledge of the teacher coupled with the best teaching approaches play a central role in teaching and learning. This relates to Priyanka & Samia's (2018) argument that the realization of quality education is challenged by teachers' lack of expertise. As mentioned earlier there seems to be a need for interpreters and teachers to be confident with the content. It also appears important that regular teachers should as well be familiar with sign language so that they can detect when interpreters do not explain concepts correctly. Thus, De Freitas *et al*. (2017) recommend that regular teachers should learn sign language so that HIL's needs can be addressed. The main point stipulated in this discussion is that both the sign language

interpreter and the regular teacher should be competent in both sign language and subject matter knowledge.

It is noteworthy to indicate that Science is a subject with universally accepted words that need further explanation for better understanding. However, the verbal explanation of concepts remains a challenge for HIL since they are deficient in language (Enderle *et al.*, 2020). This shows that not only are HIL battling with the complexity of Science as a subject, but they also must confront other challenges brought about by language issues. In this manner, a language barrier compromises HIL opportunities to learn and impacts negatively on their performance. This points out the issue of limited vocabulary that challenges the teaching of Science. This agrees with Clark *et al.*'s (2021) concern that limited vocabulary in sign language makes it difficult for scientific concepts to be clearly explained.

On a similar note, Lynn *et al*. (2020) found that interpreters found it very difficult to convey scientific messages accurately. A contributing factor to this challenge could be participants' articulation that both sign language interpreters and regular teachers are not provided with in-service training on sign language. Another reason could lie on the explanation that HIL are not taught sign language at school, yet it is the only place they learn and communicate with the language (Ngobeni *et al.*, 2020). This rests upon the absence of institutions teaching sign language and unavailable learning resources (Islam, 2020). Consequently, this presents a limited opportunity to learn for HIL, as they cannot effectively understand and communicate scientific concepts. This according to the capabilities framework is caused by a lack of educational resources (Terzi's, 2007) for teachers, sign language interpreters and learners at the school. In the end the inability to communicate with each other at school compromises quality and equity in education.

When responding to this challenge, interpreters in collaboration with HIL invented their own signs. Unfortunately, that did not to help and instead brought confusion because HIL signed differently. Andrew (2017) adds that Science terminology is challenging for HIL to learn and as a result teachers come up with incorrect signs. It is worth noting that Science

is universal and when schools invent signs it can be difficult for HIL to engage in discussions at a global level. It is on this basis that Andrew (2017) suggests that deaf people be incorporated in the development of new signs.

The participants revealed that the resolution of the language barrier could be attained through code-switching. Thuto believed that the difficulty in understanding language is one of the contributing factors to learners' poor performance in Science. Therefore, he resorted to code-switching when he realized that learners struggled understanding questions in class. He explained: "I rephrase and use simple English or ask the question in Sesotho". This is code-switching, which according to Maluleke (2019) is the use of another language in teaching and learning, besides the one stipulated as the medium of instruction. Alan and Idris (2018) consider code-switching to be an effective teaching strategy that could be used for different purposes, as it promotes learning.

Code-switching could be used in different ways, either in clarifying concepts or questions and is essential in a multilingual nation (Kumar *et al, 2021*). According to these authors Kumar *et al.* (2021), there is a dire need to code-switch in the Science classroom, as there are many jargons that need thorough clarification. As a result, learners who can hear and HIL who can lip-read benefit directly from this effort.

Besides that, code-switching indirectly benefits HIL since they get assistance from their counterparts. That is, if most of the learners have understood the scientific concepts properly, it becomes easy for them to transfer what they have understood to HIL. This argument aligns with issues of equality and justice, that inequality can be deliberate but acceptable when the disadvantaged group benefits from individuals provided with opportunities (Sen, 1999). That is when one considers that learners who can hear as benefiting largely from the code-switching that was also useful in clarifying concepts to HIL in Thuto's classroom. This indicates that in different ways code-switching heightened opportunities to learn for all learners.

It was also realised that the language barrier brought other challenges, even to approaches identified appropriate to address HIL's needs. These teaching approaches

are mainly challenged by the following: HIL's educational needs, time and contextual factors. For instance, Thuto believed that discussion was effective to clarify scientific concepts. However, due to the HIL's inability to talk, he purposively excluded them from class discussions. This was based on his realization that the HIL did not feel comfortable to talk in class because he had a speech problem. Thuto opted not to direct questions to HIL in the class but took him to a one-on-one discussion to address unclear concepts.

In a similar vein, Nare excluded HIL from the discussion with the intention of increasing the pace of his teaching. This is based on his report that HIL are slow to understand concepts. Even though Nare and Mpho believe that being slow and the repetition of concepts are amongst the effective approaches of teaching HIL, he also viewed these approaches as time consuming. With this, participants were in a dilemma to choose between being slow and cover little curriculum content or rush through the content and complete the syllabus with HIL left behind. This shows that in a diverse classroom it is not always given that the opportunities to learn can be provided at one time to all learners.

Mpho on the other hand mentioned that the repetition of concepts bored the faster learners, as they were compelled to listen many times to concepts that they had long time understood. In this way, their chances to complete the syllabus are minimised. This shows that in a diverse classroom, teachers may be confronted by situations where they choose whose opportunities to learn are to be prioritised. If this happens without complementing the group that has been marginalised equality for all may not be attained.

Another challenge raised by a participant that hindered effective teaching of Science to HIL is the context. They explained that context compelled them to act against what they had learnt in pre-service training and from the curriculum prescriptions. Tsolo explained: "The other problem is that at training college, we were encouraged to move around the class to keep learners attentive. However, in my class I had to do things differently, stand in one position because any movement I made blocked deaf learners who depend mostly on interpreters."

Even though the pre-service training prepared Tsolo to do things in a particular way, his willingness to accommodate HIL compelled him to act against the pedagogical

prescription. This shows that context can as well be a guiding factor for how HIL should be taught in schools. It is on this basis that Sen (1992) highlights that the provision of capabilities is always aligned to the environment in which an individual is placed. This depicts that when HIL are engaged in effective teaching and learning, their environment should inform the kind of accommodation teachers employ in the class. This also indicates that context has a greater influence on the choice of approaches teachers employ when teaching HIL.

Even though education is for everybody, HIL have difficulties in developing their linguistic skills, which consequently affects their cognitive abilities and reading for understanding (Riza & Firdaus, 2018). These factors impact differently on teaching approaches opted for in the teaching of Science to HIL. HIL were excluded from classroom discussions because it was realised that it does not benefit them. This relates to Rawls's (2001) conception of equality and that it is acceptable for exclusions to be made when the intentions benefit the disadvantaged individuals. Relating this to the question of educational practice, it denotes that it is not usually possible that the chosen teaching approaches can accommodate all learners all the time, but when teachers opt to use them there should always be a complimentary approach in place. This in some sense disqualifies Warnock and Norwich's (2010) concern that EFA encourages the exclusion of learners with disabilities since their needs cannot always be met.

As teachers were bound to exclude HIL from discussions, one would view that acting against Vygotsky's (2012) assertion that learning is social, meaning that interactions amongst learners foster learning. With this said, there is a reason to say that the language barrier denies HIL the chance to learn from their peers because teachers choose approaches that lack verbal expression. Even though Sen (1992) indicates that being given the liberty to choose how to achieve one's wellbeing, the study shows that HIL depend on the teachers' choices and when they are at a minimum, exclusion sets in. Thus, Matobako and Jita (2022) argue that learners with special needs choose what they consider useful from the pool of opportunities they are provided with. This shows the

prominent role teachers play when teaching HIL because they need to provide more opportunities for learners to choose what is appropriate for them. In a similar manner the data reveals that there is a need for teachers to provide wide choices of opportunities to learn as this can respond to diverse learners' needs. It can be concluded that HIL, being deprived of language, are prone to unintended exclusions from learning alongside their peers.

Another challenge is brought by sign language interpretation, according to Caselli *et al*. (2020), is that it does not only have a high error rate that requires learners to mentally correct, but also encourages regular teachers to be slow as there are long pauses included. This indicates that besides interpreters lacking content, there are some errors that could be made when interpreting. Another point refers to sign language interpretation as a slow intervention by design, therefore teachers rushing through the content may benefit general learners while they leave interpreters behind. Consequently, this delays the curriculum content coverage for HIL. It is on this basis that Hassanein *et al*. (2021) view both pre-service and in-service training essential in preparing teachers to deal with the diverse needs of learners.

5.2.4 Lack of Professional Development Opportunities

The last key finding is that there is a lack of continuous professional development, while it is essential to prepare Science teachers for HIL. Most of the challenges stipulated in the above section come because of inadequate preservice and in-service training. Thuto attested to this in that the pre-service training did not prepare him to deal with HIL. He explained:

> We never had a situation where we have a deaf learner in class and write a lesson plan to incorporate them. We only learned things theoretical but coming to the class with a deaf learner you will find that it is not easy when it is practical.

Thuto realised that there is a gap between what they learnt in theory at pre-service training and what transpires in the actual teaching of a learner with special needs. With this, he

realised that he lacks the skills to teach HIL but has explored different ways to accommodate HIL in his lesson. He also consulted other teachers to discuss how they deal with challenges encountered in their classes. Mpho also acknowledged that she was not prepared to teach Science to HIL and needed training on how to do this effectively. She explained that the Ministry of education has never given them capacity-building on issues pertaining to teaching HIL. Mpho however noted that the lack of capacity building did not stop her from learning how HIL learn. Participants learnt how to teach HIL by themselves and utilised communities of practice to acquire the content and skills required to teach HIL.

Tsolo on the other hand stated that he was equipped with a special education course in pre-service training, but pointed out that it did not prepare him to teach Science to HIL. He emphasised that sign language is an important skill that all teachers should have through continuous professional development. Tsolo explained that not being competent with teaching HIL is another factor that contributed to him conducting classes in a slow manner. He seemed to believe that receiving CPD could enhance teachers' capabilities to teach a diverse classroom with ease and at an acceptable pace. This is relevant to Hassanein *et al*.'s (2021) assertion that teachers' competences to address diverse learners' needs relies on the pre-service training they have received. Unlike other participants, Nare did not mention any incidence where he utilised collaborative learning with other teachers, however he tried to train himself on how to teach Science to HIL. On the other hand, Tsolo, Thuto and Mpho utilized collaborative work and self-capacitation on issues pertaining to Science teaching for HIL.

The discussion above clarifies that participants did not receive any form of capacity building from relevant stakeholders, but remained persistent in improving themselves on how best they could teach Science to HIL. Even though most of the time they strived to be capable of teaching HIL, they believed they could do better when given formal CPD that would enable them to be confident with content and pedagogic skills. This relates to Ndlovu and Matafwali's (2020) assertion that not only do teachers need CPD on content, but they also need special training on how to deal with HIL. Therefore, the kind of CPD

teachers receive should always be inclined to addressing their challenges. With this said, it would always be important to establish teachers' challenges prior to CPD, which is considered a resolution to their challenges with teaching HIL (Kelly *et al.*, 2020). This agrees with Mansour's (2014) assertion that CPD should consider teachers' views and concerns about what should be improved in their instructional practice. This would curb a situation where CPD is held but fails to assist teachers in addressing adversities they encounter in the classroom.

Participants were also aware that being competent to teach Science is not enough, but knowing how HIL learn is also an important attribute that one must master. This aligns with Sen's (1992) explanation of a capabilities framework that the availability of resources is not directly equivalent to the provision of wellbeing. This means that resources should be tailored to individuals' needs. Therefore, a qualified Science teacher as a resource does not guarantee the effective teaching of Science to HIL. Instead, how teachers customise curriculum content to learners' abilities is another expertise needed to widen access to quality education for all. This suggests that a general CPD cannot prepare teachers to teach in a diverse classroom. Therefore, such professional opportunities should be informed by teachers' needs, context, and the kind of resources they require for effective teaching of HIL.

Baitanayeva *et al*. (2020) add that learners can do better when teachers have undergone thorough CPD. Such a belief is based on the idea that CPD equips teachers with special skills required to address the learning needs of HIL. The evidence above indicates that CPD can come in different forms. It is evident that education reforms should always be coupled with CPD. This is in agreement with Walia and Walia's (2022) advice that CPD should be a priority for the effective implementation of policy reforms. Issaka (2018) takes the argument further that intended outcomes and how CPD will be carried out should be outlined in the policy. Engler and MacGregor (2018) also found that in CPD programmes for HIL there are issues that should be elevated because they improve the quality of teachers. These include Commitment to the profession, proficiency to the practice and

learning impact. They also reported that teachers appreciated the recognition of diversity amongst HIL and teaching methods that should be employed accordingly.

Based on the discussion above one would believe that EFA could be a success when teachers are well trained. Similarly, there are possibilities that educational equity could be achieved when teachers are well prepared to teach Science to learners with impairments. Rubini *et al.* (2018) also affirm that it is through qualified or competent teachers that HIL could effectively learn alongside their counterparts and achieve.

5.3.5 Contribution to new knowledge

This study is unique and valuable in that it combined two researched phenomena - Science education and the teaching of HIL, a topic that has been only investigated in a limited way in the context of Lesotho. Sentiments raised in this study agree with Basha *et al*. (2020) that HIL are challenged by understanding abstract concepts and that can be resolved using experiments and ICT. The study takes the argument further that HIL should be taught in line with their needs. This articulates the main tenet of the capability framework, which shows that individuals' wellbeing can always be achieved with regard to what they are able to do (Sen, 1992). That is, teachers should not see learners' impediments as obstacles to access quality education, instead consider alternative ways in which information could be accessed. The study reveals that when teaching HIL, there is always a need to review opportunities provided in the classroom under the lens of a capabilities framework. Lastly, it is realised that subject matter knowledge is not enough when teaching HIL, but there is also a need for teachers to understand how HIL learn. That is, there is a need for teachers to learn pedagogy inclined towards hearing-impairment.

5.4 Conclusions

The findings indicate that it is crucial to consider the placement of HIL in the classroom so that they can have access to what is being communicated in class. It is concluded that placing HIL in front maximises their opportunities to learn as they get closer to the communication resources. That is, the placement should be allowing HIL to access information either through lip-reading or being able to clearly see the interpreter (Harahap *et al.,* 2021). While other learners have the liberty to choose seats in the classroom, the study reveals that the placement of HIL is made by teachers. This aligns with Sen's (1992) assertion that individuals should be given an opportunity to choose what they consider to be appropriate for their well-being unless one is a minor. Teachers' experiences made them aware that HIL can optimally use their sense of sight in learning and therefore should be placed in front. This indicates that effective teaching and learning of Science to HILs depends on teachers' provision of choices which include their placement.

Another finding revealed that the use of experiments is an effective teaching approach to employ when teaching HIL. One of the reasons participants advocate experiments is that they engage HIL actively in learning and that this enables their participation in the class. Another reason is that this approach allowed HIL to be engaged in hands-on activities, manipulate objects and this helps them hold the information for a longer time. Even though the participants were aware that experiments promote learning, the limited time did not allow them to use them often. Thus, Lee and Sulaiman (2018) suggest that experiments be conducted at least once a week so that learners could reflect deeply on what they have done. The implication of this is that teachers did not use experiments frequently when teaching HIL, even though they knew that they increase their opportunities to learn.

Teachers' attitudes towards teaching HIL also seemed to be positive since they explored different ways of teaching until they realised that experiments accommodate HIL's needs. According to Alasim (2019) positive teacher attitudes heighten opportunities to learn

especially for learners with impairments. With this, one would believe that HIL would learn better when taught by teachers who are willing to accommodate their differences during their classroom practice. However, it becomes apparent in this study that positive attitudes alone cannot foster the effective teaching and learning of HIL. This relates to the finding of Ramnarain and Hlatswayo (2018) where teachers' attitudes were positive but due to a lack of resources, they were not able to effectively implement inquiry-based teaching. This study reveals that even though teachers seemed to be willing to accommodate HIL, time and context were significant in determining how opportunities to learn for HIL are manifested.

It is understood from the findings that participants believe that ICT can augment the use of experiments in schools and promote learning. They pointed out that in the absence of reagents, a projector could be used to display videos and learn the concepts under study. This shows that ICT can mimic the actual experiments conducted in the laboratory. Pradipta *et al.* (2020) are of the same view that ICT has the potential of concretising abstract concepts and enhancing learners' understanding. This also agrees with Ratheeswari's (2018) assertion that ICT improves the teaching methods and amplifies learners' opportunities to access content knowledge. It is on this basis that Jita (2018) concludes that teacher knowledge to integrate ICT in teaching and learning is the OTL variable defining teacher competence to teach Science. It inoteworthy to mention that ICT integration is not yet a component of their classroom practice as Mpho explained: "For some experiments we might not have the equipment to use but since deaf learners learn by seeing, we can just project if we have a projector or computer". Again, teachers acknowledged that there is lack of ICT resources in their schools. This shows that teachers are not yet integrating ICT in their teaching but are aware that it can address challenges that inhibit them to use experiments. This aligns with Puspawati and Juharon (2021) that even though teachers are aware that the use of ICT improves HILs' learning they are challenged by the lack of resources in their school.

In another instance, the teacher utilised an ICT tool - mobile phones to share notes and other learning materials to learners in the class. The advantage of this practice is that it saves time since there is never a time allocated for writing notes. Besides that, learning materials are made available to learners and that enables them to study in their own time and pace. This relates to the view that with ICT integration in teaching and learning it becomes easier for HIL to revise materials they have learnt during lessons and that HIL find the lessons more interesting.

Another finding of the research is that the language barrier is the main challenge when teaching Science to HIL. This challenge called for interpreters' engagement to facilitate teaching and learning. This initiative is considered as the primary accommodative strategy that enables HIL to access the curriculum content (Caselli *et al*., 2020). Again, Meghdari and Alemi (2020) enlighten us that sign language deals with issues of the language barrier when teaching HIL and fosters participation of HIL. In a similar vein, there were interpreters in some schools and teachers extended this accommodation strategy further by preparing them prior to the Science lesson.

The preparation included interpreters being familiarised with concepts to be taught during the Science lesson. However, teachers indicated that interpreters still passed misconceptions on to HIL, meaning that they often had inadequate content knowledge. This replicates an argument raised by Bamu *et al*. (2017) that due to the language barrier, regular teachers rely on interpreters who lack content knowledge, therefore they are not that relevant to increased HIL opportunities to learn. Based on this, Ngobeni *et al.* (2020) show that there is a need for interpreters to be competent with the sign language necessary to avoid mistranslation. A need to use sign language consistently when teaching HIL is also articulated by Khalid (2021).

Without disputing the points this study outlines that the presence of an interpreter in the classroom is not enough, as they still need to be acquainted with other skills making them relevant to teach HIL. It is on this basis that the study concludes that there is a need for both teachers and interpreters to be competent with the subject matter, pedagogy that best accommodates HIL and the sign language. These three aspects are presented in this study as crucial variables for HILs' opportunities to learn Science in a diverse classroom setting. The study also concludes that opportunities to learn for HILs differ according to individuals' capabilities. Therefore, accommodative teaching approaches cannot be homogeneous. It is revealed that a capabilities framework coupled with opportunities to learn should be theories effectively guiding the teaching and learning of HIL.

Another finding is that continuous professional development is key when teaching HIL. This relates to Kelly *et al*. (2020) that CPD prepares teachers to be acquainted with the skills and knowledge required to address challenges they encounter in their teaching. However, participants noted that they were not offered any continuous professional opportunities but that this did not stop them from capacitating themselves. As a result, they engaged in research and communities of practice where they learnt from their colleagues. Even though participants explored different avenues to improve their skills and knowledge on how to teach HIL, they still believed that they can do better with provision of in-service training from the ministry of education. As stated earlier that teachers' opportunities to learn places them in an appropriate position to facilitate the teaching and learning for HIL. It is through capacity building that teachers can be able to come up with appropriate teaching approaches for HIL. Thus, Rubini *et al.* (2018) are of the view that competent teachers are enablers of access to Science content.

Based on the findings articulated above, the study concludes that HILs are taught like any other learner in Science lessons, but the problem rests with language deficiency, unavailability of resources, limited time, contextual challenges and other impediments to the adoption of effective teaching approaches. Another point is that when teaching

Science to HIL, OTL and CF should be brought together to address diverse learners. Lastly, it is realised that even when teachers are willing to follow policy guidelines, context influences how Science should be taught to HIL.

5.5 Recommendations

This section presents the recommendations of the study based on what has been identified as the major findings. The recommendations will inform policy, classroom practice and future research. Based on the conclusions presented above, it is recommended that learners be placed where they are not obstructed to optimally use their sense of sight to receive scientific information when it is communicated. The study also suggests that teachers should use experiments in a manner that promotes learning while the curriculum should also be completely covered. That is, the use of experiments should not dominate Science lessons since they are time consuming. Alternatively, teachers are advised to utilize ICT in their instructional practices because it provides HIL with multimedia representations without taking a longer time.

It is also recommended that the medium of instruction for HIL should always be similar to the language used in assessment. This recommendation comes from the identification that HIL are taught through sign language but are assessed with standard English. For this reason, HIL tend to get answers wrong not because they do not know them, but because they have to use the language, they are not familiar with. In realization of the aforesaid recommendation, sign language should be standardised and be taught as a subject in schools.

The study also recommends that continuous professional development for teachers should be a policy issue with significant influence going to teacher training institutions to have an additional special education course. CPD should introduce teachers to different types of disabilities and how to handle them. Again, the use of ICT appears to be a need when teaching Science to HIL, therefore pre-service institutions should also consider capacitating teachers on the integration of ICT in teaching and learning of Science. The

study revealed that there is a need for teachers to be conversant with sign language. Therefore, it is recommended that teachers learn sign language to increase their opportunities to communicate and interact with HIL while sign language intepreters are capacitated on subject matter knowledge.

In other instances, teachers are held back from using ICT due to a lack of resources, either electricity or ICT tools. Therefore, the Ministry of Education should provide learning resources including ICT tools. Future research studies should engage more teachers because this study only used four teachers. Besides this, further studies should consider using observations to corroborate participants' statements. It is also realised that interpreters play a pivotal role in the teaching and learning of Science to HIL. Therefore, future research should consider exploring the involvement of interpreters in the teaching and learning of Science to HIL.

References

Aas, H.K. 2020. Professional development for inclusive and adaptive education: Lesson Study in a Norwegian context. *Professional Development in Education*, pp.1-15.

Abdulkareem, A., Ismaila, A. & Jumare, M.A. 2018. Understanding the use of research paradigm and theory in the discipline of library and information Science research: Reflection on qualitative and quantitative approach. *Journal of Research in Librarianship*, *4*(2): 24-32.

Adeniyi, S. & Kuku, O. 2018. Effectiveness of two instructional methods on reasoning ability of children with hearing impairment in Nigeria. *Specijalna edukacija i rehabilitacija*, *17*(4):395-417.

Adigun, O.T. 2020. Computer-assisted instruction, project-based learning and achievement of deaf learners in biology. *Journal of E-Learning and Knowledge Society*,*16*(1): 23-32.

Ahmad, L., Bokhari, A. & Waqar, F. 2020. Teaching of Science to students with hearing impairment with demonstration method in inclusive education. *Journal of Inclusive Education*, *4*.

Akben, N. 2020. Effects of the problem-posing approach on students' problem solving skills and metacognitive awareness in Science education. *Research in Science Education*, *50*(3):1143-1165.

Aldrich, B.E. 2020. An overview of inquiry-based learning in Science education. Thesis: Unpublished.

Alharahsheh, H.H. & Pius, A. 2020. A review of key paradigms: Positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences*, *2*(3) :39-43.

Anagün, S.S. 2018. Teachers' perceptions about the relationship between 21st century skills and managing constructivist Learning Environments. *International Journal of Instruction*, *11*(4): 825-840.

Andrade, C. 2021. The inconvenient truth about convenience and purposive samples. *Indian Journal of Psychological Medicine*, *43*(1): 86-88.

Andrews, F.J. 2017. Teaching Science to deaf students: Language and literacy considerations. *Research Gate*

Anna, C. & Denys, S., 2019. Science education as a response to the needs of the modern open" education for everyone" system. *Future Human Image*, *11*:14-21.

Anyolo, E.O., Kärkkäinen, S. & Keinonen, T. 2018. Implementing education for sustainable development in Namibia: School teachers' perceptions and teaching practices. *Journal of Teacher Education for Sustainability*, *20*(1): 64-81.

Ardianingsih, F., Rofiah, K. & Ainin, I.K. 2020. Learning for students with hearing impairment in inclusive class on sensorimotor development course. In *International Conference on Special* Education *In Southeast Asia Region* (10): (283-290). Redwhite Press.

Atika, I.N., Ediyanto, E. & Kawai, N. 2018. Improving deaf and hard of hearing students' achievements using sts approach: A literature review. *International Journal of Pedagogy and Teacher Education*, *2*:3-19.

Bacca, J., Baldiris, S., Fabregat, R. & Graf, S. 2015. Mobile augmented reality in vocational education and training. *Procedia Computer Science*,*75*: 49-58.

Baglama, B., Haksiz, M. & Uzunboylu, H. 2018. Technologies used in education of hearing-impaired individuals. *International Journal of Emerging Technologies in Learning 13*(9):53.

Baitanayeva, B., Aubakirova, Z., Aitbembetova, A. & Sansyzbayeva, A. 2020. Problems of improving the quality of education. In *E3S Web of Conferences*. EDP Sciences.

Bajaj, R. & Sharma, V. 2018. Smart Education with artificial intelligence-based determination of learning styles. *Procedia computer Science*,*132*: 834-842.

Balakrishnan, S. 2018. Who wants to be a chemist? Formative assessment made fun and engaging. J*ournal of Educational Technology*,*15*(2): 1-7.

Bamu, B.N., De Schauwer, E., Verstraete, S. & Van Hove, G. 2017. Inclusive education for students with hearing impairment in the regular secondary schools in the North-

West Region of Cameroon: Initiatives and challenges. International Journal of Disability, Development and Education. 64 (6): 612-623.

Bans-Akutey, A. & Tiimub, B.M. 2021. Triangulation in research. *Academia Letters*, *2*.

Basha, T., Engida, T. & Tesfaye, M. 2020. Educational practices and challenges of students with hearing impairment in arba minch college of teacher's education, south ethiopia. *Turkish International Journal of Special Education and Guidance & Counselling ISSN: 9*(1): 36-49.

Bayram-Jacobs, D., Henze, I., Evagorou, M., Shwartz, Y., Aschim, E.L., Alcaraz-Dominguez, S., Barajas, M. & Dagan, E. 2019. Science teachers' pedagogical content knowledge development during enactment of socioscientific curriculum materials. *Journal of Research in Science Teaching*, *56*(9):1207-1233.

Bearman, M. 2019. Focus on methodology: Eliciting rich data: A practical approach to writing semi-structured interview schedules. *Focus on Health Professional Education: A Multi-Professional Journal*, *20*(3):1-11.

Begaliyev, J.U., Otojonova, N.B. & Tadjibaev, I.U. 2021. The role of physics in the teaching of exact and natural Sciences. *Academic research in educational Sciences*, *2*(5):42-57.

Bemiller, M. 2019. Inclusion for all? An exploration of teacher's reflections on inclusion in two elementary schools. *Journal of Applied Social Science*,*13*(1): 74-88.

Bhardwaj, P. 2019. Types of sampling in research. *Journal of the Practice of Cardiovascular Sciences*, *5*(3):157.

Bhatti, A., Shamsudin, S. & Said, S.B.M. 2018. Code-Switching: A Useful Foreign Language Teaching Tool in EFL Classrooms. *English Language Teaching*,*11*(6): 93-101.

Bourke, T., Henderson, D., Spooner-Lane, R. & White, S. 2022. Teacher Educators as Agents of Change: New Tools as Enablers. In *Reconstructing the Work of Teacher Educators: Finding Spaces in Policy Through Agentic Approaches—Insights from a Research Collective* (pp. 3-28). Singapore: Springer Nature Singapore.

Braun, D.C., Clark, M.D., Marchut, A.E., Solomon, C.M., Majocha, M., Davenport, Z., Kushalnagar, R.S., Listman, J., Hauser, P.C. & Gormally, C. 2018. Welcoming deaf students into stem: recommendations for university Science education. *CBE—Life Sciences Education*,*17*(3): 10.

Bremner, N. 2021. The multiple meanings of 'student-centred' or 'learner-centred' education, and the case for a more flexible approach to defining it. *Comparative Education*, *57*(2):159-186.

Broderick, A. 2018. Equality of what? The capability approach and the right to education for persons with disabilities. *Social Inclusion*, *6*(1): 29-39.

Buli-Holmberg, J. & Jeyaprathaban, S. 2016. Effective practice in inclusive and special needs education. *International journal of special education*, *31*(1):119-134.

Busetto, L., Wick, W. & Gumbinger, C. 2020. How to use and assess qualitative research methods. *Neurological Research and practice*,*2*, 1-10.

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D. & Walker, K. 2020. Purposive sampling: complex or simple? Research case examples. *Journal of research in Nursing*,*25*(8): 652-661.

Canals, L. 2017. *Instruments for Gathering Data*. Research-publishing. net. La Grange des Noyes, 25110 Voillans, France.

Caselli, N.K., Hall, W.C. & Henner, J. 2020. American Sign Language interpreters in public schools: An illusion of inclusion that perpetuates language deprivation. *Maternal and Child Health Journal*, *24*: 1323-1329.

Chabongora, B.N. & Jita, L.C. 2013. Opportunities to learn (OTL) grade-10 algebra in three South African catholic secondary schools. *Journal of Educational Studies*, *12*(1):172-188.

Chai, C.S., Jong, M. & Yan, Z. 2020. Surveying Chinese teachers' technological pedagogical STEM knowledge: A pilot validation of STEM-TPACK survey. *International Journal of Mobile Learning and Organisation*,*14*(2): 203-214.

Chatwirakom, W. 2018, June. A Study of Chemistry Teaching and Learning for Hearing Impaired Students by Using Multimedia. In *Proceedings of the 4th International Conference on Frontiers of Educational Technologies* (pp. 24-28).

Chen, L. & Xiao, S. 2021. Perceptions, challenges and coping strategies of Science teachers in teaching socioscientific issues: a systematic review. *Educational Research Review*, *32* :100377.

Chia, P.L. & Maat, S.M. 2018. An exploratory study of teachers' attitudes towards integration of STEM in Malaysia. *International Journal of Electrical Engineering and Applied Sciences (IJEEAS)*,*1*(1): 45-50.

Clark, K., Sheikh, A., Swartzenberg, J., Gleason, A., Cummings, C., Dominguez, J., Mailhot, M. & Collison, C.G. 2021. Sign Language Incorporation in Chemistry Education (SLICE): Building a Lexicon to Support the Understanding of Organic Chemistry. *Journal of Chemical Education*, *99*(1):122-128.

Cleland, J.A. 2017. The qualitative orientation in medical education research. *Korean journal of medical education*, *29*(2): 61.

Cohen, L., Manion, L., & Morrison, K. (2018). Research methods in education (eighth edition). Abingdon, Oxon.

Constantinou, C.P., Tsivitanidou, O.E. & Rybska, E. 2018. What is inquiry-based Science teaching and learning? In *Professional development for inquiry-based Science teaching and learning*, Springer, Cham (1-23).

Creswell J. & Poth C.N. 2017. Qualitative inquiry and research design: choosing among five approaches (4th ed.) Sage

Creswell, J. W., & Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, CA: Sage Publication, Inc.

Creswell, J.W. & Creswell, J.D. 2017. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Davies, C. & Fisher, M. 2018. Understanding research paradigms. *Journal of the Australasian Rehabilitation Nurses Association*, *21*(3): 21-25.

De Freitas, C.G., Delou, C.M., da Silva Amorim, G., de Melo Teixeira, E. & Castro, H.C. 2017. Sign language interpreters: Perception analysis about working with deaf students in a federal institute of education, Science and technology in the Northern Region of Brazil. *Creative Education*, *8* (04): 657.

Dewi, R.K. & Wardani, S. 2018. September. Analysis of Student Difficulties and Learning Outcomes with Guided Inquiry Learning Model. In *International Conference on Science and Education and Technology* 379-384. Atlantis Press.

Dewi, S.S. & alimunthe, H.A. 2019. The Effectiveness of Universal Design for Learning. *Journal of Social Science Studies*, *6*(1):112-123.

Dostal, H., Gabriel, R. & Weir, J. 2017. Supporting the literacy development of students who are deaf/hard of hearing in inclusive classrooms. *The reading teacher*, *71*(3): 327-334.

Ediyanto, E & Kawai, N. 2019. Science learning for students with visually impaired: A literature review. In *Journal of Physics: Conference Series* 1227(1): 12035.

Edmonds, W.A. & Kennedy, T.D. 2016. *An applied guide to research designs: Quantitative, qualitative, and mixed methods*. Sage Publications.

Ellis, P. 2021. Sampling in qualitative research (3). *Wounds UK*, *17*(1).

Emiliasari, R.N. 2019. Lesson planning in EFL classroom: A case study in lesson plan preparation and implementation. *Wiralodra English Journal*, *3*(2): 367-375.

Enderle, P., Cohen, S. & Scott, J. 2020. Communicating about Science and engineering practices and the nature of Science: An exploration of American Sign Language resources. *Journal of Research in Science teaching*,*57*(6): 968-995.

Engler, K.S. & MacGregor, C.J. 2018. Deaf education teacher preparation: A phenomenological case study of a graduate program with a comprehensive philosophy. *American Annals of the Deaf*,*162*(5): 388-418.

Ertzgaard, S.I., Kristin, N., Sofie, T., Sindberg, H.G., Bang, H.T., Cosmas, M., Vedul, T.T., Aslam, N. & Jon, O. 2020. Prevalence of hearing impairment among primary school children in the Kilimanjaro region within Tanzania. *International Journal of Pediatric Otorhinolaryngology*,*130* :109797.

Fadzil, H.M. 2018. Designing infographics for the educational technology course: perspectives of pre-service Science teachers. *Journal of Baltic Science Education*, *17*(1): 8.

Fairuz, T., Kaniawati, I. & Sinaga, P. 2019. Integrated Science teaching materials oriented on critical thinking skills and information literacy. *Journal of Physics: Conference Series*, 1157(2):22037.

Fast, D. & Wild, T. 2018. Teaching Science through Inquiry Based Field Experiences Using Orientation and Mobility.*Journal of Science Education for Students with Disabilities*, *21*(1): 29-39.

Ferguson, B.T., McKenzie, J., Dalton, E.M. & Lyner-Cleophas, M. 2019. Inclusion, universal design and universal design for learning in higher education: South Africa and the United States. *African journal of disability*, *8*(1): 1-7.

Firman, M.A., Ertikanto, C. & Abdurrahman, A. 2019. Description of meta-analysis of inquiry-based learning of Science in improving students' inquiry skills. *Journal of Physics: Conference Series*. 1157(2):22018.

Fithriyyati, N. & Maryani, I. 2018. Science lesson plan evaluation for 7th grade secondary school: A learning process reflection. *Psychology, Evaluation, and Technology in Educational Research*,*1*(1): 9-18.

Fitzgerald, M., Danaia, L. & McKinnon, D.H. 2019. Barriers inhibiting inquiry-based Science teaching and potential solutions: Perceptions of positively inclined early adopters. *Research in Science Education*, 49: 543-566.

Flick, U. 2017. *The Sage handbook of qualitative data collection*. Sage.

Florian, L. 2008. Inclusion: Special or Inclusive Education: Future Trends. British Journal of Special Education, 35: 202-208.

George, M.J. 2017. Assessing the level of laboratory resources for teaching and learning of chemistry at advanced level in Lesotho secondary schools. *South African Journal of Chemistry*,*70*:154-162.

Gholam, A.P. 2019. Inquiry-based learning: Student teachers' challenges and perceptions. *Journal of Inquiry and Action in Education*,*10*(2): 6.

Goos, M.2014. Creating opportunities to learn in mathematics education: A sociocultural perspective. *Mathematics Education Research Journal*, *26*:.439-457.

Gormally, C., 2017. Deaf, hard-of-hearing, and hearing signing undergraduates' attitudes toward science in inquiry-based biology laboratory classes. *CBE—Life Sciences Education*, *16*(1):6.

Groenland, E. & Dana, L.P. 2020. *Qualitative methodologies and data collection methods: Toward increased rigour in management research*.

Großmann, L. & Krüger, D. 2022. Students' Conceptions as a Neglected Perspective in Trainee Teachers' Biology Lesson Plans. In *Current Research in Biology Education* (pp. 181-193). Springer, Cham.

Hackman, S.T., Zhang, D. & He, J. 2021. Secondary school Science teachers' attitudes towards STEM education in Liberia. *International Journal of Science Education*,*43*(2): 223-246.

Hadi, F.N., Wahyuni, D.S. & Sulistyawati, H., 2019. Teacher's Strategies in Teaching English for The Hearing–Impaired Students. *English Education*, *7*(2): 264-271.

Hameed, A., 2020. Challenges Faced by Higher Education Institutions in Including Students with Hearing Impairment. *Journal of Inclusive Education*, *4*(1):13-28.

Hankebo, T.A. 2018. Being a Deaf and a Teacher: Exploring the Experiences of Deaf Teachers in Inclusive Classrooms. *International Journal of Instruction*, *11*(3): 477-490.

Harahap, R.M., Santoso, I., Wahjudi, D. & Martokusumo, W. 2020. Study of interiority application in deaf space ased lecture space: case study: the center of art, design &

language in ITB building. *Journal of accessibility and design for all: JACCES*,*10*(2): 229-261.

Hassan, R.H. & Neves, J. 2019. Teaching vocabulary to deaf students through enriched subtitling: A case study in Qatar. *International Journal of Language, Translation and Intercultural Communication*, *8* :10-27.

Hassanein, E.E., Alshaboul, Y.M. & Ibrahim, S. 2021. The impact of teacher preparation on preservice teachers' attitudes toward inclusive education in Qatar. *Heliyon*, *7*(9):7925.

Hennink, M. & Kaiser, B.N. 2022. Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social Science & medicine*, *292*: 114523.

Herron, M.D. 1971. The nature of scientific enquiry. *The school review*, *79*(2) :171-212.

Hidayat, D., Rakhmat, C., Suryadi, A., Rochyadi, E., Nandiyanto, A.B.D. & Maryanti, R. 2022. Wheat flour as a thermal insulator for learning media for students with hearing impairment. *Journal of Engineering Science and Technology*,*17*(1): 85-94.

Im, S. & Kim, O.J. 2014. An approach to teach science to students with limited language proficiency: In the case of students with hearing impairment. *International Journal of Science and Mathematics Education*, *12*: 1393-1406.

Iqbal, M.H., Siddiqie, S.A. & Mazid, M.A. 2021. Rethinking theories of lesson plan for effective teaching and learning. *Social Sciences & Humanities Open*, *4*(1) :100172.

Issaka, C.A. 2018. an appraisal of needs and access of in-service education and training for teachers in basic schools for the deaf in Ghana. *Educational Research and Reviews*, *13*(19): 664-673.

Jerrim, J., Oliver, M. & Sims, S. 2022. The relationship between inquiry-based teaching and students' achievement. New evidence from a longitudinal PISA study in England. *Learning and Instruction*, *80*,101310.

Jita, T. 2018. Exploring pre-service teachers' opportunities to learn to teach Science with ICTs during teaching practice. *Journal of Education,* (71): 73-90.

Johnson, R.B., & Christensen L.B. 2014. Educational Research: Quantitative, Qualitative, And Mixed Approaches. Fifth edition. Sage, Thousand Oaks CA.

Kabir, B.M. 2021. Conceptual Understanding of Science Facilities: A Study benefits for Science Teaching. 9(7): 9-26

Kaluyu, C. & Ndiku, J.M. 2020. Pedagogy and information technology integration, as strategies for improving academic performance in stem Subjects: A Critical Literature Review. *Journal of Education and Practice*, *11*(21).

Kang, D.Y. & Martin, S.N. 2018. Improving learning opportunities for special education needs (SEN) students by engaging pre-service Science teachers in an informal experiential learning course.*ASIA pacific Journal of education*, *38*(3): 319-347.

Keiler, L.S. 2018. Teachers' roles and identities in student-centered classrooms. *International journal of STEM education*,*5* (1):1-20.

Kelly, J.F., McKinney, E.L. & Swift, O. 2022. Strengthening teacher education to support deaf learners. *International Journal of Inclusive Education*, *26*(13):1289-1307.

Khalid, L.A.I.L.A. & Asghar, M.Z. 2021. Exploring Institutional Support for Inclusion of Hearing-Impaired Learners in Regular Primary Schools. *International Review of Social Sciences*, *9*(5): 258-270.

Khan, R., Grijalva, R. & Enriquez-Gates, A. 2019. November. Teachers as change agents: Promoting meaningful professional development using action research to support international educational reform. *Forum for international Research in Education*, 5 (2): 214-225.

Khurshid, F. & Bibi, M. 2020. A research study to explore the effectiveness of the interactive cd for remedial teaching in Science at the elementary school. *International Journal of Management (11*(8).

Khuyen, N., Van Bien, N., Lin., P., Lin, J. & Chang, C. 2020. Measuring teachers' perceptions to sustain STEM education development. *Sustainability*, *12*(4): 1531.

Kisanga, S.E. 2019. Barriers to learning faced by students who are deaf and hard of hearing in higher education institutions in Tanzania. *Papers in Education and Development*, *37*(2).

Kolb, D.A. 2014. *Expeential learning: Experience as the source of learning and development*. FT press.

Kubat, U. 2018. Identifying the individual differences among students during learning and teaching process by Science teachers. *International Journal of Research in Education and Science*, *4*(1):30-38.

Kumatongo, B. & Muzata, K.K. 2021. Barriers and Facilitators to academic performance of learners with hearing impairments in Zambia: A review of literature. *Journal of Educational Research on Children & Parents 2*(1): 169-189.

Kyngäs, H. 2020. Inductive content analysis. In *The Application of Content Analysis in Nursing Science Research.* Springer: Cham. (13-21).

Leavy, P. 2017. *Handbook of arts-based research*. Guilford Publications.

LeClair, K.L. & Saunders, J.E. 2019. Meeting the educational needs of children with hearing loss. *Bulletin of the World Health Organization*, *97*(10): 722.

Lee, M.C. & Sulaiman, F. 2018. The effectiveness of practical work in physics to improve students' academic performances. *People: International Journal of Social Sciences*, *3*(3):1404-1419.

Lehesvuori, S., Chan, K.K.H., Ramnarain, U. & Viiri, J. 2017. In search of dialogicity: A comparison of curricular documents and classroom interactions from Finland and Hong Kong.*Education Sciences*, *7*(4): 76.

Liu, Q. 2020. The Application of Visual Teaching Resources in Chinese Teaching in Schools for the Deaf. *Management, Law and Education,* 1156-1159.

Long, M.R. & Grunert, K M. 2021. Understanding STEM Instructors' Experiences with and Perceptions of Deaf and Hard-of-Hearing Students: The First Step toward Increasing Access and Inclusivity. *Journal of Chemical Education*,*99*(1): 274-282.

Lucas, L.B., Pimentel, R.G. & Luccas, S. 2018. Teaching Sciences and biology for deaf individuals: investigating the context of teaching practice in regular classrooms of a municipality in the state of paraná. *Revista Tempos E Espaços Em Educação*, *11*(26): 201-218.

Lune, H., & Berg, B. L. (2017). Qualitative Research Methods for the Social Science. Essex: Pearson Education Limited.

Lynn, M.A., Butcher, E., Cuculick, J.A., Barnett, S., Martina, C.A., Smith, S.R., Pollard Jr, R.Q. & Simpson-Haidaris, P.J. 2020. A review of mentoring deaf and hard-of-hearing scholars. *Mentoring & tutoring: Partnership in learning*, *28*(2): 211-228.

M'mbijiwe, J.M., Jagero, N., Mburugu, B.M. & Barchok, H.K. 2018. Relationship between teacher training practices and transition to secondary school for public primary school learners with disabilities in meru county, kenya. *International Journal of Academic Research in Progressive Education and Development*,*7*(2):64-71.

Mackieson, P., Shlonsky, A. & Connolly, M. 2019. Increasing rigor and reducing bias in qualitative research: a document analysis of parliamentary debates using applied thematic analysis. *Qualitative Social Work*, *18*(6): 965-980.

Madani, R.A. 2019. Analysis of educational quality, a goal of education for all policy. *Higher Education Studies*, *9*(1):100-109.

Maison, A., Kurniawan, D.A., Perdana, R. & Anggraini, L. 2019. The phenomenon of physiology senior high school education: Relationship of students' attitudes towards physics, learning style, motivation. *Universal Journal of Educational Research*,*7*(10): .2199-2207.

Majoko, T. 2019. Teacher key competencies for inclusive education: Tapping pragmatic realities of Zimbabwean special needs education teachers. *Sage Open*, *9*(1): (1-14).

Mandyata, J. 2018. Stakeholders' Views on Use of Sign Language Alone as a Medium of Instruction for the Hearing Impaired in Zambian Primary Schools. *International Journal of Special Education*, *33*(1): 62-76.

Mansour, N. EL-Deghaidy, H., Alshamrani, S. & Aldahmash, A. 2014. Rethinking the theory and practice of continuing professional development: Science teachers' perspectives. *Research in Science Education*,*44*(6): 949-973.

Marchut, A.E. & Gormally, C.L. 2019. Successes and Limitations of Inquiry-Based Laboratories on Affective Learning Outcomes for Deaf, Hard-of-Hearing, and Hearing Signing Students. *Journal of the Scholarship of Teaching and Learning*,*19*(4):18-31.

Marchut, A.E., 2017. *Persistence of deaf students in Science, technology, engineering, and mathematics undergraduate programs*. Gallaudet University.

Margot, K.C. Kettler, T. 2019. Teachers' perception of stem integration and education: a systematic literature review. *International Journal of STEM education*, *6*(1):1-16.

Margunayasa, I.G., Dantes, N., Marhaeni, A.A.I.N. & Suastra, I.W. 2019. The Effect of Guided Inquiry Learning and Cognitive Style on Science Learning Achievement. *International Journal of Instruction*, *12*(1): 737-750.

Maričić, M., Cvjetićanin, S. & Anđić, B. 2019. Teacher-demonstration and student hands-on experiments in teaching integrated Sciences. *Journal of Baltic Science Education*,*18*(5): 768.

Maryanti, R., Nandiyanto, A.B.D., Hufad, A. & Sunardi, S. 2021. Science education for students with special needs in Indonesia: From definition, systematic review, education system, to curriculum. *Indonesian Journal of Community and Special Needs Education*, *1*(1):1-8.

Matobako, S. & Jita, L.C. 2022. How visually impaired learners construct opportunities to learn mathematics? *Armenian Journal of Special Education*, *5*(1): 65-80.

McLinden, M., Douglas, G., Hewett, R., Lynch, P. & Thistlethwaite, J. 2020. Teaching learners with vision impairment: an analysis of evidence-based practice. In *Oxford Research Encyclopedia of Education*.

Meda, L. 2016. Are we helping them to pass or setting them up for failure? Assessment related experiences of partially sighted students. Journal of Communication, 7(1), 43-52.

Meghdari, A. & Alemi, M. 2020. STEM teaching-learning communication strategies for deaf students. In *Proc. 17th international RAIS conference on social Sciences and humanities*, 47-55).

Messiou, K. 2017. Research in the field of inclusive education: time for a rethink?. *International journal of inclusive education*, *21*(2):146-159.

Miles, S., Khairuddin, K.F. & McCracken, W. 2018. Deaf learners' experiences in Malaysian schools: access, equality and communication. *Social Inclusion*, *6*(2): 46-55.

Ministry of Education and Training. 2009. *Curriculum and assessment policy: education for individual and social development*. Maseru: Ministry of Education and Training

Mitra, S. 2006. The capability approach and disability. *Journal of disability policy studies*, *16*(4): 236-247.

Mkimbili, S.T. 2019. Meaningful Science learning by the use of an additional language: a tanzanian perspective. *African Journal of Research in Mathematics, Science and Technology Education*, *23*(3):265-275.

Moiinvaziri, M. & Shatery, H. 2022. Lesson Plan Preparation and Implementation: Iranian EFL Teachers' Perceptions in Focus. *International Journal of Foreign Language Teaching and Research*, *10*(42): 37-52.

Moser, A. & Korstjens, I. 2018. Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis. *European journal of general practice*, *24*(1): 9-18.

Murray, J.J., Hall, W.C. & Snoddon, K. 2019. Education and health of children with hearing loss: the necessity of signed languages. *Bulletin of the World Health Organization*, *97*(10): 711.

Najami, N., Hugerat, M., Kabya, F. & Hofstein, A. 2020. The laboratory as a vehicle for enhancing argumentation among pre-service Science teachers. *Science & Education*,*29*(2): 377-393.

Nandiyanto, A.B.D., Asyahidda, F.N., Danuwijaya, A.A., Abdullah, A.G., Amelia, N.I.A., & Hudha, M.N. ziz, M. 2018. Teaching “nanotechnology” for elementary students with deaf and hard of hearing. *Journal of Engineering Science and Technology*, *13*(5):1352-1363.

Nasri, N., Rahimi, N.M., Nasri, N.M. & Talib, M.A.A. 2021. A comparison study between universal design for learning-multiple intelligence (Udl-mi) oriented stem program and traditional stem program for inclusive education. *Sustainability*,*13*(2): 554.

Ndhlovu, R. & Matafwali, B. 2020. Teaching Integrated Science to Junior Secondary School Learners with Hearing Impairment: Teachers’ Perceptions in Selected Special Schools of Chipata and Lusaka Districts. *Multidisciplinary Journal of Language and Social Sciences Education 3*(3): 73-91.

Neild, N.R., Taylor, K. & Crecelius, A. 2022. Universal Design for Learning and Technology in Deaf Education. In *Deaf Education and Challenges for Bilingual/Multilingual Students* (pp. 281-301). IGI Global.

Ngobeni, W.P., Maimane, J.R. & Rankhumise, M.P. 2020. The effect of limited sign language as barrier to teaching and learning among Deaf learners in South Africa. *South African Journal of Education*, *40*(2): 1-7.

Noble, H. & Heale, R. 2019. Triangulation in research, with examples. *Evidence-based nursing*, *22*(3): 67-68.

Noprianto, E. 2019. Remedial Teaching Program for Low-Achievers: An EFL Teacher’s Perception. *Eternal (English Teaching Learning and Research Journal)*, *52*.

Ntinda, K. & Tfusi, B. 2019. Experiences of Teachers of Deaf and Hard-of-Hearing Students' in a Special Needs School: An Exploratory Study. *Journal of Education and Training Studies*,*7*(7): 79-89.

Nussbaum, M.C. 2011. Capabilities, entitlements, rights: Supplementation and critique. *Journal of human development and capabilities*, *12*(1): 23-37

Ogegbo, A.A., Gaigher, E. & Salagaram, T. 2019. Benefits and challenges of lesson study: A case of teaching Physical Sciences in South Africa. *South African Journal of Education*, *39*(1): 46.

Orosz, G., Németh, V., Kovács, L., Somogyi, Z. & Korom, E. 2023. Guided inquiry-based learning in secondary-school chemistry classes: A case study. *Chemistry Education Research and Practice*,*24*(1):50-70.

Parveen, Z., 2017. Educational effectiveness of the 5E model for scientific achievement of students with hearing impairment. *Journal of Baltic Science Education*, *16*(5) : 723-732.

Petrus, R.M. 2018. A Comparison of Teachers' and Students' Perceptions of the Factors Contributing to Poor Performance in Physical Sciences: A Case of South Africaa. *Journal of Turkish Science Education*, *15*(4):93-103.

Pizzo, L. & Chilvers, A. 2019. Assessment of language and literacy in children who are d/deaf and hard of hearing. *Education Sciences*, *9*(3): 223.

Pozas, M., Letzel, V. & Schneider, C. 2020. Teachers and differentiated instruction: exploring differentiation practices to address student diversity. *Journal of Research in Special Educational Needs*, *20*(3): 217-230.

Pradipta, R.F., Purnamawati, F., Yasin, M.H.M., Dewantoro, D.A., Irvan, M. & Susilawati, S.Y. 2020. October. online learning resource based on one id website for all access (oiaa) as a student Learning Assistance System. *Education and Technology (ICET)*: 77-83.

Prinsloo, C.H., Rogers, S.C. & Harvey, J.C 2018. The impact of language factors on learner achievement in Science. *South African Journal of Education*,*38:*(1).

Priyanka, S. & Samia, K. 2018. Barriers to inclusive education for children with special needs in schools of Jammu. *The International Journal of Indian Psychology*, *6*(1):93-105.

Putri, A. 2016. EFL teachers' understanding in developing lesson plan. *Indonesian EFL Journal*, *2*(1):1-11.

Ramnarain, U. & Hlatswayo, M. 2018. Teacher beliefs and attitudes about inquiry-based learning in a rural school district in South Africa. *South African Journal of Education*, *38*(1).

Rasul, S., Shahzad, A. & Iqbal, Z. 2019. Teachers' misconceptions in Science: Implications for developing a remedial teacher training program. *Global Social Sciences Review*, *4*(3): 221-228.

Ratheeswari, K. 2018. Information communication technology in education. *Journal of Applied and Advanced research*, *3*(1): 45-47.

Raven, S. and Whitman, G.M. 2019. Science in silence: How educators of the deaf and hard-of-hearing teach Science. *Research in Science Education*, *49*: 1001-1012.

Rawls, J. 2001.*Justice as fairness: A restatement*.rw Harvard University Press.

Ren, H., Xu, N., Lin, Y., Zhang, S. and Yang, T. 2021. Remedial teaching and learning from a cognitive diagnostic model perspective: Taking the data distribution characteristics as an example. *rontiers in Psychology*,*12*: 628607.

Reynaga-Peña, C.G. & del Carmen López-Suero, C. 2020. Strategies and technology aids for teaching Science to blind and visually impaired students. In *User-Centered Software Development for the Blind and Visually Impaired: Emerging Research and Opportunities* (pp. 26-37). IGI Global

Rich, R.C., Brians, C.L., Manheim, J.B. and Willnat, L. 2018. *Empirical political analysis: Quantitative and qualitative research methods*. Routledge.

Richardson, V. 1996. The role of attitudes and beliefs in learning to teach. *Handbook of research on teacher education*, *2*(102-119): 273-290.

Riza, L.S., Firdaus, D.S., Junaeti, E., Hidayat, T., Abdullah, A.G., Nandiyanto, A.B. & Abdullah, C.U. 2018. A concept and implementation of instructional interactive

multimedia for deaf students based on inquiry-based learning model. *Journal of Engineering Science and Technology*,*13*(7): 2016-2035.

Robeyns, I. 2006. The capability approach in practice. *Journal of political philosophy*, *14*(3): 351-376.

Rodrigues, F.M., Rato, J.R., Mineiro, A. & Holmström, I. 2022. Unveiling teachers' beliefs on visual cognition and learning styles of deaf and hard of hearing students: A Portuguese-Swedish study. *Plos one*,*17*(2): 263216.

Roller, M.R. 2019. A quality approach to qualitative content analysis: similarities and differences compared to other qualitative methods. *SSOAR-Social Science Open Access Repository.*

Ross, A.D., Yerrick, R. & Pagano, T., 2020. Use of Scientific Argumentation by Deaf/Hard-of-Hearing Students in Environmental Science Topics. *Journal of Science Education for Students with Disabilities*,*23*(1):1.

Roulston, K. &Choi, M. 2018. Qualitative interviews. *The SAGE handbook of qualitative data collection*, pp.233-249.Frey, B.B. ed. 2018. *The SAGE encyclopedia of educational research, measurement, and evaluation*. Sage Publications.

Rubini, B., Ardianto, D., Pursitasari, I.D. & Hidayat, A. 2018. Science Teachersâ€™ Understanding on Science Literacy and Integrated Science Learning: Lesson from Teachers Training. *Jurnal Pendidikan IPA Indonesia*, *7*(3): 259-265.

Rusyani, E.N.D.A.N.G., Maryanti, R.I.N.A., Muktiarni, M. & Nandiyanto, A.B.D. 2021. Teaching on the concept of energy to students with hearing impairment: changes of electrical energy to light and heat. *Journal of Engineering Science and Technology*,*16*(3): 2502-2517.

Ryan, G. 2018. Introduction to positivism, interpretivism and critical theory. *Nurse researcher,* 25(4): 41-49.

Sağlam, A.G., Şahin, M., Çelik, E., Çelebi, Ö., Akça, D. & Otlu, S. 2017. The role of staphylococci in subclinical mastitis of cows and lytic phage isolation against to Staphylococcus aureus. *Veterinary World*, *10*(12): 1481.

Sahin-Taskin, C. 2017. Exploring pre-service teachers' perceptions of lesson planning in primary education. *Journal of education and practice*, *8* (12): 57-63.

Schwab, J. J.1962. The teaching of Science as enquiry. In J.J. Schwab & P.F. Brandwein (Eds.). Cambridge: Harvard University Press*. The teaching of Science*. 3-103.

Sen, A.K. 1992. Inequality Reexamined, Harvard University Press, Cambridge, Mass

Shah, R., Das, A., Desai, I. & Tiwari, A. 2016. Teachers' concerns about inclusive education in a hmedabad, india. *Journal of Research in Special Educational Needs*,*16*(1): 34-45.

Shambare, B. & Simuja, C. 2022. A Critical Review of Teaching with Virtual Lab: A Panacea to Challenges of Conducting Practical Experiments in Science Subjects beyond the COVID-19 Pandemic in Rural Schools in South Africa. *Journal of Educational Technology Systems*, *50*(3): 393-408.

Shanthi, W.G. & Roy, B.R. 2023. Integrating ICT, AI Based Education System for Deaf and Dumb Using Indian Sign Language in Telangana Region. *Telematique*, *22*(01): 1014-1018.

Shulman, L.S. 1986. Those who understand: Knowledge growth in teaching. *Educational researcher*, *15*(2): 4-14.

Silvestri, J.A. & Hartman, M.C. 2022. Inclusion and Deaf and Hard of Hearing Students: Finding Asylum in the LRE. *Education Sciences*, *12*(11):773.

Skoumios, M. & Skoumpourdi, C. 2021. The Use of outside Educational Materials in Mathematics and Science: Teachers' Conceptions. *International Journal of Education in Mathematics, Science and Technology*,*9*(2): 314-331.

Smale-Jacobse, A.E., Meijer, A., Helms-Lorenz, M. & Maulana, R. 2019. Differentiated instruction in secondary education: A systematic review of research evidence. *Frontiers in psychology*,*10*: 2366.

Song, M. 2020. Integrated STEM teaching competencies and performances as perceived by secondary teachers in South Korea. *International Journal of Comparative Education and Development*, *22*(2): 131-1

Taub, D.A., McCord, J.A. & Ryndak, D.L. 2017. Opportunities to learn for students with extensive support needs: A context of research-supported practices for all in general education classes. *The Journal of Special Education*, *51*(3): 27-137.

Taylor, K. 2020. One-stop lesson planning: how universal design for learning can help students who are deaf or hard of hearing. *Odyssey: New Directions in Deaf Education*, *21:* 48-51.

Taylor, S.J., Bogdan, R. & DeVault, M. 2015. *Introduction to qualitative research methods: A guidebook and resource*. John Wiley & Sons.

Taylor, S.J., Bogdan, R. & DeVault, M. 2015. *Introduction to qualitative research methods: A guidebook and resource*. John Wiley & Sons.

Terzi, L. 2007. Capability and educational equality: the just distribution of resources to students with disabilities and special educational needs. *Journal of philosophy of education*,*41*(4): 757-773.

Terzi, L. 2010. Justice and equality in education*:* a capability perspective on disability and special educational needs. *A&C Black*.

Terzi, L. 2014. Reframing inclusive education: educational equality as capability equality. *Cambridge Journal of Education*,*44*(4): 479-493.

Tibbitt, J. 2020. Formative Assessment: A Tool for Closing Achievement Gaps in Diverse Classrooms. *Odyssey: New Directions in Deaf Education*,*21*: 72-75.

Tiggs, S.C. 2021. *Perceptions of Professional Development: A Descriptive Study Investigating Learning Opportunities for Teachers of Students Who Are Deaf or Hard of Hearing*.

Timms, M.J., Moyle, K., Weldon, P.R.& Mitchell, P. 2018. Challenges in stem learning in australian schools: *literature and policy review*.

Tohara, A.J.T. 2021. Exploring digital literacy strategies for students with special educational needs in the digital age. *Turkish Journal of Computer and Mathematics Education*, *12*(9): 3345-3358.

Trimble, J. E. 2003. Cultural sensitivity and cultural competence. In M. J. Prinstein & M. D. Patterson (Eds.), The portable mentor: Expert guide to a successful career in psychology (pp. 13–32). New York: Kluwer/ Plenum Press.

Trinidad, J.E. & King, R.B. 2021. Ability grouping predicts inequality, not achievement gains in Philippine schools: findings from PISA 2018. *Educational Research for Policy and Practice*,1-18.

UNESCO. 1994. The Salamanca statement and framework for action on special needs education. Paris: Author

United Nations. 2006. Convention on the rights of persons with disabilities. Retrieved May 14, 2014, from www.un.org

Van Leendert, A., Doorman, M., Drijvers, P., Pel, J. & van der Steen, J. 2019. An exploratory study of reading mathematical expressions by braille readers. *Journal of Visual Impairment & Blindness*,*113*(1): 68-80

Vasileiou, K., Barnett, J., Thorpe, S. & Young, T. 2018. Characterizing and justifying sample size sufficiency in interview-based studies: systematic analysis of qualitative health research over a 15-year period. *BMC medical research methodology*, *18*: 1-18.

Villeneuve, M., Abson, L., Pertiwi, P. & Moss, M. 2021. Applying a person-centred capability framework to inform targeted action on Disability Inclusive Disaster Risk Reduction. *International journal of disaster risk reduction*, *52*:101979.

Vivian, E.C.P. & Leonel, A.A. 2022. Teaching-learning Physics in Bilingual Education Schools for the Deaf. *Revista Brasileira de Pesquisa em Educação em Ciências*, 38163-25.

Vygotsky, L.S. & Cole, M. 1978. *Mind in society: Development of higher psychological processes*. Harvard university press.

Wang, C. & Gao, J. 2021. Peer Teaching as an Effective Method: A Case Study at ST University in China. *Journal of Higher Education Theory and Practice*, *21*(6):189-199

Warnock, M. & Norwich, B. 2010.*Special educational needs: A new look*. Bloomsbury Publishing.

Wilcox, B.R. & Lewandowski, H.J. 2017. Students' views about the nature of experimental physics. *Physical Review Physics Education Research*,*13*(2).

Wilson, E. & Abibulayeva, A. 2017. *An Introduction to Educational Research Methods* (In Russian and Kazakh). Faculty of Education, University of Cambridge, Eurasian National University, Kazakhstan & The British Council.

Winarno, N., Rusdiana, D., Susilowati, E, & R.M.A. 2020. Implementation of integrated Science curriculum: a critical review of the literature. *Journal for the Education of Gifted Young Scientists*,*8*(2): 795-817.

Xohua-Chacón, A., Benítez-Guerrero, E., Muñoz-Arteaga, J. & Mezura-Godoy, C.2022. Using a tangible system to promote inclusive, collaborative activities to learn relational algebra for students with hearing impairment. *Universal Access in the Information Society*, 1-13.

Yin, R. K 2017. Case Study Research and Applications: Design and Methods. Washington DC: Sage Publications.

Yin, R. K. 2018. Case study research design and methods (6th Ed.). Thousand Oaks, CA: Sage Publishing.

Zafar, A., Gull, H., Farooq, U., Rahim, M.S.M. & Abid, A. 2021, November. teaching english and Science to the deaf students. In *2021 International Conference on Innovative Computing (ICIC).* IEEE. (1-6).

Zakia, D.L., Sunardi, S. & Yamtinah, S. 2017. The Study of Visual Media Use on Deaf Children in Science Learning. *European Journal of Special Education Research*.

Zhang, X., Admiraal, W. & Saab, N. 2021. Teachers' motivation to participate in continuous professional development: relationship with factors at the personal and school level. *Journal of Education for Teaching*, *47*(5): 714-731.

Zulfiani, Z. & Herlanti, Y. 2018. Scientific inquiry perception and ability of pre-service teachers. *Journal of Turkish Science Education*,*15*(1):128-140

Appendices

Appendix A - Interview Protocol

Interview schedule on the experiences of Science teachers on the teaching of learners with hearing impairment in Lesotho Secondary schools. The study explores teachers' experiences of teaching Science to HIL in Lesotho secondary schools. four teachers teaching Science to HIL were interviewed. The questions were as follows:

1. What is your name, background, and your qualification? Why did you major in teaching of Science and how long have you been a teacher?
2. Which class do you teach and how many learners are there in your class?
3. How long have you been a teacher?
4. Can you tell us about the efforts you take for hearing impaired learners to understand concepts in the regular classroom?
5. What kind of hearing impairment does your learner have?
6. Is it your first time to teach the hearing-impaired learners? Tell me your thoughts the first time you saw the hearing-impaired learner in class.
7. How do you plan for the lesson in consideration of hearing-impaired learners in the class? Does it assist you to teach physics concepts in class?
8. Do you find the teaching approaches that you were taught helpful?
9. What kind of a support do you get from different stakeholders to teach hearing impaired learners?
10. If you are to tell a new teacher about teaching hearing impairment what can you say?
11. What can you say is the main challenge of teaching this learner?
12. Tell me about the way you assess this learner,

    Can you encourage the ministry to bring more hearing impaired learners in your school?

Appendix B - Ethical Clearance Certificate

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS UV

GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)

12-May-2023

Dear Mrs Maretsepile Relebohile MM Molahloe

Amendment Approved

Research Project Title:
Experiences of science teachers on the teaching of learners with hearing impairment in Lesotho Secondary schools

Ethical Clearance number:
UFS-HSD2019/1143/2507/21

We are pleased to inform you that your amendment application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. you are requested to submit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for notifying the ethics committee of the changes/amendments that have been made to your study; we wish you the best of luck and success with your research.

Please keep in mind that ethical clearance is valid for a period of 12 months only.

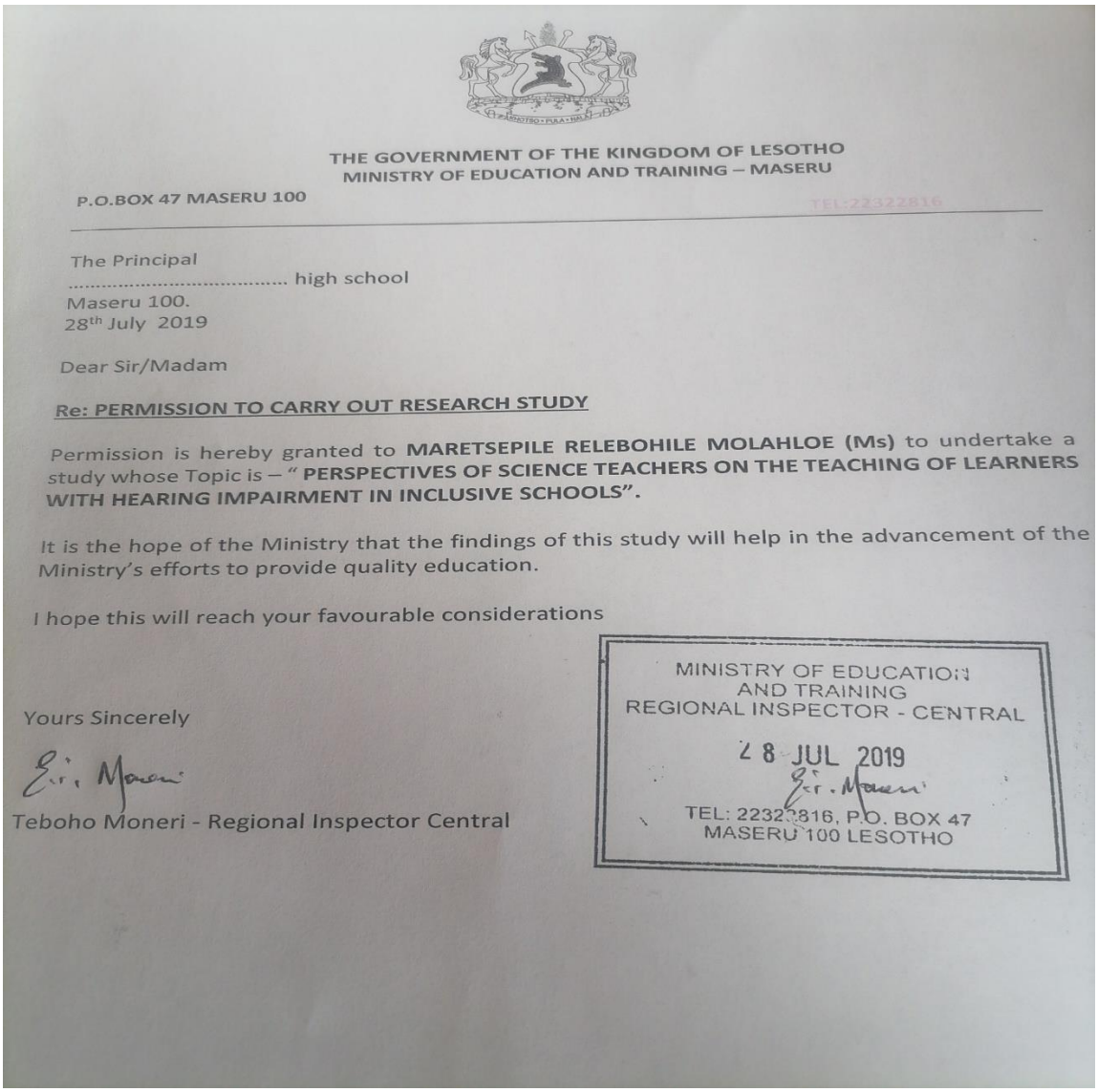
Yours sincerely

Dr Adri Du Plessis
Chairperson: General/Human Research Ethics Committee

205 Nelson Mandela Drive
Park West
Bloemfontein 9301
South Africa

P.O. Box 339
Bloemfontein 9300
Tel: +27 (0)51 401 9337
duplessisA@ufs.ac.za
www.ufs.ac.za

Appendix C: Permission To Conduct Research



THE GOVERNMENT OF THE KINGDOM OF LESOTHO
MINISTRY OF EDUCATION AND TRAINING – MASERU

P.O.BOX 47 MASERU 100

TEL:22322816

The Principal
..... high school
Maseru 100.
28th July 2019

Dear Sir/Madam

Re: PERMISSION TO CARRY OUT RESEARCH STUDY

Permission is hereby granted to **MARETSEPILE RELEBOHILE MOLAHLOE (Ms)** to undertake a study whose Topic is – " **PERSPECTIVES OF SCIENCE TEACHERS ON THE TEACHING OF LEARNERS WITH HEARING IMPAIRMENT IN INCLUSIVE SCHOOLS".**

It is the hope of the Ministry that the findings of this study will help in the advancement of the Ministry's efforts to provide quality education.

I hope this will reach your favourable considerations

Yours Sincerely

Teboho Moneri - Regional Inspector Central

MINISTRY OF EDUCATION
AND TRAINING
REGIONAL INSPECTOR - CENTRAL
28 JUL 2019
TEL: 22322816, P.O. BOX 47
MASERU 100 LESOTHO

Appendix D- Letter to The School

NCDC
P.O Box 1126
Maseru 100
August 2019

The Principal
XXX Secondary school

Dear sir/madam

APPLICATION FOR CONDUCTING RESEARCH AT YOUR SCHOOL

I am a Doctoral Research Student at the University of Free State. I am carrying out a research study which investigates perspectives of Science teachers on the teaching of learners with hearing impairment in inclusive schools. I hope the findings of the study will provide useful information that can assist the policy makers, curriculum developers, principals, teachers as well as the parents or guardians of hearing-impaired learners. I am writing to ask if you would be willing to give me permission to ask your teachers if he/she would like to take part in my research.

I am writing to enquire whether you would give me permission to recruit participants from among the teachers at your school. I would need your help to approach these teachers and ask them if they would be willing to take part in my study. I would also need permission to complete the interview during school hours and have access to an appropriate space in which to conduct the interviews. These interviews should at least take thirty minutes and, at most, 60 minutes.

The normal school program will not be interrupted. Please let me know if you require further information.

Regards

Maretsepile Molahloe

PhD candidate (University of free state)

Contact no: +266 63689641

Appendix E- Informed Consent

NCDC
P.O Box 1126
Maseru 100

August 2019

The Science Teacher
XXX High School

Dear Sir/Madam

I hereby request permission to conduct an interview with you. My name is Maretsepile Molahloe and I am presently studying for a Doctoral degree with the University of the Free State. As part of my Doctoral programme
, I am carrying out a research study which investigates perspectives of Science teachers on the teaching of learners with hearing impairment in inclusive schools.

The study seeks to understand how Science is taught in four regular schools with hearing impairment (LHI) and to establish how Science teachers perceive teaching LHL. This information is expected to be of use in assisting teachers to develop effective approaches for teaching Science to hearing impaired learners. The findings of the study are also intended to provide assistance to policy makers and curriculum developers to make informed decisions when engaging in educational transformation.

The study will involve:

1. Interviews with selected Science teachers assigned to teach hearing impaired learners (interviews are not expected to exceed 1 hour)
2. Document analysis of written texts

I undertake to observe confidentiality and to protect you from physical and/or psychological harm.

No names of the schools and/or persons shall be used in any reports of the research. You are humbly asked to participate voluntarily in the study, and you may as well withdraw at any time should you so wish.

Upon the completion of the study, I undertake to provide the Ministry of Education and Training with a copy of the research report and to share my findings with accounting curriculum leaders (and possibly other) districts as necessary.

If you need any further information and/or have suggestions, please contact me and/or my research supervisor Professor Matseliso Mokhele Makgalwa.

E-mail address: MokheleML@ufs.ac.za
Phone no: 27825042053

I hope my request will reach your favourable consideration.

Yours sincerely
Maretsepile Molahloe

Appendix F– Certificate of Language Editing

13 Union Street
Villiersdorp
6848
12 June 2023

Professor Matseliso Mokhele Makgalwa
School of Education Studies
University of the Free State
Bloemfontein

Experiences of Science teachers with the teaching of learners with hearing-impairment in Lesotho Secondary schools

Thesis by Maretsepile Relebohile Molahloe

This is to confirm that I have edited the language of Maretsepile's doctoral thesis to the best of my ability.

Yours sincerely

Derek Gripper
derekgripper@gmail.com

Appendix G – Turn-it-in report

Maretsepile Molahloe. Final Thesis.docx

by Maretsepile Relebohile Molahloe

Submission date: 13-Jun-2023 02:23PM (UTC+0200)
Submission ID: 2112458456
File name: Maretsepile_Molahloe._Final_Thesis.docx (999.68K)
Word count: 61908
Character count: 334318

Thesis for Turn it.docx

ORIGINALITY REPORT

8%	7%	2%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	scholar.ufs.ac.za Internet Source	2%
2	researchspace.ukzn.ac.za Internet Source	1%
3	uir.unisa.ac.za Internet Source	<1%
4	hdl.handle.net Internet Source	<1%
5	repository.up.ac.za Internet Source	<1%
6	journals.unza.zm Internet Source	<1%
7	vital.seals.ac.za:8080 Internet Source	<1%
8	repository.tml.nul.ls Internet Source	<1%
9	"Handbook of Speech-Language Therapy in Sub-Saharan Africa", Springer Science and Business Media LLC, 2023	<1%