Investigating the Challenges that Senior Phase Natural Sciences Teachers Face in Making Science Content Meaningful for Deaf and Hard-of-Hearing Learners

By

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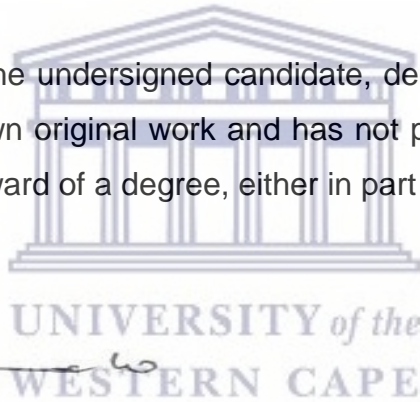## University of the Western Cape (UWC)

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DECLARATION

I, **Buzani Mavis Khumalo**, the undersigned candidate, declare that the content of this Masters dissertation is my own original work and has not previously been submitted to any other university for the award of a degree, either in part or in its entirety.

Signature

Date   01 November 2021

ABSTRACT

The 1994 transition process provided an opportunity for a massive change in South African society in all spheres, including education. In the previous political era, deaf learners and other learners with disabilities were marginalized by the education system. In particular, there were weak mechanisms in place to ensure that these learners were placed in a system which recognized the many challenges of learners with disabilities, such as their disability needs, the training of teachers for deaf learners, acquiring equipment to support deaf learners, reserving special classes for deaf education, and most importantly, integrating all these aspects into the curriculum. Hence, the transition during the 1994 period provided a chance and an opportunity to address these challenges.

In this context, the main aim of this study was to examine the challenges faced by Senior Phase Natural Sciences teachers in making science content meaningful for deaf and hard-of-hearing learners. Three schools for the deaf and hard- of-hearing were selected because of their proximity to the researcher and their varying nature and categorization. The study employed in-depth interviews with semi-structured questions to collect data from the respondents and five teachers who teach Natural Science in Grades 7-9 were interviewed. The study adopted a qualitative research approach through in-depth interviews as a method of collecting data. The findings of the study reflect that the challenges facing Senior Phase Natural Science teachers include lack of training, cultural attitudes towards deaf learners, lack of sign language resources and lack of financial funding for acquiring deaf education equipment.

KEY WORDS: Deaf Learners, Inclusive Education, Science Education, Qualitative Research, Senior Phase Natural Sciences, Disability, Hard-of-Hearing

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LIST OF ABBREVIATIONS

AFCP	African Child Forum Policy
CAPS	Curriculum and Assessment Policy Statement
EFA	Education for All
LRE	Least Restrictive Environment
NCS	National Curriculum Statement
NEC	National Education Commission
OBE	Outcomes-based Education
SASA	South African Schools Act
SASL	South African Sign Language
SIAS	Screening Identification Assessment and Support
UN	United Nations
UNCRC	United Nations Convention on the Rights of the Child
UNCRPD	United Nations Convention of Rights of Persons with Disabilities
UNESCO	United Nations Educational Scientific and Cultural Organisation
UNHR	Universal Declaration of Human Rights
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organisation

CHAPTER 1
INTRODUCTION

1.1. Introduction

The purpose of this study was to investigate the challenges that Senior Phase Natural Sciences teachers face in making science content meaningful for deaf and hard-of-hearing learners. This chapter presents the foundation of the study that was undertaken. In this chapter, the background to the study is presented, motivating the reasons why it is necessary to explore the experiences of the teachers with the aim of improving how Science content is taught to learners with hearing disabilities. The main aim and the objectives of the study are presented afterwards. In addition, this chapter has sections describing the research problem, the theoretical framework, research questions and the significance of the study, concluding with a brief outline of the chapters included in this dissertation.

1.2. Teaching and learning of Science for deaf learners in the context of inclusive education.

This study is rooted in the teaching of Senior Phase Natural Sciences to deaf and hard-of-hearing learners in the context of inclusive education. The study recognises the significance of inclusion for the education of learners with disabilities, as it helps disabled learners to beneficially participate in learning activities. Inclusive education ensures all learners' right to education is recognised, and their learning needs are catered to. The study also recognises the role of teachers in the successful implementation of inclusive education goals. It examines the challenges that teachers face in executing their role of ensuring that they meet the varying special education needs of learners with disabilities and other learning impediments. However, much focus on the education of deaf and hard-of-hearing learners has been on language acquisition because deafest learners enter the school system lacking background knowledge and linguistic skills (Kurz, Schick, & Hauser, 2015). As a result, language skills take centre stage at the expense of content-based subjects like Science, rightly so because it would be difficult for deaf learners to understand content-based subjects without the prerequisite knowledge of language (Webb, 2017). While this approach has been widely used over the years in deaf education

(Mukhopadhyay & Moswela, 2010) marginalisation of content-based subjects, particularly Science Education for deaf and hard-of-hearing learners, is against the principles of inclusive education and equity in education for all learners regardless of disability. Deaf and hard-of-hearing learners have the right to be educated in Science so they can also understand how the world and the universe works, and to be afforded an equal opportunity to participate in the field of Science. Ensuring that all special education needs of learners are met in the classroom is vital with respect to the fundamental right of all children to access equal, quality inclusive education.

1.2.1. Background of the study.

The World Health Organisation document of 2011 reveals that 80% of children globally with disabilities live in developing countries like South Africa. This survey (WHO, 2011) also found that an average of 50,6% of boys and 41,7% of girls with disabilities complete primary school, which is an average of 10% lower than their peers who do not have disabilities. Nonetheless, the right of children to inclusive education is broadly recognized in international human rights law. The majority of these essential global human rights instruments recognize the right to education without discrimination on the basis of ethnicity, identity, gender and disability.

The Universal Declaration of Human Rights (UNHR), adopted in 1948 to safeguard the rights of every individual, was the initial international instrument to emphasise the essential rights and freedoms of all individuals, creating the premise for further instruments that protect the precise rights of specific groups of persons, including children and persons living with disabilities. One of the key developments from the convention was the declaration of education as a basic human right. The right to basic education was further reinforced in the Convention on the Rights of the Child (1989), formulated as a binding international framework for children's rights to protect and provide special care for children aged 18 and below. The Salamanca Statement (1994) on inclusive education accentuates the right to education for every individual without discrimination on any basis. The outcomes of the Salamanca conference are regarded as vital in providing the foundation for inclusive education, as the statement obligated the provision of inclusive

education systems that cater to the special educational needs of children who require extra support.

The Dakar Framework for Action (2000) is also essential in terms of inclusive education. It reflects the United Nation`s dedication for the provision of quality basic education for all individuals and commits government to this mandate. The mandate towards inclusive education was strengthened with the enactment of the United Nations Convention on the Rights of Persons with Disabilities (2006). The convention is the international framework that promotes and protects the rights and interests of persons with disabilities to ensure equal enjoyment of human rights, non-discrimination and equality in domains such as education, health, employment, accessibility, and personal mobility.

Inclusive education in South Africa should be understood in the context of the marginalization that occurred in the previous era; the pre 1994 Apartheid regime adopted a medical strategy for disability. During that era, a mere 20% of learners with disabilities were enrolled in schools. This was also worsened by the shortage of sufficient special schools to cater to children with disabilities. The lack of government support and the broader absence of special schools and educational support exposed learners with disabilities to barriers to learning and exclusion from the education system. The post-1994 education system sought to eliminate inequality, hence several inclusive education policies and legislation were adopted. The ratification of the United Nations Convention on the Rights of the Child in 1995 and the United Nations Convention of Rights of Persons with Disabilities (UNCRPD) in 2007 by the South African government signified a paradigm shift as the country now recognizes disability as a human rights issue, discarding the social model of disability (UNICEF, 2012)

The right to basic education was reinforced in the South African Schools Act (SASA) 84 of 1996 that promotes equal access to quality education. SASA required public schools to admit and serve the educational needs of all learners without discrimination or prejudice of any kind. In 2001 the government reiterated its commitment to reform the education system and implement an inclusive education philosophy through the adoption of the Education White Paper 6, namely 'Special Needs Education: Building an Inclusive Education and Training System'. White Paper 6 was published with the aim to   develop

initiatives that would ensure the education and training system recognised and accommodated the diverse range of learning needs within the student population (RSA DoE, 2001: Section 2 (2.1.1)). The White Paper 6 aligns South African policies with an internationally recognised philosophy of inclusive education to ensure that children who experience barriers to learning enjoy equal and quality inclusive education.

The state devised the National Strategy on Screening, Identification, Assessment, and Support (SIAS) after the adoption of White Paper 6 (Department of Education, 2008). SIAS lays out a framework for identifying and providing special support to learners who face learning and developmental challenges in school. The SIAS establishes a mechanism for assessing individual learner requirements and providing the amount and level of additional support required.

As with other policies that were enacted, the SIAS confirms the state's commitment to reform the education sector in South Africa. The policies are recognised as significant attempts to achieve inclusive education goals. Recognising that teachers are tasked with the great responsibility of providing quality services to learners who have hearing impediments (Sarin, 2015), this study notes that much of the focus in the literature has been on the students themselves as the literature on learning and disabilities for learners with hearing impairments is vast. However, little has been done on the aspect of how the teachers execute their duties in dealing with the learners. This poses significant challenges in achieving inclusive education goals, as the focus of the policies on only the learners implies that there is a lack of attention on other barriers to teaching and learning, like those that teachers face.

The challenges faced by teachers are partly responsible for the failure to achieve inclusive education goals as envisioned in the policy frameworks established by the state. Dreyer (2017) argues that there is a lack of teaching skills and knowledge of inclusive education practices to adapt the curriculum to address the special educational needs of learners facing barriers to learning, especially those with severe disabilities. In addition, Bornman and Rose (2010) argue that teachers who lack the necessary skills to handle learners with disabilities also lack enough support and resources, further crippling their ability to effectively perform their duties. Engelbrecht (2018) posits that continued discrepancies in

interpreting inclusive education in teaching practice is partly responsible for ineffective policy implementation. A similar argument was earlier presented by Donohue and Bornman (2014) who argue that the lack of clarity on how inclusive education strategies should be implemented in classrooms partly contributes to the reasons for failing to achieve inclusion goals.

Dalton, McKenzie and Kahonde (2012) assert that "special education cannot be divorced from education." It is noteworthy that learners with disabilities sit for the same examinations as able-bodied students and as such there is a huge need to meet the requirements of the learners during the teaching and learning process (Mukhopadhyay and Moswela, 2010).

As noted by Upton (2016:118), "learning is a change in human disposition or capability which persists over a period of time, and which is not simply ascribable to the process of growth. The kind of change called learning exhibits itself as a change in behaviour and the inference in learning is made by comparing what behaviour was possible before the individual was placed in a learning situation and what behaviour can be exhibited after such treatment. As a result, special education for children aims to provide learning opportunities to a child in a coordinated educational program that emphasizes natural objectives such as literacy, numeracy, and manipulative skills acquisition, as well as the development of a positive image, self-expression, and self-discipline."

According to the terms of the South African Schools Act (Act 84 of 1996), educational institutions should have access to resources such as land, cash, human resources, facilities, and equipment that ensure the efficient provision of educational services. The White Paper 6 of 2001 also supports the provision of adequate facilities and equipment, as well as infrastructure in an "inclusive education" setup. Furthermore, the legal and policy frameworks support the creation of a good teaching environment for the human resource element to education. Walton and Lloyd (2011) argue that teaching and learning should form the core of any educational institution's operations. The main aims and objectives of education are not achievable outside the firm foundation and establishment of materials that support teaching and learning. This calls for the relevant government departments to co-ordinate provision and monitoring of activities on teaching

and learning within special education institutions to ascertain that standards are not jeopardized due to a shortage of resources (Arsic & Djrodjevic, 2017:2).

It is important to note that the education of learners with hearing impairments has received little attention. As highlighted by Lekoko and Mukhopadhyay (2016), disability is stereotyped to infer that one is cursed, and cultural beliefs stigmatisation often results in children with disabilities being excluded from most social activities, including education (Mellard, Fall & Woods, 2013). This behaviour is, however, slowly changing. There has been increased enrolment of learners with hearing impairments in special schools and increased efforts to establish more special education units in mainstream schools to respond to the constitutional requirement to accommodate all learners in mainstream schools.

Despite the efforts to establish inclusive education environments that accommodate learners with disabilities in mainstream schools, there are numerous challenges that cripple the chances of success of these policies. The literature suggests that most schools are under-resourced and face a shortage of teachers qualified to handle learners with special needs. Most deaf units are characterized by the inclusion of learners of different ages and levels in the same room, being taught by one teacher. A key concern as noted by Dalton et al. (2012) is that most deaf units mix learners of different age groups and linguistic abilities in one class under the instruction of one teacher. In addition, only a few teachers are proficient in sign language, signalling that teachers lack the linguistic know-how to effectively communicate in the official language of instruction for learners with hearing disabilities. The situation can result in teachers struggling to deliver an effective mode of instruction, resulting in low academic achievement and little motivation to continue with further studies.

Science Education for deaf learners is not immune to lack of effective instruction, possibly presenting the greater risk of excluding deaf and hard-of-hearing learners from the field of Science. This study recognises how teachers are pivotal to the success of inclusion policies and therefore suggests that it is necessary to investigate the challenges that Science teachers face in making content meaningful for deaf and hard-of-hearing students. Based on this background, the study explores the challenges faced by Senior

Phase Natural Sciences teachers in executing their duties to make Science content meaningful to deaf and hard-of-hearing learners.

1.2.2. Rationale for the study

As shown from the policy perspective above, and from personal experience as a teacher, the researcher has observed that there seems to be a lack of modes of instruction to effectively communicate Science education to deaf and hard-of hearing learners. Issues related to pedagogical approaches to Science education for deaf learners, sign language, and deaf culture are often ignored. It has been shown that lack of clarity on strategies to implement inclusive education policies results in inconsistent practices in instruction methods and strategies to support learners with hearing disabilities (Donohue & Bornman, 2014). As a result of these difficulties, it has been noted that deaf learners tend to struggle to excel at school, especially in Mathematics and Science, and few deaf learners continue with Science subjects beyond the Senior Phase level (Naidoo, 2008). Of concern is the implication that such a situation results in having a very small proportion of deaf people who can participate in Science-related fields. This sets up a premise to explore how to improve the teaching of Science to deaf and hard-of-hearing learners, and possibly improve the number of people who progress further with Science studies in the deaf community.

Based on observations that there is a lack of clarity on how teachers implement inclusive strategies to support deaf and hard-of-hearing learners in Science, the study focuses on exploring the realities and experiences of teachers when teaching Senior Phase Natural Sciences to deaf learners. This then probed the need to investigate the challenges educators face when instilling Science knowledge to learners, with the aim of exploring opportunities to improve Science education for learners with hearing disabilities.

1.3. Problem Statement

Available literature and studies have focused much on the challenges faced by learners with hearing disabilities. Little has been done on the challenges of teachers in instilling "knowledge" in the mind of disabled learners. It follows that the learning curriculum remains the same for able-bodied and hearing-impaired learners in South Africa. Despite policies being in place that advocate the provision of equipment and training of teachers

In dealing with learners with hearing impediments, the progress towards efficient implementation of the policies and successfully achieving inclusivity goals is somewhat disappointing. The situation triggers enormous challenges for educators teaching deaf and hard-of-hearing learners, especially in the teaching of Science subjects in the Senior Phase. This has resulted in a huge decrease in learners with hearing impairments taking Science subjects at FET phase within schools in South Africa. It is therefore the aim of this study to investigate the challenges faced by the teachers in making Science content meaningful for deaf and hard-of-hearing learners.

1.4. Aims, Objectives and Research questions.

The main aim of this research was to investigate how teachers teach deaf and hard-of-hearing learners in Senior Phase Natural Sciences classes.

1.4.1. Research objectives

The research is guided by the following objectives:

- To unpack how inclusive education is conceptualized within the context of existing policies and legal frameworks in the South African education system and how the existing policies support the teaching of Senior Phase Natural Sciences to learners with hearing disabilities.

- To explore the challenges faced by Senior Phase Natural Science teachers in making Science content meaningful to deaf and hard- of- hearing learners.

- To suggest possible recommendations on improving the teaching of Natural Sciences at Senior Phase within the context of deaf and hard- of- hearing learners' experiences.

1.4.2. Research Questions

The main research question of the study is:

How are Senior Phase Natural Sciences content taught to deaf and hard-of-hearing learners?

The study seeks to answer the following sub- questions:

1. How do inclusive education policies and legal frameworks support the teaching of Senior Phase Natural Science to learners with hearing disabilities in South Africa?

2. What are the experiences of Senior Phase Natural Science teachers in making science content meaningful to deaf and hard-of-hearing learners?

3. What factors play a role in improving the teaching of Senior Phase Natural Science content to deaf and hard-of-hearing learners?

1.5. Brief outline of the rest of the dissertation

Chapter 2 presents a comprehensive review of literature on the principles of inclusive education and the different pedagogies for Science Education. In addition, a document analysis was conducted as part of the desktop research to uncover the legislative framework for inclusive education in the South African school system. Finally, Science Education pedagogies were deconstructed in the perspective of the theory of constructivism, giving a theoretical framework for the teaching and learning of Science content for deaf and hard- of -hearing learners.

Chapter 3 presents the research design and the methodology that guided the data collection process for this study, highlighting how the research instruments that were used and the strategies that were enforced to guarantee the validity of the findings and compliance with ethical research standards.

Chapter 4 reports on the findings of this research. The findings captured the realities and experiences of teachers teaching Science content to deaf and hard-of-hearing learners, highlighting the main challenges that ensue from the lack of support and resources and inadequate training in the pedagogical approaches in both Science Education and deaf education.

Chapter 5 concludes the research report by drawing on significant information presented in the preceding chapters to provide a summary of the research findings, conclusions, and the final recommendations.

1.6. Summary

This chapter presented the premise for this inquiry. It sets out from the perspective of an inclusive education philosophy that seeks to promote equal access to a non-discriminatory education system that supports the special education needs of all learners. The focus of the study is on the experiences of teachers dealing with deaf learners, as much of several studies and policies seem to focus more on the learner, while neglecting impediments to learning and instruction such as the factors that affect teachers. The chapter concludes with an outline of the dissertation. The next chapter presents the literature review that analyses, in detail pertinent literature on inclusive education goals and discusses relevant issues pertaining to policy implementation.

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CHAPTER 2
LITERATURE REVIEW

2.1. Introduction

The previous chapter provided a reflection of the problem statement, setting up the background to this study. The main aim of this research was to investigate how Senior Phase Natural Science are taught. This enquiry seeks to explore the challenges faced in making the science content meaningful to hearing disabilities in the context of inclusive education. This chapter reviews existing literature relevant to this study, beginning with conceptualisation of inclusive education for children with disabilities. Science Education for children with disability will also discussed with a focus on the policies and practices of inclusive education in South Africa and the development of the education curriculum in South Africa. Finally, this chapter concludes by presenting the conceptual framework underpinning this study, highlighting the theory of constructivism and its relationship to the teaching and learning of science concepts.

2.2. Conceptualisation of Inclusive Education

UNICEF estimates that of the 93 million children living with disabilities, only half are in school. Children with disabilities are frequently overlooked by society in policymaking, limiting their access and involvement in social, educational, economic, and political activities. Disabled children face the consistent challenge of being discriminated against, stigmatised and being consistently failed by policymakers and decision-makers to integrate disability in the education system. Nearly 50 per cent of children with disabilities are consistently failed and ignored by policymakers, which limit them to access to education, the inequality is significant compared to only 13 percent of those without disability out of school. In this context, inclusive education strategies are the most effective in ensuring that disabled children are fully integrated into mainstream education and have access to education.

An inclusive education system is one "where all students are put in age-suitable general education classes in their own local schools to receive high-quality instruction, services and resources that allow them to achieve success in the core curriculum; irrespective of

any difficulties they might have" (Naicker, 2018a). This necessitates that all learners receive instruction "in the least restrictive environment that ensures learners with disabilities are as integrated as possible with their peers without disabilities, with general education being the primary choice for all learners (Engelbrecht, 2006, p. 256). Recognizing, identifying, and responding to differences and disparities among learners, is central to effective inclusive education (Phasha, Mahlo and Dei, 2017). The differences in question may be physical, cognitive, social, emotional, or social issues.

2.3. Medical and social models of disability

The dominant perspective in relation to disability is influenced by the medical model, which characterizes disability as a functional constraint which views disability as a form of pathological condition (Degener, 2017). In this perspective, the challenge of disability is situated within the individual and accentuates functional constraints or a psychological loss which occurs inherently from the individual deficit (Hogan, 2019). This view is alternatively termed the personal tragedy theory of disability, which states that disability is an inherent limitation encountered by disabled individuals when situated in competitive social circumstances instead of accentuating disability as inextricably associated with the social, cultural, and political environment (Smith & Bundon, 2018). This theory states that the disabled individual is faced with deficits, hence requires medical intervention.

Disability is an evolving concept; there has been opposition to the conventional model of disability from several disciplines within humanities and the social sciences. These models transcend the field of anthropology, political science and history (Burnbury, 2019). These models including the social constructivist perspective; the social model of disability contradicts the main tenets of the medical perspective on disability, in particular viewing disability as a pathology and dysfunctionality (Smith & Bundon, 2018).

The social constructivist perspective is a fundamental alternative of producing knowledge which has been dominated by the monolithic landscape of positivist and scientific orientation (Reynolds, 2017). It is thus an important perspective for understanding disability. Most theories and framework on disability fail to interpret that most objective of disorders, for instance visual impairment, do not exist independent of culture and society (Anand, 2016). Current language of disability, with its individualistic characterization of

individual tragedy states that disability and impairment exist in a separate manner from cultural, historical or other influences (Anand, 2016), whereas the focus on the impact of society and culture on human behaviour has been largely accepted in different academic fields.

2.4. The implementation of Inclusive education in both developed and developing countries.

Most countries have adopted inclusive education policies, even countries like Finland, There have been four stages of the Finnish framework to special needs education; (I) training for pupils with sensory difficulties, as a consequence which several children with disabilities have been excluded from school; (ii) disability treatment, medical care and recovery, leading to the division of children into homogeneous groups; (iii) the concept of standardization and integration; and (iv) educational inclusion (Salovita, 2020). In the mid-1990s, when Finland committed itself to the Salamanca Declaration, the educational authorities had to carefully contemplate their relationship with inclusion. Lastly, the reaction of the educational administration to the declaration was reluctant (Takala and Hume, 2018). As time moved on, the principles of inclusive education were being gradually integrated into Finish education, for instance the Finnish comprehensive curriculum criteria from 2004 noted that if pupils are for any reason, unable to take part in mainstream education, education is supposed to be partly or wholly arranged in special education groups (Vyrnen, 2017). The government of then Prime Minister Matti Vanhanen renewed special education to incorporate educational support system. The Amendment of the Basic Education Act, 2010, saw the shift from the dual system to the Three Tier Support Model. Which meant that special education could be provided a platform in the Finish Education System (Engelbrecht, Savolainen, Koskela, and Okkolin, 2017). The main purpose was to provide learners with remedial teaching.

2.5. International situation in education for children with disabilities

According to Mtuli (2015), in recent times, inclusive education has escalated to be significant and is becoming a central point of discussion of issues in education in the world, especially within Science Education. Several countries now acknowledge educational methodologies that are geared towards inclusive education, concentrating

their endeavours to identify and eliminate obstacles to learning and acquisition of knowledge (Prinsloo, 2001). One of the concerns that fuelled the move towards inclusive education is the exclusion of persons with disabilities from participating in socio-economic, political, cultural activities. The principle of inclusive education pursues to challenge discrimination and marginalisation as well as broaden the fight against biased discrimination and abuse of human rights (UNESCO, 2002). Therefore, at the gist of inclusive education is the expedition for parity, social justice, and barriers to learning in the education system that segregate learners with disabilities (Mtuli 2015). Consequently, inclusive education addresses criticism about the segregated education system that designated special schools for learners with disabilities under the premise that they needed special support due to "their inability to perform" (Ohba & Malenya, 2020).

The initial response to criticism about the segregated system emerged through the concept of mainstream schools where learners with disabilities are integrated into the same schools with their peers without disabilities (Centre for Educational Research and Innovation, 2000). This integrated system would soon receive criticism. Firstly, school curriculums were hardly adapted to accommodate learners with disabilities, instead, most countries continued to provide a special curriculum for learners with disabilities (Shevlin, 2019). In addition, the school environment hardly adapted to accommodate learners with disabilities, instead, learners with disabilities were required to adapt and "fit in" the regular school environment (Ohba & Malenya, 2020). These drawbacks made it necessary to pay more attention to the concept of inclusive education to encourage the restructuring of education systems, so all learners feel they belong to the educational environment (Ciyer, 2010). The world through educational boards that are managed and monitored by the United Nations, are advocating for the right to education for all and hence the reason why there have been enough evidence with regards to the participation of the disabled in school activities as well as in the sporting arena. This has been undertaken to make sure that every child is treated as equal, and with or without the disability, he/she can take part in the school curriculum activities amicably.

2.6. Education for children with disabilities in Africa

Mtuli (2015) is of the view that one of the major challenges in implementing inclusive education in emerging economies is inadequate resources and in appropriate facilities. Studies have shown that since establishing the Kenyan policy framework for inclusive education in 2009, little funding was allocated to train teachers and modify regular schools to adapt and transition to an inclusive environment (Ohba & Malenya, 2020). The cry for effective government response in allocating adequate resources to support inclusive education practices is a common theme in many studies from across Africa (Asongu, 2015; Botts & Owusu, 2013; Engelbrecht, Nel, Smit, & Van Deventer, 2016; Lomofsky & Lazarus, 2001; Pather, 2019).

In an attempt to synthesise the challenges prevalent across Africa, Pather (2019) contends that the challenges are either systemic or attitudinal. The concerns referred to include "poverty, limited or lack of human and material resources, large numbers of under-qualified or unqualified teachers, discriminatory attitudes, lack of physical accessibility, lack of resources and materials, inflexible curriculum, pedagogy and assessment, lack of clear conceptualisation of inclusion, the lack of participation of parents and community organisations in decentralised processes of decision-making, and the lack of policy integration" (Pather, 2019). Increased awareness of this challenges has necessitated the move towards inclusion in education, challenging the traditional cultural attitudes and models of disability such as regarding disability as a curse, punishment or taboo that seek to exclude disabled people from social activities such as education.

2.6.1. Examples from Kenya.

In Kenya the implementation of inclusive education dates back to the colonial period, especially in 1946, with the establishing of vocational training programs for the blind. Following this was the establishment of special institutions for those with mental, hearing and physical disabilities (Kiru, 2019). In the post-colonial era, Kenya implemented various policies to cater for inclusive education. Commissions in particular became a common feature of the attempt to implement inclusive education policy (Kawaguchi, 2019). The Ominde Commission of 1964 recommended the government to enhance the quality of services and the approach to train and educate persons with disabilities (Wanjiru, 2017).

The commission also recommended capacity development through teacher training in special education programs at regular teacher colleges so that learners with disabilities could be accommodated in mainstream schools (Zigler,et al, 2018). Though, the commission had provided substantial recommendations, some of the challenges were not entirely eliminated (Ondieki, 2017). One of the recurring challenges was coordinating of special education, whose responsibility was with the Ministry of Social Services, as opposed to the Ministry of Education. This led to parallel education systems in two different ministries, consequently marginalising learners with disabilities (Kawaguchi, 2020).

The National Education Commission (NEC) was established in 1976 to examine the issue related into the broader education system, recommending guidelines for integrating learners with special needs in mainstream classes and the establishment of the Kenya Institute of Education's Special Needs department to develop learning materials for special needs learners (Carew, Deluca and Groce, 2019). To address the shortage of trained special needs teachers, it was recommended to introduce a special education programme at Kenyatta University (Elder, Damiani and Okongo, 2016). Following recommendations from several commissions such as the Kamunge Commission of 1988, the Koch Commission of 1999 and the Kochung Task force of 2003, Kenya adopted the Sessional Paper No. 1 2005, National Special Education Policy Framework 2009 and Disability Mainstreaming Policy 2012 as the essential legal instruments for inclusive education in Kenya. These laws complement the Children`s Act of 2001 and the Persons with Disability Act of 2003 to reinforce Kenya's commitment to inclusive education and international conventions such as UNCRC, UNCRPD and the UNSR.

2.7. Science Education for children with disabilities in South Africa

The South African education system experienced several changes in the curriculum (Prinsloo, 2007). These included the implementation of Outcomes-based Education (OBE) the National Curriculum Statement (NCS), the Revised National Curriculum Statement (RNCS), and Curriculum and Assessment Policy Statement (CAPS). Although there were motivational factors for curriculum reforms, numerous policy reforms were erroneous and fallible. Teachers were not properly trained to grapple with the changes.

The curriculum was deemed to be also providing adequate Science Education for deaf and hard-of-hearing children, but because of their health status many find it difficult to penetrate these areas within the South African education system. The teachers were not provided with guidelines for handling the basic principles of learning and assessment (Jansen and Taylor, 2003). OBE was introduced largely to democratise education and eradicate inequality in the post-apartheid system (Jansen, 2008). Inequality created an ailing environment. In response, OBE was introduced to ensure relevance and appropriateness. However, the environment did not allow for any radical changes.

According to Collair (2001) the development of expert education in South Africa is related to developments in specialised education in other parts of the world, as well as the beliefs and legislation of the time. Traditionally the massive discrepancies in services were related to the beliefs of separatism established on race. In the early provision of education in South Africa, deaf children and hard-of-hearing learners, like all other disabled children, were at first not considered. In 1863 the first Institute for the Deaf, Dominican Grimley, was founded by six Irish sisters of the Roman Catholic Dominican Order. The school however succumbed to the beliefs of separatism and split into two namely the Dominican Grimley for the White children and the Dominican School at Wittebome for Coloured children. Later the Dutch Reformed Church founded the Institute for the Deaf and Blind in Worcester in 1881 followed by Dominican School for the Deaf in King Williams Town in 1896 and St Vincent's School for the Deaf in Johannesburg in 1934.

During the Apartheid years the quality and quantity of education of both general and specialised education was improved for white children, but other racial groups were methodically abandoned (Collair, 2001). Education systems for the Black children fell under the management of one or other racially-based national section (Engelbrecht, Naicker and Engelbrecht, 2001; D.N.E., 2003). Inequalities in financial aid, growth and development of staff in the diverse racially-based sections gave rise to enormous variances in quality and provision. There was insufficient or no focused education for black children on the one end of the continuum to high excellence, customised service for White children (Engelbrecht, Naicker, Engelbrecht, 2001). A non-existence of health services, as well as underprivileged socio-economic circumstances intensified the incidence of disability in Black societies, resulting in greater need and fewer amenities.

Although there have been legislative changes with regards to funding, staffing, governance and unification of all schools (S.A. Schools Act, 1996), the move from policy to practice still remains a challenge. Whereas there have been particular variations such as augmented self-governance of schools and the introduction of restricted education provision in areas where there was nothing previously, the aftermath of the Apartheid epoch is still obvious in the current education system. The present-day government is confronted with the task of initiating policies that would transform education and other structures with the intention of bringing about eloquent change that would ultimately result in the anticipated democratic order (Engelbrecht, Naicker & Engelbrecht 2003). According to Collair (2001), at the present moment, it is still basically the custom to educate learners who are deaf and hard-of-hearing in distinct, special schools and only a small proportion is educated in normal classes. The current reality in education for students who are deaf is that those who formerly enjoyed the benefits of well-resourced special schools still enjoy the benefits and those who were underprivileged either continue unsupported in the mainstream or have access to inadequate support.

2.8. Policies and Practices of Inclusive Education in South Africa: document analysis.

In order to understand the context of inclusive education policies in South Africa, it is necessary to analyse the pertinent policies from a legal perspective. It is from this standpoint that a document analysis was conducted to establish the legal principles that govern education in South Africa. The analysis also took a view to understand how the different laws affect the rights of learners with disabilities and special education needs. In this regard, the analysis focused on the fundamental laws governing education in South Africa, particularly the supreme law as ascribed in the Constitution of the Republic of South Africa of 1996, the South Africa Schools Act of 1996 that governs the organisation and standardisation of the education sector, and the National Education Policy Act of 1996 that establishes the mandate to transform the national education system. Attention was also given to the subsequent education policies that have a specific focus on inclusive education and accommodating learners with special learning needs. These

policies include the Education White Paper 6: Building an Inclusive Education and Training System (2001) and the Policy on Screening, Identification, Assessment and Support of 2014.

2.8.1. Constitution of the Republic of South Africa (1996)

The Constitution of the Republic of South Africa of 1996 serves as the supreme law of the republic and is regarded as the basis for the development of all the other governing laws and policies that are enacted by the state. The Constitution has been chosen as the basis for analysis of all the laws and policies that govern education in South Africa because to be valid, all laws or conduct should be consistent with the constitution and fulfil the obligations that are imposed by the constitution (RSA, 1996a: Section 1).

The constitution sets out the fundamental principles of governance by which the state should be organised. It specifies rules for authority, and instruments that control how authority is exercised, and spells out the rights and duties of the citizens of the country (Department of Justice &Constitutional Development, 2019). It therefore implies that all policies must protect the rights of all the citizens, and align with the values engrained in the Constitution, those of "human dignity, the achievement of equality and the advancement of human rights and freedoms" (RSA, 1996a: Section 1(a)).

The thesis of inclusive education ties in well with the values of the constitution. At its core, inclusive education seeks to establish equal, supportive non-discriminatory education systems that pay attention to all the learning needs of their learners, to ensure that no learner is disadvantaged or excluded on any basis. This ties in well with the principles of equality and non-discrimination as espoused in Section 9, which states that "everyone is equal before the law and has the right to equal protection and benefit of the law." This puts an obligation on the state to protect and advance the rights and freedoms of all citizens, particularly people who are disadvantaged by unfair discrimination. The constitution further emphasizes this principle in Section 9, sub-section 3, stating that the "state may not unfairly discriminate directly or indirectly against anyone on one or more grounds, including race, gender, sex, pregnancy, marital status, ethnic or social origin, colour, sexual orientation, age, disability, religion, conscience, belief, culture, language and birth" (The Constitution of the Republic of South Africa, 1996: 6).

Sections 29 and 30 are of significance with regard to the provision and access to education in the republic of South Africa. Section 29(1) establishes the right "to a basic education, including adult basic education." Together with Section 9, the Constitution emphasizes equal access and equal treatment before the law, hence it is significant that in its development of education policies and laws, the state recognises and advances the interests of those who are unfairly disadvantaged, in the interests of advancing equality, human dignity, and non-discrimination.

2.8.2. National Education Policy Act (1996)

Given the Apartheid Regime's trajectory of segregatory education policies, on attaining independence, there was an immediate need to transform the education system and alter the course of discrimination and segregation in the sector. During the Apartheid era, the education system was segregated on racial basis. Resources and funds were allocated discriminatively, effectively establishing an unequal system that emphasised the provision of higher quality education for white schools, while systematically neglecting the provision of quality education for other racial groups. It was therefore "necessary to adopt legislation to facilitate the democratic transformation of the national system of education into one which served the needs and interests of all the people of South Africa and upheld their fundamental rights (RSA,1996c)."

The National Education Policy Act of 1996 (NEPA) was established as part of initiatives to transform the South African education system and align it with the values and principles engrained in the Constitution of 1996. This entailed protecting the fundamental rights of all citizens, to enforce non-discrimination, and advance the interests of individuals that were unfairly disadvantaged. The aims of the NEPA were significant with regards to inclusive education, as the Act aimed to ensure that "no person is denied the opportunity to receive an education to the maximum of his or her ability as a result or physical disability" (RSA, 1996c: Section (4)(d)).

2.8.3. South African Schools Act (1996)

The South African Schools Act (SASA) was promulgated together with the NEPA in 1996. The SASA was passed into law to "provide for a uniform system for the organisation, governance and funding of schools; to amend and repeal certain laws relating to schools;

and to provide for matters connected therewith" (RSA, 1996b: Section 3). The law sets standards by which the education system should be organised.

Of significance is the fact that the Act also reinforces the principles of equality and non-discrimination, while emphasizing the fundamental right to equal access to quality basic education as espoused in the Constitution. Section 5(1) of the South African Schools Act (1996) states that "[a] public school must admit learners and serve their educational requirements without unfairly discriminating in any way." Of significance to this study is the emphasis that the educational requirements of all learners should be served indiscriminately. This implies that the needs of learners with special education needs should be adequately addressed, including those with disabilities and other learning impediments.

SASA also specifies compulsory school attendance for all children between the ages of seven and fifteen and stipulates that the responsibility lies with parents and guardians to ensure that children of school-going age who are under their care attend school. In addition, the Act criminalises actions of withholding any child under the age of fifteen or any child who hasn't completed Grade 9 from attending school, and anyone found guilty is liable to a fine or an imprisonment term not exceeding six months. Again, this is significant to this study as some parents of children with disabilities tend to isolate their children at home instead of sending them to school.

2.8.4. Policy on Screening, Identification, Assessment and Support of 2014 (SIAS).

The government continued with its trajectory of embracing inclusion in the education system, adding the SIAS policy to its portfolio of education policies. The SIAS policy was introduced "to respond to the needs of all learners particularly those who are vulnerable and most likely to be marginalised and excluded" (RSA DBE, 2014: Foreword). It is noted that this reaffirms the commitment to protect and advance the interests of those that are vulnerable to being unfairly disadvantaged.

The SIAS policy provides a policy framework for "the standardisation of the procedures to identify, assess and provide programmes for all learners who require additional support to enhance their participation and inclusion in school" (RSA DBE, 2014: Section 1(1)). In

this regard, the SIAS policy aligns itself with the Constitution, the SASA and NEPA Acts to enforce the requirement that the educational requirements of all learners be addressed in public schools. The policy is significant for learners with disabilities and special education needs, as it spells out the appropriate procedures and standards to ensure they are provided with adequate support. Such efforts are significant, as they position learners with special education needs to fully benefit from their right to basic education. Beyond aligning teaching practices and standards with the Constitution and other relevant laws. the SIAS is also an attempt to align South Africa's policies with international law. As a signatory to the United Nations Convention on the Rights of Persons with Disabilities, the South African government is obligated to comply with the provisions agreed upon by all the member states. One of the provisions of the UNCRPD that is relevant to this study is Article 24 which stipulates that member states recognise the right of education on the basis of equal opportunity for persons with disabilities, including facilitating an inclusive education system at all educational levels.

2.8.5. The Curriculum and Assessment Policy Statement (CAPS)

Hoadley & Jansen (2009:10) indicated that in 2000 the Education Ministry broadcasted a review of Curriculum 2005. The evaluation teams' first report was understood as signifying a move away from a radically integrated, real-world based curriculum to one in which the subject content was re-emphasized. Curriculum Statements, informed by the review committee's endorsements, were then written. The National Curriculum Statement became the official curriculum in 2006. The Department of Education (2011a:05) stated that the National Curriculum Statement (NCS) was modified, adjusted and replaced by the Curriculum and Assessment Policy Statement (CAPS). These policies still have gaps, especially when it comes to the participation of deaf and hard-of-hearing learners in Science Education. For the few that participate, the teachers tend to have massive challenges in explaining issues to them.

2.9. The development of education curriculum in South African education sector

According to Hoadley (2012:188), following undesirable public insights about Outcomes-based Education (OBE) in South Africa, the Minister of Basic Education came up with a Ministerial Committee in 2009 to embark on an assessment of the education curriculum.

In reaction to the recommendation of the Ministerial Committee to rationalise, modernise and elucidate the curriculum policy, a national CAPS was established for every subject listed in the NCS. The Department admits that CAPS is not a solution to execution challenges (DoE, 2011b:08). According to Mbatha (2016), the Ministerial Committee emphasises that the simplification of the education curriculum would support learners facing learning barriers through an inclusive education system for all. On the other hand, CAPS was designed in such a way that it contemplated the interests of all the vital stakeholders through consultation. Hoadley & Jansen (2012:88), assert that the principle for knowledge organisation in the curriculum was centred on the following characteristics.

- It was content led as the content was structured according to distinct subjects.

- Content was frequently abstract and theoretical and unrelated to students and teachers.

- Experiences of the real world.

- Preceding curriculum had a habit of being imposed on teachers and students.

- Focus was on question-and-answer sessions.

- Assessment aimed to emphasis on the capability to remember the content.

- According to Mbatha, (2016) the above is not the case with CAPS. This is because with CAPS teachers have alternatives about what to teach, the order in which the content needs be taught and when content must be taught. Carl (2010:67) contends that the design must consider not only the subject content but also the approaches, methods, and skills essential for the learning process. Curriculum developers need to recognise and comprehend the needs of curriculum stakeholders. Mbatha, (2016) stated that in order to carry out curriculum design and application magnificently and to prevent a clash of interests, a degree of support should be made available to teachers to effectively implement the curriculum. Curriculum developers therefore should be conscious of the learners' strengths and weaknesses in order to teach them accordingly. The curriculum stipulated that teachers needed to be capacitated in various forms, especially when they were dealing with deaf and hard-of-hearing learners. If a teacher was effectively capacitated, he/she would be in a position to produce effective results and deaf and hard-

of-hearing learners would feel the significance of being at school and the inclusive education norm would come into being.
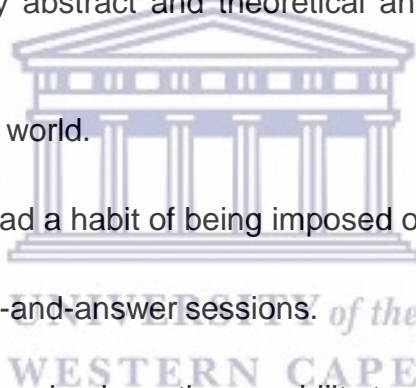
According to Mbatha (2016) letting students use and apply their understanding, knowledge and skills by thinking; contextualise and make facts on their own; take accountability of their education; grow in self-confidence; inspire growth and development of social skills and abilities; take part in debates, discussions and being empowered, are the components of what that the novel curriculum (CAPS) ought to bring about. Mbatha (2016) stated that CAPS, similar to all other curricula, needs to be assessed, corrected and to go through recurrent levels of modernisation as it is not a stationary system. Luneta (2011:26) posits that teachers' level of experience impacts on their classroom practice. The more competent we are at building, developing and evaluating theories of teacher education and professional growth that are contextualized and grounded in relevant concepts, the better we will be able to train teachers and guide them in their responsibilities This notifies the training of teachers and guides them with their responsibilities. Any curriculum is interpreted by the teacher in the classroom. This is supported by Shalem (2010), who contends that good teachers are the most valuable source of an education system. However, they are also expected to fulfil roles which interfere with their core duty of systematising methodical learning. No matter how skilled the teacher may be, the presence of interfering roles is likely to encumber the effective implementation of CAPS (Shalem, 2020, pg 27).

Maree (2012:21) contends that NCS as a curriculum appeared to fit into the demands of CAPS. This ensures that teachers will use approaches that would support learners in their learning. This certified that teachers do not depend on approaches that do not enthusiastically encompass learners in their learning (Mbatha, 2016). Teachers may possibly no longer see themselves as the conveyors of knowledge. CAPS provides learners with contexts that are familiar to them, and also promotes values and develops expertise in techniques that are significant to their own lives. CAPS certifies that learners attain and apply familiarity, values and expertise in techniques that are significant to their own lives.

This was clearly articulated for instance, when the Minister of Basic Education developed a Ministerial Committee in 2009 to embark on an evaluation and assessment of the curriculum, the concerns of which had been the growth of the strengthened NCS. This, therefore, was intended at nurturing learning which is sensitive to the values of reconciliation and nation building (Mbatha, 2016). Hopkins, Ainscow & West (2004) proposed that in order for teachers to consent to change and implement the curriculum efficaciously, they needed to be supported and sustained by the education system, either at provincial level, district level, school level or departmental level. The implementation of CAPS does not concentrate simply on teachers; it entails change in the school management team and reorganisation of the school environment. The change that transpires in a top-down way is not entrenched in realities of schools. Conversely, in the case of CAPS the fundamental stakeholders were accessed in the policy-making process. According to Mbatha (2016) school management needs to transform their outdated traditions of managing, inferring and implementing CAPS. Pretorius (2000) is of the impression that leaders need not reorganise schools and their management in a mundane way. Coetzee (2012) stipulates that CAPS is not a new curriculum, but a modification to NCS. The revision was intended to make the curriculum more accessible to teachers, as well as to the learners with deaf and hard-of-hearing challenges.

2.9.1. The principles of CAPS

These are the seven principles that underpin the NCS GRADES R-12:

- Social transformation

- Active and critical learning

- Progression

- High knowledge and high skill

- Human rights, inclusivity, environmental and social justice

- Valuing indigenous knowledge systems

- Credibility, quality and efficiency

(Adopted from DoE NCS Grades R-12, 2011d, pg. 4

CAPS requires one to design classroom activities that promote:

- Creation of opportunities to relate one's subject to the broader social goal of promoting human rights, environmental justice and social justice.

- Taking into account how one is grappling with issues such as poverty, language and disability, in learners' daily lives, and to inspire learners to explore concerns in ways that relate to their subjects. An example would be identifying a social problem or issue of relevance in the learners' community and helping them to design a small research project to gather and analyse information.

- CAPS acknowledges the diverse knowledge systems through which people make sense of and attach meaning to the world in which they live.

- CAPS is content-based and guarantees that teachers teach according to teaching plans.

- CAPS is both teacher- and learner-friendly as it outlines the topics to be completed on a weekly basis.

(Adopted from DoE NCS Grades R-12, 2011, pg. 14)

2.9.2. CAPS curriculum for Science Education.

The CAPS curriculum is described as an outcome-based or objectives-based curriculum that is learner-centric – that is, all teaching and learning processes should have a focus on the needs of the learner. As far as Science Education is concerned, the CAPS curriculum puts an emphasis on scientific inquiry as the primary goal for science education (Department of Basic Education, 2011a). These curriculum developments also pivot on the inclusion of Indigenous Knowledge Systems into the Science curriculum, with many authors attesting to the importance of incorporating indigenous knowledge in a learner-centric system that recognises the familiar experiences and realities of learners in their learning experience (De Beer, 2016; Opoku & James, 2021; Vaughn & de Beer, 2020). Arguments are also brought forward in favour of Indigenous Knowledge Systems as a desirable move towards the decolonisation of education in South Africa (De Beer, 2016; Opoku & James, 2021). Argumentation has gained attention in recent years, with authors like Erduran and Msimanga arguing for increased articulation of argumentation through teacher development (Erduran & Msimanga, 2014a)

Pedagogies in Science Education

Recent developments have seen a renaissance of interest in Science Education, owing to the globally recognised need to invest in STEM education. This renewed interest is of particular importance to developing countries like South Africa and other African nations, where STEM education is perceived as the key to developmental issues and bridging the technological gap between Africa and the rest of the world (Formunyam, 2020). Considering the widespread interest in Science Education, several pedagogies have been brought into the spotlight in recent scholarly works on scientific literacy. Scientific literacy has been the primary goal for Science Education, despite numerous debates about the precise definition of the term which has evolved with developments in history (Stinken-Rösner et al., 2020). Roberts and Bybee (2014) defined scientific literacy as "the

ability and competencies to engage in scientific discourse, to understand scientific inquiry, interpret scientific discourse and to explain scientific phenomena."

Numerous pedagogies have been proposed to enhance scientific knowledge by including scientific inquiry, guided discovery, Science Technology and Society (STS), maker pedagogy, argumentation, and the problem-based approach (De Beer, 2016; Eberlein et al., 2008; Erduran & Msimanga, 2014b; Lindholm, 2018; U. D. Ramnarain & Rudzirai, 2020; Rundgren, 2018; Sondezi, 2015; Vaughn & de Beer, 2020). Similarities such as the encouragement of inquiry instruction exist between all the proposed approaches. Literature suggests that pedagogies fall into one of two epistemic modes of instruction: direct instruction and inquiry instruction. Some scholars have described direct instruction in Science Education as the traditional mode of instruction where concepts are explained directly to the students and then confirmation follows afterwards by means of a practical demonstration. On the other hand, with inquiry instruction, learners are guided to acquire scientific knowledge through inquiry-based explorations of the subject matter (Eberlein et al., 2008). With respect to the two broadly generalised classifications of approaches to teaching Science, Cobern et al. (2014) argue that the widely accepted portrayal of direct instruction as a passive "teaching-by-telling" approach that presents direct and inquiry instruction as absolute contrasts is skewed, and they propose that teaching approaches can be presented as a spectrum that shows variations of each of the two approaches. Van Biljon (2016) presented a similar framework for the different modes of instruction used in science. According to the spectrum, Science content is presented as factual in a direct manner, and where students are actively involved in practical demonstrations it is considered active direct, whereas when student are passive receptors of the content the process is didactic direct. With inquiry instruction, two variants exist: guided and open inquiry – and in recent years, inquiry-based teaching and learning was identified as the goal for Science Education. However, implementation challenges exist

2.10.1. Challenges in implementing inquiry-based learning.

Inquiry base learning is a learning process that is based on the constructivist theory of how students learn. Constructivist believe that individual gains knowledge by constructing reality through experience.

While inquiry-based teaching and learning is recognised as the goal for Science Education, implementation has proved to be a challenge. From the point of view of learner assessment, inquiry-based teaching has been criticised for its apparent conflict with standards-based assessment systems that measure student knowledge relative to predefined criteria. However, formative assessments have been forwarded as an instrument to cover that gap (Cobern et al., 2014). In his book, "Science Education and Curriculum in South Africa, Koopman (2017) criticises inquiry learning in its current form as prescribed by the CAPS curriculum, through the historical and political lens of decolonising Science Education. He argues that the outcomes-based approach of formative assessment needs to be revised as it embodies elements of colonial education, which he describes as factory models of teaching inspired by Frank Taylor (1911). Presented with such criticism, teachers may develop attitudes towards inquiry instruction, especially if they perceive it to be imposed and flawed (Ahmad, Ching, Yahaya, & Abdullah, 2015). Additionally, if standards of teaching under inquiry instruction are not clearly defined, teachers may end up frowning upon adopting the approach, especially considering that most of the teachers in the education system were instructed and trained using didactic approaches and therefore may be unfamiliar with inquiry instruction (Unal & Akpinar, 2006). There is enough evidence to suggest that teacher attitudes and training have a significant impact on student outcomes, and as such numerous researchers have advocated for teacher professional development programs to equip teachers with the necessary knowledge and skills to successfully implement inquiry-based teachin

(Erduran & Msimanga, 2014b; U. Ramnarain, 2016). The literature posits that because inquiry-based methodologies are more effective when the teacher is skilled in directing the discovery process for learners to achieve the learning outcomes, implementation is more challenging when teachers have not been adequately trained (Ahmad et al., 2015; Erduran & Msimanga, 2014a; Kgothule, Ntseto, & Okeke, n.d.). In addition to requiring more resources for all the learners to actively engage with the discovery process, inquiry- based teaching consumes significantly more time during the planning and discovery stages. Due to lack of resources, insufficient training, and the limited amount of time available, South African Science teachers in most schools find it challenging to incorporate science inquiry while navigating the hurdles of inclusive education practices in science classes (Ndaba, 2017).

2.10.2 CAPS and inclusive Science Education for deaf and hard-of-hearing learners

In the spirit of equality and in accordance with the principles of the constitution, CAPS for Senior Phase Natural Sciences was designed with a clear intent to achieve inclusive education and scientific inquiry goals (Department of Basic Education, 2011a). Under the prescription of the Education White Paper 6, CAPS gives guidelines for identifying and acknowledging diversity amongst learners; and takes measures to ensure that the diverse needs of all learners are attended to in all schools (Bornman & Donohue, 2013). According to a directorate for inclusive education published by the Department of Basic Education (Department of Basic Education, 2011b), measures to respond to the diverse needs of learners include differentiating the curriculum through the delivery of content, learning environments, teaching methods and assessment methods. Alternate assessments are proposed for learners facing barriers to learning, including those with disabilities such as deafness (Department of Basic Education, 2011b). Significantly for learners with hearing disabilities, the guidelines prescribe alternate formats of assessments that afford them equal opportunities to demonstrate their knowledge according to their abilities, such as more time to complete assessments, alternate formats, and electronic equipment. The policy also prescribes differentiated progression; for instance, a learner may be at different grade levels for different individual subjects. While policy advocates for alternate assessments for learners with disabilities, it is not

clear to what extent these guidelines are being implemented for learners with disabilities, particularly deaf learners, and there is not enough evidence of where these policies have been successfully implemented to improve outcomes for deaf and hard-of-hearing learners.

2.10.3 Inclusive education for deaf and hard-of-hearing Science learners

According to Mthuli, (2015) one of the terms of inclusive education is that learners with disabilities should acquire suitable skills and behaviours by spending time with typically developing peers who do not look down upon them. Even though being a member of a group and taking part in standardised setting is significant, being there is just not sufficient (UNESCO, 2002). One of the most important outcomes about research on mainstream and inclusion is that if one puts a child with disabilities and a child without disabilities in a room together, deprived of some distinct special programming, the two children will probably not interact with each other (Nydal, 2008). To attain social communication and integration, there is need to plan for the children. Therefore, there is significant need to determine the support mechanisms that are needed by the children with disabilities, the children without disabilities and the teachers who work in the classroom, in order to afford effective interaction within the classroom. Inclusion is an active process (UNESCO, 2002).

2.10.4 Challenges of inclusive education in the South African education system

A challenge for inclusive education in the South African education system is how to include learners with disabilities in schools that cater for learners without disabilities, when these schools do not have the necessary facilities for doing so. (Mbatha, 2016). Having a learner with a disability placed in classroom with no advance preparation and no ongoing support, means that the student will be in the classroom but not necessarily gain any benefit of being there. Therefore, inclusion calls for all participants, including the teacher, to be systematically included in program planning for the successful implementation of education. In other words, inclusion requires that training for the adults in the setting should be undertaken in advance - before the child with disabilities is placed in the classroom setting. However, inclusion also requires continuing consultation and support for all members of the team. The need for concrete and practical assimilation of the inclusive

education programme with the National Curriculum Statement, the need for teacher capacity development in general, the need for role-player capacity development for collaboration, the need to address contemporary teacher self-esteem and attitudes, the need to reconsider training and development for inclusion and address the present physical and psychosocial environment in many schools remains a priority.

2.11. Theoretical review

2.11.1. The Constructivist theory

The study that was undertaken by Vygotsky (1978) about children with special needs, as alluded to by McLeod (2019), shows how learners may possibly be assisted in the special program in the school. McLeod (2019) described two techniques for applying Vygotsky's theories to modern-day special education. McLeod's (2019) general theory, called the theory of "disontogenesis", is known in the west as "Cultural-Historical Activity Theory". Cultural-Historical Activity Theory is a very common theory in education recognised by McLeod (2019). McLeod (2019) articulated a distinctive theoretical framework for the most comprehensive, all-encompassing, human practice of special education known in the 20th century. His model provides a theoretical framework for assisting students with special needs, especially those with hearing impairment.

McLeod's steps for assisting learners with special needs are described in the sections that follow. Rehabilitation and education of children with disability. Vygotsky (1978) indicated that any strategies introduced to compensate for children's disabilities, should be efficient enough to cover all types of disabilities. Appropriateness and suitability with regards to the methodology used are significant. One of the most exceptional endorsements of Vygotsky's theory was its implementation with deaf-mute-blind children.

A significant feature of Vygotsky's theory was that the loss or weakness of natural functions could be compensated through the improvement and development of the advanced psychological functions. Logically, visual, auditory, or motor senses could be compensated with abstract reasoning, logical memory, voluntary attention and goal directed behaviours. McLeod (2019) citing Vygotsky, pointed to the confines of traditional sensory-motor training, saying that unpolluted biological compensation, for example,

superior hearing in individuals who are blind, has remained an exception rather than the rule, despite the fact that the domain of higher psychological accomplishments has no restrictions. Training perceptiveness of hearing in a blind person has natural boundaries; compensation through the mightiness of the mind, that is the imagination, reasoning, memorization, has fundamentally no limits (Vygotsky, 1978, cited by McLeod, 2019).

McLeod (2019) indicated that in Vygotsky's (1978) view, special education curriculums must have the same social or cultural goals as general education curriculums. Their specificity is in addressing the secondary incapacity condition, that is, contradicting the adverse social concerns of the primary disability. Directives and instructions in special education must follow the same norm as general education, namely, that education leads to development. In the article, "Defect and Compensation" Vygotsky (1978) discussed the two-sided nature of a handicap: that is an underdevelopment or non-appearance of the functions interrelated to a gradual flaw and establishing an adaptive-compensatory mechanism. The efficiency of this mechanism hinges on the competence and appropriateness of the methodological approaches of rectification used in educating the child.

McLeod (2019), citing Vygotsky (1978), believed that a physical or mental impairment might possibly be overwhelmed by the alternative cultural development initiatives. Common laws of growth and development for children with a disability and their non-disabled peers include internalisation of the peripheral cultural activities into internal procedures through psychological tools and facilitated learning provided by adults.

The notion of the internalisation of psychological implements as the main mechanism of development has an exceptional significance for reintegration in the field of special education. Diverse means of communication might perhaps deliver fundamentally identical educational information, with the same meaning. Different emblematic classifications achieve the same content of education. Meaning is more imperative than the sign. Signs change but preserve meaning. McLeod (2019) citing Vygotsky (1978), pointed out that our development has already accomplished diverse means of communication, to accommodate the distinctive way of acculturation for a child with a disability through obtaining diverse symbolic systems. These include Braille reading, sign language, lip-reading, finger-spelling. He concluded by signifying that special

psychological tools should continue to be developed to address special needs within children. This suggestion was made well before the epoch of classy, automated devices and computers is now more fascinating than ever.

The work of Vygotsky is related to this study in the following ways:

- Both Vygotsky and this study narrate on improving learning and access to learning facilities for the people with disabilities, particularly those deaf and hard-of-hearing learners.

- Vygotsky recommended various tools like total communication, sign language and lip-reading and this study intends to investigate the challenges experienced and present a proposition on how to improve learning for deaf and hard-of- hearing learners through the use of total communication, sign language and lip- reading.

- Vygotsky focussed on how to improve the education system for students with disabilities, specifically hearing-impaired learners. This study investigates the challenges facing hearing-impaired learners, and proposes how to improve their situation, using the same tools as Vygotsky.

Therefore, there is great relationship between Vygotsky's theoretical foundation and this study, which prompted the implementation of the Vygotskian theory in this study. Inappropriate education of hearing-impaired learners might be attributed to numerous factors such as structural, social and psychological factors (Mthuli, 2015). If these factors are not sufficiently addressed, they could lead to poor academic performance, poor self-concept, and lowliness feelings and negatively affect the learners' future (Heward, 2006). According to Heward (2006), in order for schools to offer real and effective learning to hearing-impaired learners, they should have access to special teachers, resource rooms, enough books, teaching aids, special interventions in sign language.

2.11.2. Social model of disability

According to Murambidzi (2014), society's obligation is to embolden, protect, respect and accomplish with utmost earnestness, the rights and commitments of people with disabilities.

The characteristics of the social model are parity through empowerment, ease of access, positive attitudes, full participation and inclusion, as well as social sustenance with the intention to guarantee that the incapacitated individuals also comprehend their full potential in society and in the education systems within the country. The model encompasses how these social services and support are best conveyed through organizing a comprehensive range of stakeholders comprising the persons with disabilities, their families and the community at large.

In 1983 the disabled academic Mike Oliver coined the expression "social model of disability". Oliver (1983), cited in Murambidzi (2014), delineates the social model as an objective to certify that disabled individuals enjoy the status of full citizenship within modern society. In this understanding, Oliver did not only institute the social model to be an all-inclusive theory on disability, but a starting point in reframing how society understands disability. According to Caswell (2010), equal rights are thought to offer empowerment and the capacity to live life to the fullest. According to Murambidzi (2014), the key notion is safeguarding the rights of disabled persons by levelling their opportunities at all levels in the same fashion that able-bodied persons are acknowledged within the Science Education community. Consequently, children with disabilities should be given identical opportunities of access Science Education as able-bodied children.

The social model of disability emphasizes changes essential in a society that offers social support. According to Barton (2007), society is occasionally guilty of harming people through social insolences such as stigma and discrimination. Disabled persons are excluded from Science Education on the grounds of their conditions, despite their abilities. Societal needs side line them further as they remain unseen in the mainstream. For example, the disabled are regarded as slow learners in all circumstances, and they are often ignored and get left behind in Science Education because of the stereotype that they are slow learners. In numerous schools it is common for children with disorders to be compared to able-bodied children, which affects their self-esteem since they are

continuously looked down upon.

The social model elucidates that it is society that incapacitates an individual, hence there is necessity for the individuals in society to accommodate disabled children in order for them to be part of society and to have an equal opportunity to gain access to Science Education (Murambidzi, 2014). Norwich (2006) signifies that equal rights are said to empower and give people the ability to make decisions and live life to the fullest. Also, the United Nations Convention on the Rights of People with Disabilities (CRPD) was embraced in South Africa to stimulate and safeguard the rights and dignity of the disabled, which is underpinned by the philosophies of non-discrimination, accessibility, full effective participation and inclusion in society. Consequently, effective enactment and involvement is obligatory to make sure the deaf and hard-of-hearing are able to access Science Education.

2.12. Chapter summary

After reviewing pertinent literature related to this study, it becomes apparent that the South African government's commitment to international laws and standards of inclusive education is duly supported by extensive legislation and policies that are conducive for inclusive education. This chapter embarked on a document analysis to uncover the legal framework that was devised to support inclusive education in South African schools. The constitution, in conjunction with several laws including SASA and NEPA, and several policy statements such as the Education White paper 6, SIAS and the CAPS and National Curriculum Statement reinforce that the right to education is universal, and hence should be afforded to every individual without prejudice or discrimination. Of particular significance is that the aforementioned policies emphasise the importance of addressing the individual educational needs of learners who require additional support, particularly learners who face different barriers to learning such as disability. However, previous studies suggest that there is not enough clarity on how the policies can be interpreted in the classroom, particularly in respect of learners with hearing disabilities, with many agreeing that the implementation of inclusive education policies has been ineffective.

Learners with hearing disabilities face unique learning challenges when compared to other learners, as most are affected by language delay and language deficiencies.

The effects of language delay are also topical with researchers, as many authors express concern over the focus on language acquisition that overlooks content-based subjects such as Science. As a consequence, Science Education for the deaf and hard-of-hearing is marginalised, posing an eminent threat to inclusive education through the possibility of the exclusion of the deaf community from the field of Science. Scholarly works have conceptualised the numerous challenges faced in Science Education for deaf learners to include issues with the language of instruction, symbols for scientific terms in sign language and the application of Science pedagogical approaches to benefit deaf learners. Further, this study explored the constructivist theory as the main theoretical framework guiding scientific inquiry as the preferred pedagogical approach for teaching science. The next chapter details the research methodology that was followed in the attempt to discover the intersectionality that exists between the challenges of applying effective Science pedagogical approaches, the ineffective implementation of inclusive education policies, and the experiences of Senior Phase Natural Sciences teachers as they conduct their duties of making Science content meaningful to deaf and hard-of-hearing learners.

CHAPTER 3
RESEARCH METHODOLOGY

3.1. Introduction

In order to explore the experiences of teachers in making Science knowledge meaningful to deaf learners, it was necessary to examine the landscape on which they perform their duties. The previous chapter served this purpose through an in-depth review of pertinent literature on inclusive education. To understand how inclusive education is contextualised in the South African setting, the researcher explored inclusive education from the global perspective, exploring global conventions, international law, and practices that are implemented abroad. The researcher was also interested in how inclusive education has been implemented on the African continent. The chapter concluded with an overview of the policies relevant to inclusive education in South Africa.

This chapter provides an overview of the research methodologies and procedures utilized to compile the findings. There are additional discussions about the study design, research philosophy, and research instruments that were used. Furthermore, the sampling procedures, data collection and analysis are also explored.

3.2. Research Paradigm

The research paradigm has significant impact on the research process. The particular approach and tools used affect decisions taken in the research process, as well as the methods adopted to collect data (Kaushik and Walsh, 2019). According to Bryman (2012), "the research paradigm reflects the beliefs about reality, the factors that influence the objectives of the research, the effects of such influence on the interpretation of the reality, and the suitability of methods to capture such reality" (Bryman, 2012, pg 46). It follows that the research paradigm also informs how interpretation and conclusions can be derived from the data collected. The research paradigm can be defined as "the collection of shared values and principles held by scientists on how problems should be interpreted and solved (Walsh, 2019). The manner in which scientists relate to three fundamental questions which include ontological, epistemological and methodological questions will define research paradigms. The paradigm can be defined as a mechanism to discern the

universe (or "analytical lens" similar to a pair of glasses) and a foundation for interpreting human experience (Khaldi, 2017).

Several paradigms specific to qualitative research have been suggested to include interpretivism, phenomenology, grounded theory, critical theory, feminism, and postmodernism amongst others (Schram, 2005). While several exist, Maxwell (2008) points out the importance of specificity in the choice of paradigm a study draws from amongst the pool of options available to qualitative researchers. However, Maxwell clarifies that a research project may not be limited to just one paradigm but can draw inspiration from compatible elements of different paradigms. Equipped with this information, the researcher was influenced by personal professional experience with inclusive education, prior assumptions about the study and methodological preferences to adopt the interpretivist research paradigm. This research paradigm is commonly adopted within qualitative research methodology (Morgan, 2018). The interpretivist paradigm is mainly oriented to comprehend the universe from the subjective experience of those being examined and investigated (Rahi, 2017). Unlike the positivist paradigm which influences quantitative research and understands reality as objective, the interpretivists paradigm seeks to understand the universe and reality from the perspective of the individuals being investigated (Davies and Fisher, 2017). Such is the nature of the outcomes of this study, as the researcher hopes to explore how the teaching of science to deaf learners can be improved by drawing from the experiences and the perspectives of the teachers handling the learners. Hence, every effort at answering research questions emanate from the need to understand the meaning that teachers have with regards to their reality and experiences when dealing with deaf and hard-of-hearing learners (Wilson, 2017).

With reference to the background to this study, deficiencies have been identified in the efforts to implement inclusive education in South Africa. The literature identifies that one of the causes for ineffective implementation of inclusive education is the apparent lack of focus on the experiences of teachers and the lack of involvement of teachers who deal with learners with disabilities, during research and in the development of educational

policies. The research recognises this gap and seeks to gather findings in a reflexive approach that centralises on the experiences and contexts of the teacher, which according to Dean (2018) is the approach of interpretivism, to turn to a rehumanised and contextualised approach to making meaning of human experiences and knowledge assimilation. The varying teachers' experiences at their schools suggests that multiple realities exist within their individual contexts. I am also aware that my own realities will influence the research; I am bound by ethics and values which include objectivity, honesty, fairness and accountability as the researcher. Thus I am guided by this paradigm, noting that the assumption of multiple realities can lead to a more in-depth understanding of reality

3.3. The Research Design

Saunders et al. (2012) describes a research design as an outline of the plan that a researcher will typically follow in the process of answering the research questions. Research designs conceptualise the structure, procedures and processes that should be followed when conducting a research study. This entails articulating clearly the research problems that the inquiry seeks to solve and defining the procedures and techniques that should be used for gathering information. There should also be a clear definition of the population to be studied and the procedures for drawing interpretations from the data analysis (Brace, 2013 :69).

Andrew et al. (2011:8) define three types of research designs – exploratory, descriptive, and explanatory. Exploratory research is often used for research problems that are considered infant, and where the research problem is not well structured. As such, there is often the need to clarify concepts and gather preliminary explanations that give insights to generate ideas and develop hypotheses for further research. Some of the research instruments used in exploratory research include literature reviews, surveys, interviews and case studies (Andrew et al., 2011:8). The research area focusing on Science Education for deaf learners is not entirely new, as previous work has been done in this field. Hence exploratory research was excluded as an option for this study.

Descriptive research is also popular with both quantitative and qualitative studies. Researchers often embark on descriptive research with the aim of describing the characteristics of a population or phenomenon of interest. Descriptive research is also useful when there is a need to systematically describe a phenomenon, and to describe and predict the relationships between variables (Andrew et al., 2011:8). To explain why something happens, explanatory research goes beyond descriptive research. Explanatory research assesses causality and helps to clarify explanations about the relationships between two or more variables. Researchers have utilised explanatory research as a tool to evaluate existing theories, as well as extending existing theories to new contexts (Andrew et. al, 2011:8).

According to Maxwell (2008), one of the aims of explanatory research is to generate outcomes that are understandable and credible enough to have an influence on the intended audience for the research. The analysis should be dependable enough to back up the recommendations and decisions that can stem from the research findings. This is particularly true for this research, as the researcher hopes to suggest how the teaching and learning of science may be improved for deaf learners. Hence, an explanatory research design is appropriately suited for this study. The researcher explored the experiences of teachers teaching Science to deaf learners, with the aim to develop causal explanations of how the teaching of science can be improved for deaf learners. These research objectives are also in line with the primary goals of an explanatory research design, qualifying explanatory research as a suitable approach for this study.

3.4. Research Methodology

Kothari (2004: 8) defines methodology as a means of gathering, organising, and analysing collected data. Research methodology can further be defined as a framework that has the ability to deliver reliable and valid scientific theories (Kumar, 2005, pg 293). Vithal (2010) argues that the tools and techniques are research methods that are used for doing research. According to Walliman (2011) the basic methods of collecting data include asking questions, conducting interviews and observing without contact with the respondents (Walliman, 2011, pg 92).

3.4.1. Qualitative Approach:

The research methodology was based on the constructivist approach that was guided by the assumption that multiple realities exist within any given situation. Inspired by constructivism, the research focused on the perspectives, feelings, and beliefs of the participants (McMillan & Schumacher 2010:347) with the aim of understanding how Senior Phase Natural Sciences teachers deal with learners with disabilities in South Africa, how they interpret their experiences and how they then create their realities. The assumption is that teachers who work with learners with disabilities can construct their own realities from their personal experiences, with policy implementation. The aim was to uncover how they relate their experiences with existing policies on inclusive education policies in the South African education system. The main research question was:

How are Senior Phase Natural Sciences content taught to deaf and hard-of-hearing learners?

Three sub-research questions were formulated, which formed a guide to the study:

1. How do inclusive education policies and legal frameworks support the teaching of Senior Phase Natural Science to learners with hearing disabilities in South Africa?

2. What are the experiences of Senior Phase Natural Science teachers in making science content meaningful to deaf and hard-of-hearing learners?

3. What factors play a role in improving the teaching of Senior Phase Natural Science content to deaf and hard-of-hearing learners?

There are three main procedures of inquiry available to researchers, namely quantitative research, qualitative research, and a mixed methods approach. The qualitative and quantitative approaches lie on the extreme ends of a continuum, and the mixed method approach lies in the middle, as it incorporates both qualitative and quantitative methods (Creswell, 2015). The main distinction between quantitative and qualitative approaches is that quantitative research is framed in terms of variables that can be measured and quantified in numbers, rather than in qualitative terms such as words used in qualitative research (Dawson, 2002). Quantitative research uses instruments to measure variables and statistical data analysis methods to analyse the relationships between the variables,

and is mostly used to test an objective theory (Creswell & Cresswell, 2018). On the other hand, qualitative research seeks to derive meaning that is ascribed to the research phenomenon. Qualitative research has often been described as exploratory in nature, as it seeks to describe and explain the why and the how associated with the research problem. According to Leech & Onwuegbuzie (2008), mixed methods research represents research that involves collecting, analysing and interpreting quantitative and qualitative data in a single study.

This research used a qualitative research methodology. The main rationale for choosing the qualitative research methodology was the need to understand the Senior Phase Natural Sciences content is taught to deaf and hard-of-hearing learners from the perspective of the individuals being studied. The research methodology was based on a constructivist approach that was guided by the assumption that multiple realities exist within any given situation. Inspired by constructivism, the research focused on the perspectives, feelings, and beliefs of the participants (McMillan & Schumacher 2010:347) with the aim of understanding how Senior Phase Natural Sciences teachers deal with learners with disabilities in South Africa, how they interpret their experiences and how they then create their realities. The in-depth interviews would allow the researcher to gather rich qualitative data for the study. The assumption is that teachers who work with learners with disabilities can construct their own realities from their personal experience with policy implementation. The aim was to uncover how they relate their experiences to existing policies on inclusive education policies in the South African education system.

This study was mindful of the main drawbacks of qualitative research, particularly the concern that the small sample size employed in this study might not be representative of the whole population of Senior Phase Natural Sciences teachers handling learners with hearing disabilities. Secondly, qualitative research is susceptible to sample bias and self-selection bias. Sample bias happens when the selection of the study participants is influenced both consciously and subconsciously to influence an anticipated outcome. To minimise the influence of selection bias, candidates are often asked to volunteer their participation, giving rise to the possibility of self-selection bias as the resulting sample is self-selected rather than a random sample of the population. Despite these drawbacks, qualitative research allows for greater depth in understanding and describing the reality,

experiences, and feelings of the participants (Rahman 2016). As a result, qualitative research was a more appropriate approach to understanding how Senior Phase Natural Sciences teachers dealt with learners with hearing disabilities, how they interpreted their experiences to uncover how they related their experiences in making Science content meaningful within existing policies on inclusive education policies in the South African education system.

3.4.2. Selection of participants

Purposeful sampling is a sampling technique widely used in qualitative research for identification and selection of information-rich cases, for the most effective use of limited resources (Patton, 2002). Purposive sampling was used to select participants for the interviews as it allowed the researcher to target teachers that were in close proximity for ease of access. Additionally, purposive sampling allowed a deliberate selection to be made, based on their teaching experience in teaching Science. Three experience levels were identified to reduce the potential of having a biased sample. The researcher classified 0-3 years in deaf school as recent, 4-7 years in deaf school as mid-level experience and classified 8 and above years in deaf school as highly experienced.

The participants were Senior Phase Natural Sciences teachers at schools for the deaf and hard-of-hearing, one of the schools was an oral deaf school. An oral deaf school is a school that teaches through oral-aural such as speech, lip reading, and mimicking mouth shapes and breathing patterns of speech. The participants were selected according to their experience categories: highly experienced, mid-level experience and recently graduated. This reduced the potential of having a biased sample. The researcher invited principals of the selected schools to supply names of teachers who were willing to participate. The teachers who presented themselves to participate in the study were labelled as key informants to this research. The schools were selected because of their varying nature and categorization. At School A, the tuition is provided by sign system of communication. The school is not well resourced. At School B the tuition is provided in the sign system communication and is better resourced. At School C the tuition is provided in the oral-aural method rather than in the manual (sign) system of communication and is well resourced.

The table below constitutes the biographical details of the participants. The participants are Senior Phase Natural Sciences teachers, teaching at deaf and hard-of-hearing schools.

Table 3.1: Biographical Details of participants.

	Teacher 1 School A	Teacher 2	Teacher 3 School A	Teacher 4 School B	Teacher 5 School C
Gender	Female	Female	Female	Female	Female
Age Group	20- 30	30- 40	30 - 40	40 - 50	40 – 50
Number of years in mainstream	0	3	3	3	0
Number of years at a Deaf School	1	4	7	12	13
Total number of years' experience	1	7	10	15	13

3.4.3. Research instruments

The use of semi-structured interviews is a popular practice in qualitative research (McMillan & Schumacher, 2010). Interviews were conducted with the research participants, who were comprised of Senior Phase Natural Sciences teachers for the deaf and hard-of-hearing. The researcher intended to capture the challenges faced by the participants and their perceptions on implementing inclusive education practices in Science classes for the deaf and hard-of-hearing. The study gathered empirical data through semi-structured interviews with the selected respondents, with the aim to explore the experiences in special schools for deaf learners. Particularly, the study focused on the challenges experienced by the teachers handling learners with deaf and hard-of-hearing disabilities. The study also sought to provide insights and recommendations for solutions to improve the implementation of existing policies, particularly to improve how Senior Phase Natural Sciences can be taught to learners with deaf and hard-of-hearing disabilities. The researcher intended to capture the challenges faced by the participants and their perceptions on implementing inclusive education practices in science classes for the deaf and hard-of-hearing. The interview schedule comprised semi-structured questions. Semi-structured questions enabled the interviews to be conducted in an organised manner whilst allowing open-ended responses and follow up questions to probe more in-depth information. Observations were also a key source of information to identify and record mannerisms and expressions.

3.4.4. Semi-structured individual interviews

The use of semi-structured interviews is a popular practice in qualitative research (McMillan & Schumacher, 2010). Interviews were conducted with the research participants, who comprised of Senior Phase Natural Sciences teachers for the deaf and hard-of-hearing. The researcher intended to capture the challenges faced by the participants and their perceptions on implementing inclusive education practices in Science classes for the deaf and hard-of-hearing.

3.4.4.1 Questions about inclusive education (Interview schedule 1-4)

The interview questions (see Appendix E) that were asked can be grouped into three general groups. The first group of questions 1-4(Page 139) served to initiate rapport and create trust between the researcher and the respondents. To this end, in order to encourage the respondents to talk about their daily activities at the school the researcher asked questions such as "How are you involved in the handling of deaf and hard-of-hearing students at the school?" In addition to building rapport, this group of questions also initiated the conversations about inclusive education, soliciting responses that epitomised the respondents' opinions about inclusive education. In one of the questions, the researcher asked the respondents to give their general understanding of the existing policies on inclusive education, which was followed up with specific questions in areas that needed more elaboration, for example when the respondent said something that the researcher found interesting.

3.4.4.2 Questions about Science Education (Interview schedule 5-10)

The next group of questions were aimed at investigating the pedagogical approaches that the teachers used in making Science content meaningful. Under this section, the researcher was interested in knowing which Science Education practices the teachers were using, and the challenges that they faced in making Science content meaningful for their learners. Respondents were also asked to describe how the challenges they faced affected conducting lessons, and to give their opinions on the level of readiness and competence of themselves and their colleagues to teach Science to deaf and hard-of-hearing learners.

3.4.4.3 Questions about considerations on external factors (interview schedule 11&12

Finally, the researcher asked questions that encouraged discussions about external factors such as the school support system, the resources available at the school and the support offered on the curriculum from the Education Department at the District Office.

3.5. Data generation strategies

The study gathered empirical data through semi-structured interviews with the selected respondents, with the aim to explore the experiences in special schools for deaf learners. Particularly, the study focused on the challenges experienced by the teachers handling learners with deaf and hard-of-hearing disabilities. The study also sought to provide insights, and recommendations for solutions to improve the implementation of existing policies, particularly improving how Senior Phase Natural Sciences could be taught to learners with deaf and hard-of-hearing disabilities.

The selection of three schools for this multiple case study facilitated an extensive study of the individual teachers at these schools. This provided detailed responses and captured feelings, meanings and understanding, thereby getting more information. The table below show how participants were coded. Participant codes were used to protect the identity of the participants.

Table 3.2: Codes to identify the five participants

Teacher	Gender	Age range	Years teaching	Qualification
T 1	Female	20- 30	1	Education Degree
T 2	Female	30 - 40	7	Education Degree
T 3	Female	30 - 40	10	Education Degree
T4	Female	40 -50	15	Education Degree
T5	Female	40 -50	13	Post-Graduate Degree in Education

The data shows that interviewed teachers were qualified to teach the students in these grades. The interviewed teachers were mainly university graduates and had undergone in-service training for sign language, organised by Department of Education to teach deaf and hard-of-hearing learners. Each interview lasted between 30–55 minutes, first 4 participants were interviewed on their school sites and the 5th participant preferred to be interviewed on her choice of site.

3.6. Data Analysis

After completing the data collection process, it was necessary to analyse the data that would be used to inform the findings of the study. Bryman (2012) refers to data analysis as the stage of processing and analysing the data collected to enable the researcher to make sense of the data (Bryman, 2012, pg 13). The researcher employed thematic analysis to identify patterns, links, and connections between the data collected, in order to generate themes that informed the findings of this study.

Interviews with participants were recorded and transcribed into text files. A combination of Atlas ti8, word processers and card systems were used to code and analyse the transcripts. The analysis of the questionnaire's open-ended responses and the interview data involved thematic analysis of the responses to develop a thematic framework for this study. The analysis focused on the content of the discussions in terms of the realities of the teachers through their lived experiences, and on the dynamics of interactions within the interview respondents.

The thematic analysis process was completed in the following manner. Data was coded separately for each interview transcript. During this stage, in vivo codes were used to label key phrases and sentences in the transcripts. Next, the codes were aggregated across all the transcripts, systematically reducing the codes and grouping codes with similar meanings into categories.

3.7. Trustworthiness of the study

It is not an easy task to carry out a naturalistic investigation in general. Qualitative studies are more complex in several ways than traditional research (Noble & Smith, 2015). A structured, static, pre-set model follows quantitative research using all defined methods. Planning and execution are concurrent in naturalistic investigations, and the nature of the study can change or emerge (Silverman, 2016). Qualitative work is repeatedly criticized for lack of intellectual rigor, with little support for the methodology embraced, lack of certainty in analytical techniques and findings being simply a set of personal views subject to research bias. This is more likely in the case of researchers that lack experience (Cypress, 2017).

It is difficult to prove rigor in the conduct of qualitative research since there is no validation (Mohajan, 2017). While the expectations and factors used to verify the accuracy and reliability of quantitative research cannot be broadened to qualitative research, there are ongoing debates as to whether principles such as validity, reliability and generalizability are applicable to the assessment of quality of the data collected in the context of qualitative research (Smith &MacGnonn, 2017). Some have argued that these merely apply to quantitative research, not qualitative research. Furthermore, where qualitative methods are intrinsically different from quantitative methods in terms of philosophic positions and objectives, alternative frameworks for qualitative researchers can be adopted (Dikko, 2016).

Validity is the ability of an instrument to measure the variables that it is intended to measure (Brink, 2006). The tools were developed to ensure that the researcher could generate the information required to investigate the perceptions of Senior Phase Natural Sciences educators on making science content meaningful for deaf learners.

According to Bulmer and Warwick (1993), for an instrument to be reliable it should yield the same results when the research is done by different people and under different conditions. Therefore, to ensure the reliability of the research instruments, interview techniques like rephrasing and avoiding asking leading questions, were be used to make sure that respondents would respond in a similar manner if the in-depth interviews were repeated. Interviews were tape recorded to ensure that all data was correctly recorded.

To ensure the reliability of data collected, the researcher ensured objectivity and notes were taken of anything that was relevant to the study.

The most prevalent methods and concepts implemented to regulate the validity and reliability of qualitative research are the concepts of trustworthiness, integrity, reliability and transferability (Cope, 2014). Trustworthiness relies on the analysis of the preceding dimensions of reliability, which rely on the researcher's trust in the reality of his or her results. In this context, the researcher would use different data sources (triangulation), such as in-depth interviews, observations and secondary literature to ensure reliability (Gray,2019).

3.8. Ethical considerations

Ethics is the branch of philosophy concerned with assessing the effects of decision-making processes in the context of what is right or wrong (Fouka and Mantzorou 2011:4). Ethical considerations in any kind of research are important to mitigate any harmful impacts that might ensue from conducting the said research (Eisenhauer and Wynaden 2001, pg 1). Every stage of the research process can be burdened with potential conflicts between the greater good of others and the objectives of the research. Considerations have to be made concerning the privacy of the participants, and ensuring no harm is inflicted on the participants or any individuals due to the research process or the impact of the research (refer to Appendix C). Additionally, ethical concerns also focus on eliminating biases held by both the researcher and the participants that could affect the outcomes of the research.

3.8.1. Participant consent

In order for a participant to make a logical, informed decision to participate in a study, the concept of informed consent demands that all relevant information regarding the study be supplied before participating in the study. The fundamental objective of informed consent is for individuals to freely choose whether or not to participate. They should not be forced to participate in any way (Gravetter and Forzano, 2011, pg 118). To ensure that the participants gave informed consent, the researcher provided the participants with a Participant Information sheet (refer to Appendix C), that detailed the objectives of the

study and explained their right to withdraw from the study if they decided not to participate. In addition, the participants were asked to sign the consent form after the researcher had repeated the information on the Participant Information sheet to emphasise that their participation in the study was voluntary (refer to Appendix D).

3.8.2. Privacy, confidentiality, and anonymity

According to Saunders et al (2012), research participants are exposed to harm that can be both physical and psychological. For instance, if participants believe that their participation in the study might jeopardise their professional and personal relationships and integrity, participants might be unwilling to respond honestly to interview questions. To guard against this happening, participants were informed that their participation in this study was confidential, anonymous, and voluntary. Anonymity and confidentiality, according to Cottrell and McKenzie (2010), are two strategies used to preserve the privacy of study participants. Confidentiality occurs when there is a relationship between personal information and a study participant's identity, but that information is kept private from others. When there is no relationship between personal information and the participant's identity, anonymity occurs. To prevent other forms of harm, no offensive or discriminatory language was used throughout the data collection exercise.

3.9. Conclusion

Chapter 3 outlined the methodological approach that was selected for this study. In selecting the research philosophy on which to base the study, the researcher considered prior experience, methodological preferences, prior knowledge and assumptions about inclusive education in South Africa. Recognising that the phenomenon of inclusive education as it relates to making Science content meaningful to deaf learners can be understood from different perspectives and contexts, particularly from the experiences and realities of the teachers who teach deaf and hard-of-hearing learners, the researcher drew on interpretivism to guide methodology of the study. Grounded in interpretivism, the research used explanatory research to help improve the teaching and learning of science for deaf learners. The chapter goes on to justify the research instruments that were selected to gather findings of the study. Considerations made to ensure the validity and reliability of the research findings were also discussed, setting the stage for the presentation of the findings in Chapter 4.
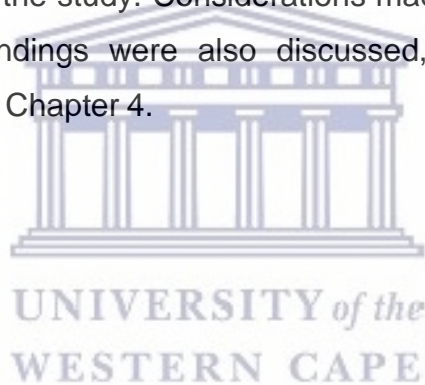
CHAPTER 4
RESEARCH FINDINGS

4.1. Introduction

This section presents the findings that emerged from the study. The aim of the study was to understand the experiences of the teachers that taught Senior Phase Natural Sciences to deaf and hard-of-hearing learners. Semi-structured interviews were conducted with educators. The interview participants expressed clearly articulated narratives about their experiences when dealing with learners with deaf and hard-of-hearing disabilities, articulating the challenges they faced daily in the classroom and sharing ideas on how they thought the system could be improved. The findings are presented in terms of the themes that emerged from the data analysis.

4.2. Research findings

The data analysis process followed was described in the previous chapter resulting in the emergence of four broad themes. The broad themes are indicated with their subsequent subthemes in Table 4.1 below.

Table 4.1: Identification of the themes

Theme 1: Perspectives on inclusive education in relation to dealing with learners with deaf and hard-of-hearing disabilities.
• Inclusive education accepts all learners regardless of disability
• Teachers accommodate learners with barriers to learning
• Curriculum accommodates the special needs of learners with barriers to learning
Theme 2: Reflections on science education for deaf and hard-of-hearing learners • Language of instruction • Science inquiry • Interventions, monitoring and evaluation of science content for deaf and hard-of-hearing learners

Theme 3: Challenges faced in teaching Senior Phase Natural Sciences to deaf and hard-of hearing learners

- Shortage of resources for Science Education

- Lack of training to accommodate deaf learners

- Lack of teacher motivation/ incentives

- Policy Implementation Challenges

- Lack of Sufficient Funding

- Cultural Attitudes

- Lack of proper of facilities and infrastructure for deaf learners

- Ineffective Curriculum

- Lack of support from the Department of Education

- Failing to fully implement South African sign language in the classroom

Theme 4: Solutions to the challenges faced in teaching Senior Phase Natural Sciences to deaf and hard-of hearing learners

- Adopting Sign language

- Acquiring equipment and Assistive technology

- Training teachers for inclusive education

- Increasing funding for deaf infrastructure and facilities

- Provide incentives for teachers.

- Ensuring reliable data and information for deaf learners

The following sections discuss the main themes that emerged from the interviews with the participants.

4.2.1. Theme 1: Perspectives on inclusive education in relation to dealing with learners with deaf and hard-of-hearing disabilities.

The narratives in this theme focused on how educators teaching learners with deaf and hard-of-hearing disabilities conceptualised inclusive education and its application in the Senior Phase Natural Sciences curriculum. Inclusive education was explored in the context of the existing policies and legal frameworks within the South African education system, and how the policies were being implemented in the curriculum, particularly the Senior Phase Natural Sciences curriculum. During the coding stage of the data analysis, three sub-themes emerged that described how the respondents conceptualised how inclusive education policies and the curriculum should be implemented in the teaching of Senior Phase Natural Sciences to deaf and hard-of-hearing learners.

4.2.1.1. Inclusive education accepts all learners regardless of disability

After interviewing the respondents, the researcher got a sense that the respondents somehow have a good understanding of the inclusive education policies applicable in the South African education system. Inclusive education policies are perceived as legislative tools that allow all children equitable access to basic education without being discriminated against on the basis of disability, race, gender or any other factors. These policies are meant to protect the right to access to quality basic education for all learners, without excluding any child from the schools within their communities. The right to free basic education for every child is underpinned in the Constitution of the Republic of South Africa. The undertakings by the government to preserve the right to education for children with disabilities is recognised as vital in the implementation of inclusive education policies.

When asked to give their general understanding of the existing policies on inclusive education, Teacher 1 (T1) responded:

> "…My understanding of inclusive education means that all children are allowed to learn in any school, they are not excluded [from] our education [system], they can fit in each and every [school]…wherever they want to be, whether they are disabled or what, that is my understanding of inclusive education, they are free to study anywhere."

The views of Teacher 1 on inclusive education are in line with those of Teacher 3 (T3) who responded:

> "The only thing I understand about inclusive education is that it's about children with disabilities being able to attend whichever school that they want to attend and not being isolated from the [mainstream schools]."

A point of commonality is identified within the logic of both responses, in that "all children" regardless of disability should be able to attend any school of their choice, "wherever they want to be," and be able to "fit in" and feel "free to study anywhere." These findings reveal the importance of choice when selecting which schools to enrol in, underpinning that deaf and hard-of-hearing learners, together with learners with other disabilities, should not be deprived of choice and be restricted to a limited number of special schools for children with disabilities.

As alluded to in both accounts, the Policy on Screening, Identification, Assessment and Support (SIAS policy) aims to ensure that all learners with disabilities have equal access to education as other learners in the communities in which they reside in (RSA DBE, 2014: Section 4(2)). From the standpoint of the SIAS policy, the needs of learners with deaf and hard-of-hearing disabilities should be addressed in the mainstream schools, where they can be accommodated on an equal basis with other learners.

From the perspective of teachers teaching at specialised schools for deaf learners, there is an indication that deaf and hard-of-hearing learners have been deprived of the element of choice in terms of which schools accommodated their needs. The deprivation of choice holds true particularly for learners who are orally deaf. When reflecting on behaviour management issues with learners, Teacher 5 (T5) who teaches at an orally deaf school had this to say:

> *"they can't go to a regular school if they're put out, and they wouldn't get into signing school, so we are the only place they can be, so because we're the only place we've got to accommodate them. So that's a unique problem that we have that no other school has got, and the school I'm at is the only oral school for the deaf in the country."*

Teacher 5 showed concern over the situation of having just one oral deaf school in the whole country. This situation creates a possibility that oral deaf learners who cannot attend the school because of location would be enrolled in schools that cannot adequately cater to their special needs as oral deaf learners. The risks include learners dropping out of school because of a low potential to excel in their studies. If anything, this phenomenon highlights the urgent need to successfully implement an inclusive education system that equips all schools to accommodate learners with a varying range of disabilities to include oral deaf learners within the communities that they serve.

4.2.1.2 Teachers accommodate learners with barriers to learning

Building on the first, this sub-theme explores how the respondents conceptualise their roles as educators teaching Senior Phase Natural Sciences against the backdrop of an inclusive education system where they are required to cater for the needs of deaf and hard-of-hearing learners. The role of the educator is critical in ensuring that an inclusive education system is not only receptive of all learners but goes beyond just giving children equitable access to basic education, to cater to learners who have special learning needs. Barriers to learning include, but are not limited to, physical disability or other factors that may be developmental, sensory, or neurological and that inhibit the ability of a learner to acquire knowledge.

This sub-theme partly points to some of the teachers' perspectives on the effectiveness of the implementation of inclusive education policies. Specifically, as stated by Teacher 5, with inclusive education policies, learners with special needs are supposed to be accommodated in mainstream schools, rather than at special schools like where she teaches:

> *"I have read some of the policies on inclusive education, I have read it, but it's not really applicable as much to my particular school, because the way I understand inclusive education is that, had I been a teacher at a mainstream school, I would have to make some adjustments for those students that have special disabilities and that those policies govern those adjustments."*

In addition, Teacher 3 stated:

> *"Yes, we do have policies on inclusive education whereby all learners need to learn irrespective of their disabilities, so learners need…we need to follow the learners needs, we need to cater accordingly to learners."*
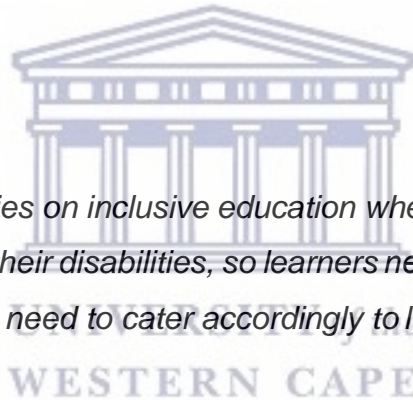
Several policies and frameworks like the Policy on Screening, Identification, Assessment and Support (SIAS policy) were enacted to ensure that learners that experienced barriers to learning were not excluded from the school system because their special learning needs were neglected. Learners that fall into this category often require special interventions and methods to ensure they benefit from participating in learning activities. Some deaf learners suffer from additional factors that inhibit learning such as language deprivation, and it is the responsibility of the teacher to ensure they overcome such factors in order to make the content meaningful to the learners (Andrews, 2017). For instance, Teacher 3 revealed that she had to simplify Science terminology to help the learners understand concepts.

"I see it as a difficult subject because especially the terminology. For the children, it's very difficult, and sometimes they take longer, some of them do not even understand some of the terminology that we use in Natural Science, and then we have to change it, for example when I was teaching [about the] bio-sphere, they do not understand those terms so I had to change them and say [simpler words] and everything, then I had to say the clouds, the sky…."

In addition, teachers are also presented with the responsibility of making textbooks accessible to deaf and hard-of-hearing learners, and many teachers have revealed that they have to rewrite some book sections since the language used in the prescribed books is beyond the learners' reading levels (Andrews, 2017).

4.2.1.3 Curriculum accommodates the special needs of learners with barriers to learning

The researcher was also interested in how inclusive education is conceptualised in its application in the Senior Phase Natural Sciences curriculum. This was an important consideration to make because how teachers make Science content meaningful is closely related to the way the curriculum is structured and administered. Methods of instruction and assessments in Senior Phase Natural Sciences classes should accommodate learning styles and modes suitable for deaf and hard-of-hearing learners.

Teacher 3 felt that in its current form, the curriculum did not do justice in serving the needs of deaf and hard-of-hearing learners.

> *"It doesn't accommodate their needs, hence I said that we have to intervene each and every moment, we have intervention books, if a learner cannot complete a certain task, we have to intervene and provide them with a less difficult…a much easier activity, therefore compromising the content that has been provided by the curriculum, school-based curriculum."*

These interventions ensure Science content is presented in languages that are accessible to the learners, as well as reinforcing concepts in the English language as this is the language used in the Senior Phase Natural Sciences curriculum. In this way, the interventions address the language deprivation that affects most deaf and hard-of-hearing learners (Lederberg, Schick, & Spencer, 2013). These practices that the teachers are implementing are aligned with the requirements and guidelines given in relevant frameworks such as the SIAS policy that require teachers to identify the risks and address them accordingly. Successful implementation of similar practices helps make Science content meaningful to deaf and hard-of-hearing learners. While deaf and hard-of-hearing learners benefit from the interventions, Teacher 3 goes on to suggest that "the curriculum that is currently used with them now, is very difficult for them and there should be their own separate curriculum." This observation stems from the fact that while simplifying concepts and tasks make the content meaningful, it "compromises the content that has been provided by the curriculum".

The shortcomings of the curriculum are well elaborated during assessments. Teacher 3 reported that after simplifying terms and giving examples to help convey meaning, the learners ended up using the examples and the simplified terms as answers to assessments instead of using the proper scientific terms that were required, saying that "they use what I tell them, what I'm explaining to them you see, because they do not understand those [terms] and if I give them an example of what I'm talking about then they take that example and forget the original terms".

Teacher 5 also supported the need for a different approach to conducting assessments for deaf and hard-of-hearing learners, suggesting that the exam papers should have more visual aids, and that it would be better if the assessments were "multi-media tests with pictures, animations, and other visual cues". Such an assessment strategy would be appropriately tailored to the learning modalities that deaf and hard-of-hearing learners are most comfortable with. In line with the main research question, this theme explored how the respondents made Science content meaningful by investigating how the respondents delivered Senior Phase Natural Sciences lessons to deaf and hard-of-hearing learners. The respondents were asked to reflect on the teaching methodologies they employed in the classroom, the tools available to them, and the philosophy behind their teaching methods.

4.2.2. Reflections on science education for deaf and hard-of-hearing learners

In line with the main research question, this theme explored how the respondents made Science content meaningful by investigating how the respondents delivered Senior Phase Natural Sciences lessons to deaf and hard-of-hearing learners. The respondents were asked to reflect on the teaching methodologies they employed in the classroom, the tools available to them, and the philosophy behind their teaching methods. Three sub themes emerged under this theme.

4.2.2.1. Language of instruction

Language of instruction is a topical issue in deaf education, and it has often been cited as a risk factor in the successful assimilation, construction, and production of knowledge by learners. In deaf education, direct translation is the practice whereby educational content is taught in sign language, whereas with translated instruction, the teacher gives the lesson in English, and a sign language interpreter translates from English to sign language. When both English and sign language are used for teaching, the mode of instruction can be described as bilingual. The respondents revealed that lessons at the school were given using a combination of direct and translated instruction, and the mode of instruction used was dependent on the signing abilities of the teacher. When asked if all of the teachers at the school could sign, Teacher 1 revealed that in the Senior Phase,t

the most common mode of instruction was direct translation, since most teachers at Senior Phase could sign. However, there are some exceptions for new teachers:

> *"Yes, in Senior Phase we don't have. But now for the new teachers, they provide interpreters for the new teachers, just to explain or to give guidance in teaching the Science. But us as old [ones] we don't have assistants."*

Teacher 1 also indicated that the translators did not receive any specialist training to translate Science and STEM-related content. This is a concern because it is highly recommended by several researchers that sign language interpreters in Science Education receive specialised training for interpreting STEM content (Braun et al., 2018; Grooms, 2015; Vaughn & de Beer, 2020). The situation is different in the case of oral deaf and those students with profound deafness. Teacher 5 who teaches at an oral deaf school revealed that they do not use sign language in their classes, and the students rely on lip reading and hearing aids to hear the teacher, stating that "there's no signing at all". Teacher 5 also indicated that post-lingual students often struggle in classes because they do not use sign language, which results in them straining themselves to be able to hear the teachers:

> *"They don't want to sign because they've always spoken, so that's what we deal with and those are the learners that also struggle because they have language background, but they can't go further now, because now they can't hear well. I want to add two more things, also the fact that students get tired because they're listening orally, they're not signing, they're listening orally and their hearing aid devices don't give them 100% hearing, so they're hearing partially and so they have to strain themselves when they're listening to teacher talk and so they get exhausted and I think we talk too much because we've got so much to cover, and so over time they switch off, some of them even switch off their hearing aids, they get tired. So then they feel frustrated that we're still teaching them and teaching them and they can't anymore because it's like hearing halfway and so they have to look for visual cues while you're talking and they're trying to figure out what you're saying and you're also repeating yourself, so those that hear a*

bit more than the others, they're frustrated because they get frustrated with hearing the same thing over and over because they have better hearing than some of their classmates"

Referring to the above quotation, Teacher T5 indicated that teaching verbally might not be the best method for students that are orally and profoundly deaf as they struggle to pay attention for longer periods of time due to them having to strain to hear the teachers, Teacher 5 also makes an important indication that having leaners with different hearing capabilities in the same classroom is not efficient and may be disadvantageous to other learners as learners with differing hearing capabilities have different learning needs.

4.2.2.2. Science inquiry

Science inquiry is a pedagogical approach for learning and teaching science based on the constructivist approach to learning, that individuals should independently construct knowledge on a subject matter dependent on previously acquired knowledge, experiences, assimilated knowledge, and construction of relationships. Science inquiry is heralded as the gold standard for Science Education as it promotes the learners' ability to develop the scientific process and explore the nature of science. The respondents agree that Science inquiry is not fully utilised in deaf education ad that there are difficulties in implementing Science inquiry with deaf and hard-of-hearing learners. Despite the inability to effectively implement Science inquiry in their classes, the respondents shared some of the innovative ways they use to promote inquiry with their learners:

Teacher 1 indicated that they used multiple modalities to help their students understand Science content better as one of the ways for taking advantage of technology and multimedia to teach lessons:

"Most of the teachers, we are using the whiteboards, the projectors, teachers are working with those things."

T5 agreed with T1 on the use of multiple modalities in teaching Science, adding that they also made use of physical models (kinesthetics), pictures (visual), tactile and auditory methods:

> *"So sometimes you know we explain it, and we show them pictures, and we have models and so on, but it's difficult sometimes for them to understand it, you know those kinds of things and using online learning management systems, Google Drive, some online platforms which will make learning for deaf learners more visual,"*

T5 also highlighted that in-class technology allowed them to use multimedia presentations during their classes:

> *"The Education Department put in some interactive white boards, we got some contributions from the Education Department, so we got document cameras, we got projectors, teachers got laptops, so that was a lot of progress for us, because now we can use…have more multi-media presentation of lessons."*

In addition to using technology, both T1 and T5 added that they make use of experiential learning, highlighting the benefits of outdoor learning to enhance deaf learners' learning experiences and to promote curiosity and motivation to learn Science.

> T1: *"I have to take them outside so that we can feel, we can touch, like trying to make them understand, like eco system, what I'm talking about or what is around our school".*

> T5: *"I try to do experiments with them and that does motivate them, it cultivates some interest, but higher retention levels, is what you are asking about".*

4.2.2.3 Interventions, monitoring and evaluation of science content for deaf and hard-of-hearing learners

In line with the SIAS policy, the interview participants indicated that they regularly screened their learners to identify those who might need extra assistance or special interventions. Regarding orally deaf and hard-of-hearing learners, T5 indicated that the school routinely checked for functionality of hearing aids and mentioned that they referred learners to an audiologist if the need arose.

T5:

> *"To ensure that their hearing aids are working, we do Ling sounds in the morning, it's where we go shh, ooh, we make certain sounds and they stand with their backs to us, and then they must repeat what we've said and so then we can see if there's a battery in their hearing aid firstly, and we can see if the hearing aid is functional, because we won't know it otherwise, so then if they say the sounds incorrectly, then we ask them have you put a fresh battery in your hearing aid, is your hearing aid working, does the audiologist need to adjust it, you know, like that, so by doing that we're ensuring that at least the hearing aids are working at the beginning of the day, if they have them with on the day".*

When asked to evaluate how they monitored that the Science content they presented catered to the needs of the deaf learners, Teacher 5 indicated that they used more regular assessments and educational games to test the learners' knowledge and identify learning gaps where they needed to intervene:

> *"Well, they have regular tests and assignments, they get tested, they have more pieces of assessments than is done in other schools, we do it more regularly, so even in maths for example, instead of giving one test which is required, I would give three tests and then count them together so that they have more regular assessment to check for understanding, and … I think for myself I play a game called Kahoot, an online game and in this game they compete against each other in their knowledge of science, so after I've taught the lesson then they sit with their cell phones and I put the PIN, the numerical PIN on the smartboard and they type it into their smart phones*

and they play Kahoot with me and it's got all science questions and they play it online, so then I can see, with Kahoot I can go back and print out their results and see what they understood and what they didn't understand, which questions they were good and bad at, so I use that."

It is encouraging to notice that some of the respondents were using gamification of educational content to enhance the learning experiences of the learners. Gamification has been proven to enhance the learning outcome for learners as it increases student motivation, engagement and curiosity (Kalogiannakis, Papadakis, & Zourmpakis, 2021). Gamification is also included in some pedagogical frameworks of curiosity-based learning in Science Education (Lindholm, 2018). Other respondents indicated that their intervention methods included approaches like simplifying the content so that the learners could understand concepts, which sometimes included giving simpler activities.

T3: *"It doesn't accommodate their needs, hence I said that we have to intervene each and every moment, we have intervention books, if a learner cannot complete a certain task, we have to intervene and provide them with a less difficult…a much easier activity, therefore compromising the content that has been provided by the curriculum, school-based curriculum".*

… and rewriting textbook content:

T5: *"Deaf learners have a language delay and so the language level, even at high school level would be equivalent to that of primary school children, so their understanding of words and language is very low and we struggle with that a lot, so we have to re-write the text book because the level of the text book is too high and the language is too difficult for them, we have to use ways and means of getting them to understand the meaning of words, before we can teach the content".*

4.2.3 Challenges faced in teaching Senior Phase Natural Sciences to deaf and hard-of-hearing learners

4.2.3.1 Shortage of resources for Science Education

Despite using innovative pedagogical approaches to teaching Science such as multiple modalities and experiential learning, there is an indication from the respondents that the full extent of science inquiry is not utilised with deaf and hard-of-hearing learners. All respondents lamented the absence of science laboratories at their schools, limited resources for Science demonstrations and limited time to complete the curriculum.

T1: *"We don't have science apparatus, we need a science lab or so, because our learners are visually, so we don't have in our school, I'm struggling a lot and even if you give them homework, they won't bring any simple things like that…you ask them to bring, that we can do an experiment of it, they won't, I have to bring it myself so it's a big challenge."*

T2: *"There's no lab, we don't have a lab."*

T3: *"We don't have a lab, but we do have the means to carry out the experiments. Term 1 they had to do demonstrations and they quite enjoyed it because it involved less talking and more…. they enjoyed it."*

4.2.3.2 Lack of training to accommodate deaf learners

One of the commonly cited challenges by participants in the study was the lack training to accommodate deaf learners. A participant who was also a teacher stated the following: "One of the challenges that that we face as Science teachers is that in colleges, teacher training and universities there is no training specifically meant for learners with disabilities or deaf learners. Disability is only mentioned in passing or is studied as a module. However, that is different from providing specific training to accommodate learners with disabilities".

South Africa is a participant in five global human rights treaties and two African treaties that secure and guarantee economic and social rights for children. South Africa was also among the initial countries to fully implement the Convention on the Rights of Persons

with Disabilities (CRPD) in 2007. The Government has also implemented clear constitutional safeguards and institutional and legislative steps to safeguard people with disabilities (Appelbum, 2019). The lack of training to accommodate children with disabilities challenges the extent to which the South African government has provided priority access to quality inclusive education for deaf children (Ngobaine, Maimane and Rakhumise, 2019).

Approximately 13 years ago, White Paper 6 on Education reflected on the different forms of discrimination and challenges being faced by children with disabilities, including deaf children, in their endeavour to access inclusive education. There was also clear evidence in the report that the government had not reached universal education, since it had left over half a million children with disabilities without access to schooling and hundreds of thousands of children with disabilities who are currently in school, behind (Le Roux, 2019).

Another teacher also noted the following: "Lack of training is certainly a challenge with regards to deaf children and others with disabilities. However, it's not our fault as science teachers, we are rarely trained or prepared to teach children with hearing problems or disabilities. Hence, when you encounter the problem within your classroom it becomes a challenge. Some teachers react different; some are too sympathetic which might have an impact on the deaf child`s confidence some might also be unsympathetic which is a worse challenge". All in all, this reflects the need to train teachers to accommodate learners with disabilities.

Teachers are important players in any comprehensive education program, but most do not have proper education, expertise, awareness of disabilities, or how to demonstrate different skills to children. A number of NGOs delivering public school teacher training have reflected that Human Rights Watch Teachers are not fully competent and prepared to teach disabled children, especially on the mainstream and in full-service schools.

4.2.3.3 Lack of teacher motivation/ incentives

Teachers, like most workers, need to be motivated through specific incentives and allowances. However, there is no clear evidence that South African teachers currently receive allowances and incentives to teach children with hearing challenges (Mashabe and Maile, 2019). This demotivates them when they encounter such children within the classroom. The lack of incentive to teach children with disabilities is a concern, since it influences the attitude of these teachers (Mlambo and Adetiba, 2020). This lack of proper incentives, structures and arrangements for deaf children acts as a demotivation for teachers, who are expected to spend extra class time focusing on children with hearing problems. It could be argued that schools and teachers can improve the attitudes of teachers through providing specific allowances and incentives for teachers who teach deaf students (Hartell and Steyn, 2019).

This was also supported by a teacher who stated the following: "One of the things that discourages us as teachers is the lack of incentives, motivation and allowances or any monetary compensation to teach children with disabilities. This demotivates us in the classroom when we encounter such children, we are not motivated to go an extra mile to accommodate them".

Another teacher also noted the following: "The traditional schools are judged based on how many children passed the [secondary school exam] matric". It is not in their interest to take upon themselves children with disabilities who could reduce their performance.

The concept of inclusive education has been generally recognized in recent years as an ideal setting for education, both in South Africa and globally (Hazell, Spencer-Smith and Roberts, 2019). This recognition of best practices does not automatically translate into what is happening inside the classroom, however. Successful inclusion relies on the schools' attitudes, in particular the teachers who are at the forefront of interacting with these children (du Plessis and Mestry, 2019). The attitudes of teachers towards such children can be influenced by the presence of specific support in terms of training, equipment and most importantly, incentives in the form of monetary compensation. The lack of incentives and compensation for teachers is an obstacle since it demotivates and discourages them from teaching deaf children.

4.2.3.4 Policy Implementation Challenges

Education White Paper 6 consists of six broader key approaches for developing an inclusive education system:

(1) improving current special schools and converting some special schools to resources centres

(2) mobilizing approximately 300 000 learners with disabilities who are of school going age but presently not in school

(3) converting some mainstream primary schools into full-service schools, which would become inclusive schools (Mapepa, Meahbo and Magano, 2018).

(4) Orienting the staff and administrators in mainstream schools to the tenets and practices of inclusive education, and how to make early recognition of children who might have disabilities (Holness, 2016).

(5) Establishing district-based support teams to assist educators with the process of implementing inclusive practices in their classrooms.

(6) Implementing a national advocacy to orient South Africans to the ideas of inclusive education, and the inclusion and involvement of learners with disabilities in society (Manga and Masuku, 2020).

These six strategies reflect the fact that the Education White Paper itself lacks specific and detailed approaches. It merely comprises broader strategies, which provide limited guidance on how to sufficiently implement the policy in practice (Maguvhe, 2014). A principal noted the following: "Though the Education White Paper 6 reflects where it wants inclusive education to be improved, practically majority of these aspects have not sufficiently been implemented. In addition, it also took for granted specific aspects like compensating teachers, training teachers to ensure they have specific skills and knowledge for learners with disabilities".

Teacher 3 noted the following: "Coming up with a document like Education White Paper 6 is important for ensuring inclusive education is a success. However, drawing up documents is an issue, which is completely different from implementing the aspects and issues within the document. This is particularly true for the Education White Paper, though

it was drawn, implementing it is a specific challenge due to lack of direction on how the aspects within the Education White Paper 6 should be attained".

Teacher 4 also noted the following: "Though on paper the Education White Paper 6 should be commended for coming up with such a detailed document, there is no clarity on how some of these aspects will be achieved practically".

Beside school and cultural level obstacles to inclusion, challenges related to the implementation of an inclusive policy appear to emanate in part from the ambiguities within Education White Paper 6. For instance, the White Paper suggests the cost effectiveness of inclusion is one of the advantages of an inclusive policy (Walton, 2018). However, comprehensive changes to the education system in South Africa is a challenge. One challenge is mobilizing out-of-school children with disabilities, another is thatinfrastructure transformation to schools cannot be implemented without ensuring that provincial departments have sufficient short-term funding to assist in taking these necessary first steps (Wolford, 2016). This lack reflects on the gap between implementation and the concerned policy. Scholars also suggest that this ambiguity in financial assistance and departmental accountability might be deliberate, which reflects that some specific policies are implemented merely for political gain as opposed to genuine concern for transformation (Donohue and Bornman, 2014).

4.2.3.5 Lack of Sufficient Funding

One of the challenges facing teachers in relation to deaf learners and those with hearing problems is the issue of inadequate funding. In the Education White Paper 6, the issue of funding for inclusive education was promised. It was stated that government was committed to building more special schools, due to the demand for it (Barrat, 2016). There was overt pressure due to the numbers of out of school children. However, the funding model proved to be contradictory.Human Rights Watch found that the budget for special schools in the 2014-2015 academic year was 12 times bigger than the budget for inclusive education. The same analysis of investment in previous years reflected significant resources had usually gone into special school budgets with the impact of seriously compromising the government`s inclusive education program in accordance with its own appraisal (Nel, et al, 2016).

A teacher noted the following: "One of the problems facing our endeavours to teach deaf learners is the problem of insufficient funding. Without proper funding, it is thus difficult to conduct necessary extra training for teachers. It might also be a challenge for obtaining necessary equipment and technologies that is meant to accommodate deaf children". As a result, what is happening practically is not complementing the principles of inclusive education that is found in frameworks like Education (White Paper 6) and the constitution.

Another teacher also noted: "Without sufficient funding the goals of inclusive education stipulated in the Education White Paper 6 cannot be achieved, it is not possible to undertake necessary training that provide the teachers with specific skills, knowledge, and expertise. Additionally, most of these deaf learners have specific modern technology required for them to be accommodated in the classroom, whether in mainstream classroom or those classrooms that are meant for deaf learners".

The responses from the teachers reflect that the goals of inclusive education, which includes accommodating deaf learners, is not possible without sufficient funding. Since there is no sufficient training for teachers at the majority of universities and colleges, proper funding might be important for providing extra training. This would ensure that teachers are able to receive skills and knowledge that they are able to adapt according to the classroom context. (McLaren, 2017). Hence, the challenge of the lack of proper training is being compounded by the lack of proper funding for teachers. In addition, the lack of proper funding impacts the ability to provide technology to assist and accommodate deaf learners in the classroom context (Engelbrecht, 2018). There is specific modern technology that is meant for deaf learners, however most schools, especially public schools, lack the funding to purchase this equipment.

The UN Committee on Economic, Social and Cultural Rights, which is the expert body overseeing the implementation of global obligations related to these rights, has reflected that adopting positive action to eliminate structural inequalities to attain the objectives of full involvement and equality, almost invariably implies that supplementary resources are necessary if this purpose is to be achieved (Pather, 2019). Education White Paper 6 was mainly adopted with the understanding that the national government would allow a

national conditional grant by 2006, utilized to spur the implementation of national delivery of public services to the adoption of this policy. The national government has not been able to provide the grant in this timeframe. It is thus an obstacle to ensuring that inclusive education is a success.

Budget data provided to the National Assembly`s Portfolio Committee on Basic Education, as well as in the Minister of Finance`s budget report for 2014-2015, reflects broader challenges between the budgets allocated for inclusive education and special schools (Motala and Carel, 2019). In addition, analysis conducted independently of the overall annual provincial budget reflects that students with disabilities, including deaf learners, might merely account for a total of 3% of the entire provincial spending on education. Within this already restricted investment, the special schools budget absorbs most provincial resources meant for students with disabilities (Kruger, 2019). Furthermore, the Department of Basic Education`s September 2014 and June 2015 progressive reports on the adoption of its inclusive education policy suggests that Investment in inclusive education is consistently lower in comparison to provincial resources invested in special needs education. This is described as poor budgeting for the expansion of inclusive education. What is clear is that investment in inclusive or general education for children with disabilities continues to be low or erratic in provinces, mainly impacted by historical underinvestment (Spaull and Jansen, 2019).

4.2.3.6 Cultural Attitudes

One of the challenges faced by teachers of deaf learners, beside sufficient and improved infrastructure, is the issue of cultural attitudes from the parents, the school environment, and fellow learners (Gardiner, et al, 2019). In this context a change in attitudinal barriers among school professionals and the broader community is one of the important elements of making inclusive education possible in third world and developing countries (Mangiti, 2019). The significant level of involvement of children and adults with disabilities in the school and community is influenced by the cultural attitudes and value of citizens. If a community reflects disregard and prejudices towards individuals with disabilities, then discriminatory practices will continue to be propagated. Cultural attitudes are essential and should not be taken for granted. Attitudes might have an impact on whether the parent

sends the child to school or prevents the child from attending the school regularly.

In this context Teacher 4 noted the following: "Sufficient funding for enhancing infrastructures is not only the most important aspect in relation to teaching learners with the deaf problems. There should be a general need for transformation and change in the attitudes among teachers, the parents, the school community, and the learners. For instance, some principals and education officers might not understand the necessity of obtaining important equipment for deaf learners, since there are few. Sometimes parents might disrupt learners with deaf problems because they do not see them performing very well, this reflects the need for a change in attitudes among the parents. In addition, principals and those within the provincial might take time to purchase necessary equipment and technology that will benefit deaf learners".

In this context, one can state that changing cultural attitudes is an essential element. Attitudes continue to be a challenge for teachers; they face challenges from the school community, in particular principals. In addition, the participant also noted that parents might also have negative attitudes towards their own children, including a lack of belief in their ability to improve academically or perform like other children without disabilities (Moore, 2019). Because many schools charge tuition fees, it is not always financially viable for parents to send their disabled children to school, especially if they have other children of school-going age whose chances to put in earnings are much better than those of their children with disabilities (Van Steen and Wilson, 2020).

4.2.3.7 Lack of proper of facilities and infrastructure for deaf learners

In certain schools, students with hearing loss are taught in a specific environment with other learners with a hearing disability or with other learners who have different problems or disabilities (Reagan, 2020). In other instances, hearing-impaired students with average hearing abilities are included in the classrooms. Teachers may or may not be specially qualified to teach learners with hearing loss. Integrating deaf learners in traditional school settings is quite problematic and often reveals the lack of sufficient infrastructure and facilities. The most suitable learning environment for deaf learners is a setting that is separated from the mainstream classroom setting.

In this context a teacher noted the following: "We have attempted to integrated learners into classrooms that include learners without disabilities. It is quite a challenge, due to issues of communication. All in all, the main reason why we had to integrate is the lack of suitable facilities and infrastructures. The optimal situation is one deaf learner have specific classroom and facilities reserved for them. However, due to lack of proper facilities and infrastructures, as a school we are often forced to integrate them with other learners".

Another teacher also noted: "Integrating deaf learners into mainstream classroom is quite a challenge, there is usually the problem of communication which hinders their ability to cope and perform in classroom. Unless the issue of insufficient facilities and infrastructures is fixed, we will always be forced to integrate them".

The lack of facilities and infrastructure is a recurring problem in specific schools that lack funding or have been deliberately marginalized due to historical and current factors (Engelbrecht, et al, 2017). Most schools, when faced with the problem of deaf learners, often resort to integrating them with other learners in mainstream classrooms. However, most of the teachers in such classroom are not well equipped in terms of knowledge and skills to teach children with learning disabilities (Naicker, 2017). The main purpose of educating deaf learners is not to expect them to have the abilities of learners without disabilities, but to give them the potential, like other children, of being involved in adult and normal activities (Naicker and Naicker, 2018). Forcing deaf learners to integrate in mainstream schools reflects the lack of proper facilities and infrastructure specially meant to accommodate deaf learners. Often deaf learners face communication challenges in mainstream classrooms.

4.2.3.8 Ineffective Curriculum

One of the challenges faced by teaching Science to deaf learners is an ineffective curriculum which fails to accommodate deaf learners and other students with disabilities. The literature states that learners have differentiated kinds of abilities. However, the current curriculum does not seem to recognize this difference among learners and treats learners as if they have similar abilities. As a result, the curriculum lacks effective strategies and methods that can be used to teach deaf learners subjects like science.

A teacher noted the following: "One of the challenges that we face as Science teachers is the lack of support from the curriculum. Though Science is a sophisticated subject, if learners are taught according to their abilities and inherent abilities, they will be able to compete, however since the curriculum fails to recognize the differences among learners, as a teacher you are forced to teach according to this inflexible curriculum".

Another teacher also noted: "This curriculum is rigid, especially in terms of accommodating learners with disabilities, including deaf learners. This also applies to the teaching of Science; we are stuck with the similar curriculum that fails to recognize the need to transform and accommodate deaf learners".

The response from the participants reveals that one of the challenges faced by teachers in teaching deaf learners is the nature of the curriculum. They stated that the current curriculum was rigid and failed to recognize the challenges faced by both teachers and deaf learners (Walton, 2017). Through failing to perceive learners as having different abilities, this curriculum has failed to transform, which puts a burden on the teachers who interact with the learners in the classroom (Fuurman, 2019). A curriculum should be flexible and relevant to the current issues faced by both teachers and learners, since learners have different abilities; a curriculum should recognize this diversity to avoid other learners being excluded (Sanchez and de Haro Rodriguez, (2019). The literature has also reflected that deaf learner acquire knowledge in an efficient manner if a broader spectrum of material is available to enhance their learning. Certain aspects like Universal Design for Learning are recommended for deaf learners. Through the use of UDL, different methods and materials are adopted to evaluate student knowledge and skills, ensuring that there

is validity (Caap, 2020). This is something that a flexible curriculum should aspire to change, however since the current curriculum is not effective and is rigid, such changes are not possible within the curriculum.

In addition, a teacher noted the following: "There are many recommendations that can be adopted to remedy and transform the curriculum to be inclusive, this include having a sign language expert in classrooms in which learners are integrated with learners with disabilities. This will assist both the learner and the teacher, however most of the policymakers are not innovative and lack insightful thinking on changing the current curriculum".

Curriculum support is essential; an ineffective curriculum will not merely negate the learners only, but the teacher might also be affected (Love, Baker and Devine, 2019). A curriculum is mainly concerned with what is taught, how it is taught and under what conditions it is taught. If a curriculum is to be effectively implemented, it has to be less rigid and accessible to all learners, even deaf learners (Lieberman andGrenier, 2019).

This is the problem with the current curriculum in South Africa. There is many promises of transformation and changes at the policymaking level, however these are not reflected practically in the classroom (Garnia-Campos and Canabal, 2020). This negatively impacts the teachers, who have the responsibility of teaching these deaf learners daily and are also expected to make them perform like learners without disabilities. In this regard a teacher noted the following: "As a teacher you are expected to perform miracles in the classroom, even with evidence of lack of support from the curriculum, this sort of administrative inconsistency is demotivating as a teacher. For instance, ensuring that at least a school has a sign language expert could be an effective solution".

The department has consistently showed that it does not care about deaf learners through failing to change the curriculum (Kieran and Anderson, 2019). Different forms of support are required for learners who need additional support, especially deaf learners (Tobin, 2019). For instance, the Department of Education proposed that support for learners who are deaf is essential for them to learn effectively. Specific recommendations like having a

South African Sign Language (SASL) interpreter to assist the classroom teacher who is not competent enough in SASL is essential. Alternatively, deaf learners should have access to teachers and educators who have been sufficiently trained in SASAL to provide teaching. Psychosocial support to handle behaviour challenges linked to the child`s disability is also essential.

4.2.3.9 Lack of support from the Department of Education

One of the challenges that was mentioned by science teachers is the lack of support from the Department of Education. Teacher 2 noted the following: "The Department of Education has been failing to provide us necessary support for deaf learners, which might include resources, material, funding. Hence, we are stuck with limited resources and materials in the classroom. In addition, the Department has also consistently failed to change the current curriculums which rhetorically support inclusive education, but practically it is not supported sufficiently to ensure comprehensive transformation which benefits both the teachers and the deaf learners".

Teacher T3 also noted the following: "The problem with the Department of Education most of the individuals employed are either unqualified for their position to advise Natural Science for deaf teachers in the current era of technology, hence, lacks the competency, skills to ensure transformation in the classroom. There have been many changes that have occurred and some of these old education administrators fails to recognize the need to change specific issues that can benefit learners".

In the South African context, the Department of Education is a multi-tiered organization that is accountable for nine provincial Departments of Education which in turn heads numerous local and district units that are responsible for different aspects of the education system (Motala, 2019). However, at a decision-making and policy-making level, specialist skills and knowledge of deaf learners' precise needs are not sufficient to advise on suitable Deaf Education practices and support (Dreyer, 2017). Non-profit organizations and non-governmental organizations (NGOs) and private services provided regularly find themselves in contradiction to any educational decisions made by Department of Education officials, which involve deaf learners (Phahlamohlaka, 2017). Constant efforts

are designed to educate suitable individuals at the Department of Education in the unique aspects of the education of deaf children. However, the challenge in South Africa is that those employed at the Department of Education, are not involved constantly in practicalities, methodology and specialty literature. This inevitably leads to decisions that are not in the best interest with all the deaf children (Stofile, et al, 2017).

In fact, even though the sign language rights of deaf learners are in place, in most cases the deaf child is not acknowledged in documents on education reform. A clear challenge for South Africa arises when there is a need to effectively implement some of these policies (Slee, 2018). As previously reported, training expertise for Deaf Education inside the Department ranks is limited, which hinders the potential of representatives of the Department to get policies applied efficiently (Materechera, 2020). It is also believed that if one is, for instance, a specialist in blindness or autism, this status grants one expert license in other areas where they lack the expertise and skills. For deaf learners, this is a potentially catastrophic situation. Such incompetency reflects how badly run the Department of Education is. In this respect, a teacher noted the following: "The Department of Education constantly fails to make competent decisions. For instance, a teacher with no knowledge of Natural Science skills is requested to teach Natural Science for deaf learners. It is frustrating for the teacher because this is not her speciality hence no competency in the teaching of the subject. This leads to deaf learners not [being] confident enough with science subjects. Teachers are trained with specific expectations regarding the innate abilities of the learners they will interact [with] in the classroom. This reflects poor decision making and incompetency from the Department of Education".

In this context, one can recognize that maladministration in the Department of Education can have a negative impact on deaf learners and whoever works intimately with them on a regular basis. Thus, years of productive research can be reversed instantly by an ill-advised decision, which subverts national strategies because the right people are not advising on the implementation of these strategies (Nel and Grosser, 2016). A prime example of this is in South Africa Statements on National Curriculum, in what sign language is South African (SASL) is referred to alongside braille as a communication device, or style (Hugo, 2016). It did reverse many things successfully, rewarding years of

commitment on the part of the deaf community to define SASL as a language in its own right. Ensuring that the Department of Education is well run, and qualified individuals are recruited is one of the issues that should be emphasized if comprehensive changes are to be recognized (Dubin, 2018). The Department of Education provides the foundation for both teachers and deaf learners, hence in this context poor administration and lack of support from the Department translates into endless challenges for both the teachers and deaf learners.

4.2.3.10 Failing to fully implement South African sign language in the classroom

One of the constant challenges faced by Natural Sciences teachers is that South African Sign Language is not properly implemented in schools. This creates a barrier for communication between teachers who are not well trained to communicate with deaf learners, and the learners who expects the teachers to provide quality delivery during the lessons. A teacher noted the following: "The failure to recognize South African sign language is a constant challenge for us, we are supposed and expected to communicate without challenges to deaf learners. This is a challenge, since most of us are not trained to expect deaf learners in the classroom. It is frustrating for the teachers, since you expect the learners to perform in the same manner. Communication barrier[s] might prevent the teacher from providing quality delivery".

Since spoken languages make up an obstacle to learning for deaf learners, SASL is the carrier of language whereby deaf students get access to education equally comparable to that of their hearing colleagues (Seedat, 2018). The barrier of spoken language is acknowledged in the Department of Education's Education White Paper 6 (2001), According to DeafSA (1997), schools that profess to use SASL do not often achieve the desired outcomes because they tend to use Total Communication (a mixture of signs that are supported by a spoken language) in an ad hoc manner. This lack of recognition of the SASL language provides an extra burden, especially for the teacher who interacts regularly with deaf learners in the classroom (Sandler, 2017). If there are possible recommendations to transform the challenges faced by deaf learners, ensuring that SASL languages are integrated into South African schools should be one of the key changes that are adopted. Without proper communication, it might be difficult for the learners to

perform well, and it is also frustrating for the teachers in particular.

4.2.4 Theme 4: Solutions to the challenges faced in teaching Senior Phase Natural Sciences to deaf and hard-of hearing learners

The following section will provide the perspectives of science teachers in relation to the solutions and strategies that can be adopted to address the challenges faced by science teachers when teaching deaf learners.

4.2.4.1 Adopting Sign language

One of the solutions that was provided by participants as a strategy for the challenges faced by Natural Sciences teachers was adopting sign language in classrooms. A teacher noted the following: "I think the neglect and marginalization of sign language is at the core of the challenges faced by Science teachers during their interaction with deaf learners. … I think adopting sign language will improve communication, however both the teacher and the learners should have sufficient knowledge of sign language".

At the majority of schools in South Africa, SASL is not yet fully used as a language of instruction. While sign language is the official instructional medium for educating deaf learners, it is used by very few learners and teachers (Rosen, 2019). Not using SASL as a teaching tool or having sign language as a school subject also had implications for teacher credentials in deaf schools (Long, et al, 2019). For example, there was no formal training of sign language interpreters until 1997 and the sign language skills of children of deaf parents were dependent on interpretation. As previously stated, manual sign language coding was primarily used by teachers at schools for the deaf (Mhamed, 2019). The trend has changed, however, to a bilingual, bi-cultural approach, in which both sign language and one spoken language are used.

In addition, a teacher also noted the following: "Schools should adopt sign language to ensure that the burden faced by teachers is resolved. The main challenge as a science teacher when teaching deaf learners is communication, hence I would recommend adopting sign language. However, I think the teacher should be properly trained in sign language before adopting it in schools".

Storbeck et al (2010) illustrated two significant issues facing teacher preparation and the implementation of SASL. Initially, teachers enter the educational environment without the opportunity to register and learn on the job. Short-term training is not a replacement for access to the SASL academic level needed for curriculum delivery to deaf learners. So, the curriculum is implemented on the basis of basic competency of SASL. It is not enough merely to have SASL accepted in schools as a language subject for the deaf. The benefits of getting SASL recognized in schools are teachers being fully trained in SASL and offering adequate support services in traditional schools where comprehensive education is offered.

A teacher also noted, "Failing to adopt sign language has a consequence for both the learner and the Science teachers, especially in terms of communication. Hence that's why I recommend ensuring that sign language is adopted in schools which would improve communication between deaf learners and Science teachers". In addition, either schools should hire sign language experts or provide similar training for teachers. Either way the person communicating to deaf learners should be properly trained.

The above would include research into what exactly should be included for the deaf-learners-in-South-Africa context (Le Roux, 2019). Not acknowledging SASL as a linguistic and cultural right per se has ensured that certain rights are denied, for instance, the right to a fair trial, political representation, access to information, freedom of speech and the protection of cultural heritage (Reagan, 2020). DEAFSA (2006: 12) claims a few South African schools have tried to teach SASL as a subject, but no formal training was provided by the educators involved in SASL linguistics, literature or methodological teaching. It has contributed to limited teaching by the learners and most apprentices end up pursuing vocational training rather than formal training (Morgan and Kaneko, 2019). It has been found that a complete discussion of a subject using sign communication before reading the textbook is of great help for the mute, in the promotion of science concepts.

Interactive multimedia and online learning content have yielded substantially more beneficial Science knowledge to deaf students in mainstream classrooms (Napier and

Leeson, 2016). The use of corresponding interactive visual representations with verbal explanations of teachers are especially useful when learning about science principles or structures, which can be visualized with a view to comprehension. Studies involving listening students have usually shown that concurrent presentation of verbal and non-verbal resources makes the processing of information simpler.

4.2.4.2 Acquiring equipment and Assistive technology

One of the suggestions was that acquiring equipment to assist deaf learners can improve the challenges encountered by them. In this context a teacher noted the following: "Ensuring that specific technology or equipment is acquired is definitely a good strategy to ensure that the challenges faced by deaf learners are addressed. There are numerous assistive technologies for deaf people, and deaf learners should also have the similar equipment".

There are several tools and services available to assist deaf or hard-of-hearing individuals in navigating the world. Some devices visually transmit information, and some devices reinforce auditory knowledge. Individuals of all ages and in a number of settings may use these applications at home, work, education, social events, meeting, hospitals, churches, and theatres (Bell and Foiret, 2019). The participation in social life of people with disabilities depends on the opportunities to act under the standards set down by society (Frush and Holt, 2019). These applications provide support that emphasizes the skills of the individual, rather than the handicap. Children with disabilities need aids that are tracked during their childhood to promote optimum functioning and to deliver incentives, as their needs for human engagement are distinct.

In addition, Teacher 4 noted, "One of the challenges we encounter with deaf learners is that most of them are neglected and cannot afford specific equipment or assistive technology for deaf people. In this context I think the Department of Education can assist us through acquiring such equipment for deaf learners. It will certainly improve the interaction between Science teachers and deaf learners in the classroom context, since interaction and communication has been one of the main challenges faced by deaf learners".

The fact is that over 50 % of learners do not have access to sufficient support in terms of assistive technology which allows them to integrate schools and activities. This problem should be changed because it reflects the failure of inclusive education. One of the main prerequisites for accommodating children in Inclusive education environments (as outlined in Article 24 of the CRPD) is to provide available tools to promote complete and equitable engagement in all practices relating to education (Mnguni, 2017). Assistive tools and technologies are the most efficient methods to tackle pedagogic obstacles to access effectively. The process of ensuring children has access to both ordinary and special schools must include access to the necessary technical assistance and specialized equipment.

In addition, another teacher also noted, "Acquiring assistive equipment is definitely a way to resolve the challenges faced by both deaf learners and Science teachers during their interaction. I think, deaf learners have been neglected, since there are few and no one can represent [them]. Hence that's why the Department does not bother acquiring such important technology. However, I think as teachers through civil societies we can pressurize the Department of Education to acquire such technology, its [a] benefit us as science teachers and deaf learners.

4.2.4.3 Training teachers for inclusive education

A teacher noted the following: "One of the challenges faced is lack of proper training, which prepares one to encounter deaf learners and learners with disabilities. This is why I suggest that training teachers to accommodate deaf learners should be a solution. In addition, a teacher should teach learners whose disabilities he or she was trained for. This will ensure that there is no erroneous generalization. Training teachers is definitely the first step to resolve the challenges faced by science teachers".

Inclusive educational practice gives all young people the ability to learn together by eliminating obstacles to learning. It also tackles problems affecting all individuals subject to exclusion from education (Salovita, 2020). To foster school integration, teachers should be trained so that they are enabled with the necessary skills and resources to educate diverse student demographics and meet the different teaching requirements of diverse

learners' groups. This could be achieved through approaches such as school-level professional development and pre-service integration, preparation and careful instruction (Done and Andrews, 2019). This would be a particularly successful strategy to enhance the quality of the entire education system for all children, whatever their needs (Majoko, 2019). In addition, another teacher also noted, "The failure to recognize that teachers' needs to be properly trained is definitely a big challenge faced and encountered by Science teachers. Ensuring that training for science teachers also prepares them for deaf learners and learners with disabilities is definitely an appropriate solution in the context of Science teachers. However, colleges and universities should also be properly trained in terms of facilities and knowledge to be given to teachers".

Inclusive methods of education are child-centered, employing active and participatory learning techniques which enhance the ability of teachers to teach children with and without disabilities (Magumise and Sefotho, 2019). The Department of Education should ensure that educators have the right skills, versatility, and tools to educate students with different needs and styles of learning (Crispel and Karpeski, 2019). The teachers need to create and incorporate more effective teaching practices. A positive environment would affect the learning and interaction of the students in a good way (Gesser and Martins, 2019). It is the school's obligation to handle teaching in such a way that all the children's needs are met as the inclusive education principles acknowledge the schools' need to plan with the students' individual characteristics in mind and to promote consistency so that all students can accomplish their goals.

Teacher education policies that encourage positive teacher perceptions and introduce an inclusive curriculum in each particular country context are crucial to success, understanding that strategies that work well in a high-income country (e.g., broad skilled support staff) may not be available in a low-income country (Carballo and Morgado, 2019). In any event, it is crucial that the teacher is not left alone but assisted by promoting leadership, other teachers and other resources available in the school or broader community as much as possible (Mitchell and Sutherland, 2019). Research investigating teacher experiences on inclusive education, for example, found that South Africa's explicitly pro-inclusion policy climate clearly translated into positive attitudes among

teachers. Around the same time, though, mostly due to the lack of specific implementation targets and support staff services, teachers seem to be learning a little bit on how to incorporate inclusive practices in their own right (Stevens and Wurf, 2019). A teacher also noted, "This challenge of interaction is complex for teachers, most of those who design policies are not aware of these challenges, hence ensuring that there is proper training will definitely prepare us as teachers. In addition, it will also benefit the deaf learners in a way which will improve their performance in the classroom. In addition, it will motivate the teacher since the nature of the challenge is probably improved".

It is crucial to promote the learning of all children; that all teachers learn about inclusive pedagogy throughout their initial training. We need ample exposure to teaching different groups of learners in general education classes, thus encouraging their success and making their attitudes toward inclusion more optimistic (Supriyanto, 2019). For many countries the inclusion issue is still too often limited to the issue of the best place to teach children who are not learning optimally. Inclusion, however, is about using innovative methods to provide better education for all children in traditional schools, embedded in their local communities.
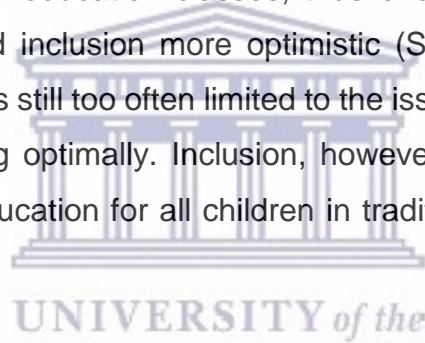
4.2.4.4 Increasing funding for deaf infrastructure and facilities

There has been a steady rise in the allocations for special schools around the country. The number of new special schools is growing steadily in a number of provinces. According to the Government progress report, the estimated cost to build a new special school was R100 million ($9 million) in 2012. Investments in 25 new special schools at the cost of R787m were installed in 2012.

One of the ways in which some of the challenges facing deaf teachers can be improved is through increasing and sourcing funds to improve the facilities and infrastructure for inclusive education by important stakeholders like non-governmental organizations, the public sector, local governments and various other governmental levels. The Ministry of Finance, for instance, can be approached to release funding for deaf education. The lack of proper infrastructure is one of the common challenges faced by science teachers for deaf learners (Chiwandire and Vincent, 2019). It stems from specific historical

marginalization and current failure of the contemporary leadership to realise the goals of inclusive education. The environment of corruption and maladministration has a negative impact on improving infrastructure and facilities. A teacher noted the following:

> *"Ensuring that there is proper funding for deaf education will definitely improve the situation being faced by both Science teachers and deaf learners. Funds are important, especially for improving the facilities and infrastructures currently being used by deaf learners. In addition, funds can also be essential for acquiring equipment that can be used as assistive technology by deaf learners in the classroom context."*

Important sectors like the Ministry of Finance might provide a strategic conditional grant to meet comprehensive education targets and pay for services like non-personal support including open services, aid equipment and resource tools for housing all children in a safe way. Such funding should also be used to establish facilities to properly equip Science, and other teachers in general, for deaf learners. Without such funding, it might be complicated to training teachers and provide them with specific skills and knowledge relevant to deaf learners. White Paper 6 on Education was originally launched in 2006 with the expectation that the national Government would assign a nationwide conditional grant to stimulate the to promote the introduction of national provision of public services Policy.

Another teacher also noted, "There is no way. These challenges cannot be addressed without structures and [a] system which provide[s] consistent funding for improving infrastructures and facilities. Most public schools in particular lack proper facilities and infrastructures for special education; hence I suggest ensuring that we improve these facilities through sourcing funds from various essential stakeholders like the Ministry of Finance, the private sectors, municipalities, non-governmental organizations and the provincial governments".

Budget details sent to the National Assembly's Basic Education Portfolio Committee and the Finance Minister's 2014-2015 Budget Report revealed broad inequalities between the funds allocated for comprehensive and special education. In addition, an independent

review of the provincial budget votes revealed that there was no differentiation in the different types of disabilities in the count. One of the solutions to funding deaf schools and special schools might include urgent investment in multi-disciplinary support teams in the district. This would achieve the building of a well-resourced execution structure to help ordinary public schools serve children with high support needs, in accordance with the criteria of commitments made in White Paper 6 on Education.

Dedicated financial resources ring-fenced for core roles in the provision of care for children with disabilities should be allocated to all focused projects, both horizontally across the various industries and vertically in all three policy realms. Agencies should be able to demonstrate the expense of offering reasonable and sufficient care to children with disabilities, depending on requirements and needs.

4.2.4.5. Provide incentives for teachers

A teacher also noted, "Ensuring that there are specific incentive structures for deaf learners is definitely a solution. Without proper incentives and salary, it is difficult to motivate teachers and educators. They encounter numerous challenges, some [of] which are beyond their training. Proper incentives and salary will ensure that this can be addressed".

One of the challenges faced by science teachers for deaf learners, beside lack of proper training facilities, is the absence of incentives structures. This demotivates them. During training, in colleges and universities, teachers are trained to teach children without disabilities. Encountering deaf learners and learners with disabilities is a certainly a challenge for them. Some teachers might be sympathetic to the deaf learners, however without proper incentives it might be difficult to motivate teachers to conduct their normal work. In this context, ensuring that appropriate incentives structure is set for teachers responsible for deaf learners is essential. Lack of proper incentives is one of the common challenges that result in learners who are deaf or have other disabilities, being neglected.

Another teacher also noted, "We cannot have similar incentive structures and salaries with those who teaches learners without disabilities". In this context I would suggest that the Department of Education and Ministry of Finance should prepare a proper system,

which rewards Science teachers of deaf learners. They face more complex issues than those who teach learners without disabilities.

4.2.4.6 Ensuring reliable data and information for deaf learners

Data provided by governmental and non-governmental data offer multiple viewpoints on how many children with disabilities are out of school nationwide. Human Rights Watch investigated organizations and service providers, and firmly agreed that the inability or reluctance of the government to disclose important data results in a lack of transparency and failure to provide sufficient solutions for deaf learners. This undermines any solution that might be undertaken to solve the problems facing both deaf learners and Science teachers. Judging from the studies by Human Rights Watch based on children with disabilities, and the findings of different organizations and experts, it appears that most estimates currently available dramatically underestimate the number of children who are out of school with disabilities. A study released by the Ministry of Education in May 2015, the White Paper on Education 6, is testimony to large inequalities. Two different sections in this progress report reflect that addressing the inequalities should be a priority. For instance, the report noted that about 597 953 children with disabilities were out of school, and up to 829 474 learners with disabilities were of school going age. It would be more efficient and cost effective if there were sufficient intervention from the government, which promoted inclusive education.

A teacher also noted, "One of the challenges being faced by Science teachers when teaching deaf learners, is that no one is providing reliable information and data to various relevant institutions like the Ministry of Education, Ministry of Finance and the non-governmental organizations about the nature of the problem. This can be addressed through providing regular data on the number of deaf learners, learners with disabilities, the amount which can be needed to improve the facilities and infrastructures and also acquire assistive technologies".

 The disaggregated data for deaf learners and other learners with disabilities is a consistent theme in many areas of service provision, contributing to inadequate service delivery and social exclusion and planning. There is a need to develop a data base on

the number of deaf learners. This will help to track and evaluate current services available to children with disabilities. Data should include tracking of applications for care dependency grants and participation in recovery and educational programs, as well as data for program planning. The database should include the number of disabled children, their accessibility and availability, organisations working with the disabled, and the number of aid devices needed, handed out and repaired.

The Campaign to Support the Right to Education for Disabled Children, among other groups, maintains that the number of children with disabilities left out of the school system greater than 500 000. This is based on previous National Census baselines and information provided by the the Department of Social Development. It is crucial for the Government, including the Portfolio of the National Assembly Basic Education Committee that monitors the coverage of the government on basic education goals, to know how many disabled children enter education, how many are left out of the school system, and how many are children of minimum age requiring mandatory school placements.

Another teacher also noted, "The problem we are facing is that though we provide details and information to our local departments of education, they in turn do not provide such information to the various ministries and other institutions, which imply that the situation cannot be improved. Hence providing reliable information is definitely a solution to the nature of our problem".

4.3. Conclusion

This chapter's main objective was to discuss the empirical findings of the results drawn from a qualitative approach. The analysis was therefore carried out using the thematic analysis. The findings presented reflect that there are numerous challenges faced by science teachers to make Science content meaningful, when teaching deaf learners. These include lack of proper training, lack of sufficient funding, lack of support from the Department of Education, lack of reliable data and attitudes towards learners who are deaf or have other disabilities. Some of the solutions suggested including proper training for teachers, sufficient funding to improve facilities and following up on numerous initiatives and strategies. The following chapter will summarize the article and give recommendations.

CHAPTER 5
DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The previous chapter discussed the findings drawn from the data collected in this study. The study set out to investigate the challenges that Senior Phase Natural Sciences teachers face in making Science content meaningful for deaf and hard-of-hearing learners, with the aim of improving how Science content is presented to learners with hearing disabilities. The study focused particularly on the intersection between the concept of inclusive education and the pedagogical approaches employed in Science Education to identify how learning outcomes could be improved in science classes for deaf and hard-of-hearing learners.

This chapter begins by summarising the contents of the previous chapters. The main research findings are then discussed in relation to the research questions that guided this scholarly inquiry. Thereafter, the conclusions, recommendations and proposed areas for future study are presented. This inquiry was guided by the following research objectives:

- To unpack how inclusive education is conceptualized within the context of existing policies and legal frameworks in the South African education system and how the existing policies support the teaching of Senior Phase Natural Sciences to learners with hearing disabilities.

- To explore the challenges faced by Senior Phase Natural Science teachers in making Science content meaningful to deaf and hard- of- hearing learners.

- To suggest possible recommendations on improving the teaching of Natural Sciences at Senior Phase within the context of deaf and hard- of- hearing learners' experiences.

The main research question of the study was:

How are Senior Phase Natural Sciences content taught to deaf and hard-of-hearing learners?

5.2 Summary of previous chapters

The preceding chapters progressively weaved arguments, observations and findings that resolved this inquiry to its intended ending. In the opening chapter, the premise for conducting this inquiry was set out. Chapter 1 presented the background to this study, establishing that inclusive education is a universally accepted mandate to afford and respect the right of all learners to access equal and equitable quality education without discrimination of any form. The study highlighted that the marginalisation of content-based subjects, particularly Science Education, and showed that there is insufficient mediation to overcome the specific problems that arise because of the limited language acquisition of learners with hearing disabilities. This limitation discriminates against such learners and is against the principles of equity in education for all learners regardless of disability. Additionally, the efforts made in implementing a legislative framework for inclusive education in the South African education system is acknowledged. Reference is given to studies that suggest that there are challenges in implementing inclusive education policies to accommodate the needs of learners with disabilities, particularly deaf and hard-of-hearing learners, and this is the conundrum that this study seeks to resolve.

Chapter 2 served three purposes in the scheme of this inquiry. Firstly, the chapter discussed a comprehensive review of literature on the principles of inclusive education, the different pedagogies for Science Education, and the development of education for learners with hearing disabilities. Secondly, document review was used to uncover the legislative framework for the implementation of inclusive education in the South African school system. Thirdly, Science Education pedagogies were deconstructed against the perspective of the theory of constructivism, giving a theoretical framework for the teaching and learning of science content for deaf and hard-of-hearing learners.

In Chapter 3, the research design and the methodology that guided the data collection process for this study were presented. Attention was given to the research instruments that were used and the strategies and measures that were enforced to guarantee the validity of the findings, while ensuring that the study adhered to ethical research standards.

Chapter 4 reported on the findings of this research. The findings captured the realities and experiences of teachers teaching Science content to deaf and hard-of-hearing learners, highlighting the main challenges that ensued from lack of support and resources and inadequate training in the pedagogical approaches for both Science Education and deaf education. The main findings are summarised and discussed in the following section.

5.3 Reflections on the methodology

Care was taken to conduct the research in line with the general guidelines for ethical research. Informed consent was received from all the participants after they had been informed of the objectives of the research. Respondents were also informed of their right to withdraw their consent at any moment during the interviews without an obligation to explain reasons for withdrawal. To protect participants from harm, the interview schedule was designed to ensure that there were no personal or sensitive questions that could trigger traumatic memories for the participants. In addition, participant information was kept in a password-protected computer and was only stored for the duration necessary to complete the study. The interview data was also anonymised, removing any identifying information that could be linked to any of the participants.

Interviews with participants were recorded and transcribed into text files. To ensure validity, the transcripts were proofread to ensure that they accurately represented the interview recordings. The analysis of the questionnaire's open-ended responses and the interview data involved a thematic analysis of the responses. Data was coded separately, and themes were analysed using the grounded theory approach, to develop a thematic framework for the perspectives of teachers on the implementation of inclusive education policies in South Africa. The analysis was then verified with references to the literature.

5.4 Summary and discussion of the main findings

This study sought to answer the following research questions:

1. How do inclusive education policies and legal frameworks support the teaching of Senior Phase Natural Science to learners with hearing disabilities in South Africa?

2. What are the experiences of Senior Phase Natural Science teachers in making science content meaningful to deaf and hard-of-hearing learners?

3. What factors play a role in improving the teaching of Senior Phase Natural Science content to deaf and hard-of-hearing learners?

The research findings are organised in relation to the research questions in the next sections.

5.4.1. Research Question 1

How do inclusive education policies and legal frameworks support the teaching of Senior Phase Natural Science to learners with hearing disabilities in South Africa?

The first research question focused on inclusive education policies within the legal framework of the South African education system. The response to this research question comprised two components. Firstly, a desktop research on literature on inclusive education was conducted in Chapter 2. The literature review revealed that the South African education system is guided by comprehensive and progressive inclusive education policies that reflect the government's commitment to ratify international accords on inclusive education. Reference is given to international accords such as The Dakar Framework for Action, the United Nations Convention on the Rights of the Child, and the United Nations Convention on the Rights of Persons with Disabilities, which emphasise the right to inclusive education for all, without any form of discrimination. The Constitution of the Republic of South Africa, which has been heralded as one of the most progressive constitutions among democratic nations, serves as the foundation for the legislative framework and the policies that have been implemented in support of inclusive education.

Some of the principles that the constitution reinforces include human rights, human dignity and equality. These are also the guiding principles that the philosophy of inclusive education is built upon. As such, all the pieces of legislation that govern education in South Africa are accommodative of inclusive education principles. On attaining independence from the apartheid regime, the democratic government of the time signed into law the National Education Policy Act of 1996 (NEPA) and the South African Schools Act (SASA) in 1996. Both laws were transformational in eliminating the racial laws of the previous era that discriminated against non-whites and persons with disabilities in education. Although the quality and quantity of general and expert education for White pupils had improved throughout the Apartheid years, other racial groups had been systematically abandoned (Collair, 2001). The education systems for Black students were administered by one or more racially biased national sections (Engelbrecht, Naicker and Engelbrecht, 2001). Inequalities in financial aid, personnel growth and development in the various racially biased sectors resulted in significant differences in quality and provision.

The National Education Policy Act (NEPA) of 1996 was enacted as part of efforts to change South Africa's educational system and align it with the values and principles enshrined in the 1996 Constitution. The act focused on safeguarding all citizens' fundamental rights, enforcing non-discrimination, and advancing the interests of those who had been unfairly disadvantaged in the provision of education services. The NEPA's goals were important for inclusive education, since it ensured that "no person is denied the opportunity to acquire an education to the utmost of his or her potential as a result of physical handicap" (Republic of South Africa, 1996c: Section (4)(d)).

SASA was enacted to "provide for a standard system for the organisation, governance, and funding of schools; to amend and repeal various laws relating to schools; and to provide for matters related thereto" (Republic of South Africa, 1996b: Section 3). The law established guidelines for how the educational system should be organised. The act also reaffirmed the values of equality and non-discrimination, while underlining the constitution's fundamental right to equal access to high-quality basic education and emphasising the need of meeting the educational needs of all students without discrimination. This suggests that learners with special education needs, such as those with impairments or other learning problems, should have had their needs met.

The Policy on Screening, Identification, Assessment and Support of 2014 (SIAS) is also valuable to inclusive education initiatives of the South African government. SIAS was introduced "to respond to the needs of all learners particularly those who are vulnerable and most likely to be marginalised and excluded" (Republic of South Africa, Department of Basic Education, Policy on Screening, Identification, Assessment and Support, 2014, Foreword), reaffirming the commitment to protect and advance the interests of those who are vulnerable to being unfairly disadvantaged. The SIAS policy provided a policy framework for "the standardisation of the procedures to identify, assess and provide programmes for all learners who require additional support to enhance their participation and inclusion in school" (Republic of South Africa, Department of Basic Education, Policy on Screening, Identification, Assessment and Support RSA DBE, 2014: Section 1(1)). Following the prescription of the Education White Paper 6 of 2001, the policy was significant for students with disabilities and special education needs because it outlined the procedures and criteria that needed to be followed to ensure that they received adequate support.

The second component of the response to Research Question 1 focused on how the inclusive education policies and legal frameworks in South Africa were conceptualised by Senior Phase Natural Sciences teachers dealing with learners with hearing disabilities. Theme 1: "Perspectives on inclusive education in relation to dealing with learners with deaf and hard-of-hearing disabilities" presented in Chapter 4 responded to how inclusive education policies support the teaching of Senior Phase Natural Science to learners with hearing disabilities in South Africa from the perspectives of the teachers.

Under this theme, the study found that the respondents had a good understanding of the inclusive education policies applicable in the South African education system. Three sub-themes emerged; These were:

- Inclusive education accepts all learners regardless of disability.

- Teachers accommodate learners with barriers to learning.

- The curriculum accommodates the special needs of learners with barriers to learning.

The following sections summarise the findings under these sub-themes.

a) Inclusive education accepts all learners regardless of disability

Inclusive education policies are perceived as legislative tools that allow all children equitable access to basic education without being discriminated against on the basis of disability, race, gender or any other factors. According to the respondents, these policies were meant to protect the right to access to quality basic education for all learners without excluding any child from the schools within their communities. The right to free basic education for every child has been underpinned by the Constitution of the Republic of South Africa. The undertaking by the government to preserve the right to education for children with disabilities has been recognised as vital in the implementation of inclusive education policies. Teachers viewed the Policy on Screening, Identification, Assessment and Support (SIAS policy) as essential to ensure that all learners with disabilities had the same access to education as other learners in the communities in which they reside. From the standpoint of some of the teachers, implementation of the policy had failed with regard to learners with hearing disabilities, as some of them have not been accommodated in the schools in their communities. In accordance with the SIAS policy, the needs of learners with deaf and hard-of-hearing disabilities should be addressed in the mainstream schools, where they can be accommodated on an equal basis as other learners. From the perspective of teachers teaching at specialised schools for deaf learners, there was an element upon which the deaf and hard-of-hearing learners had been deprived of the element of choice in terms of which schools could accommodate their needs. The deprivation of choice was true, particularly for learners who were orally deaf, as there was "only" one oral school for the deaf in the country" (Teacher 5). (Naicker, 2018a) confirm the necessity of providing all learner with their learning needs in the least restrictive environment and in their localities as a vital part of achieving inclusive education goals.

b) Teachers accommodate learners with barriers to learning

This sub-theme investigated how respondents view their duties as educators teaching Senior Phase Natural Sciences, in the context of an inclusive education system that required them to meet the needs of deaf and hard-of-hearing students. The   educator's

role is crucial in ensuring that an inclusive education system is welcoming to all students and provides equal access to basic education to students with unique learning needs. Physical impairment, as well as other developmental, sensory, or neurological issues that restrict a learner's ability to acquire knowledge, are examples of learning barriers.

In line with SIAS, teachers were aware of their responsibility to screen and identify potential learning barriers and make appropriate interventions to address the needs of the learners. For deaf and hard-of-hearing learners, the process included checking that the learners' hearing aids were working properly, replacing batteries and referring learners to audiologists and social workers for additional support. In addition, teachers also made use of sign language interpreters and interactive learning methodologies to incorporate audio and visual presentations, educational games on learners' mobile devices and hands-on experiments where resources allowed. All the respondents indicated that they had to employ multiple modes of teaching in their lessons to repeat the Science content in different ways. The respondents emphasised their use of visual teaching tools and the need to simplify textbook content, as the language in science textbooks was too complex for deaf and hard-of-hearing learners. However, the less experienced teachers indicated that they struggled with interventions related to the curriculum content. These findings support the findings of Ntseto, Kgothule, Ugwuanyi, & Okeke (2021) who surveyed teachers' perspectives on the implementation of the SIAS policy. In Ntseto et al. (2021), the teachers emphasised the importance of adequate teacher training to give teachers the necessary practical experience to make appropriate interventions. This study therefore confirms that inadequate teacher training inhibits the attainment of Inclusive Education goals both in mainstream schools and special needs schools because of inadequate practical experience to incorporate inclusive education strategies in classes (Ndaba, 2017).

c) The curriculum accommodates the special needs of learners with barriers to learning

This sub-theme explored how inclusive education was conceptualised in its application in the Senior Phase Natural Sciences curriculum. This was an important consideration to make because how teachers make science content meaningful is closely related to the way the curriculum is structured and administered. Methods of instruction and

assessments in Senior Phase Natural Sciences classes should accommodate learning styles and modes suitable for deaf and hard-of-hearing learners.

The general opinion held by the respondents was that in its current form, the curriculum did not accommodate learning styles and modes suitable for deaf and hard-of-hearing learners. As mentioned in the previous sub-theme, teachers were already making interventions to simplify the content presented in the textbooks prescribed by the curriculum for the Senior Phase Natural Sciences, in order to make the content accessible to deaf learners. While this approach was recommended in SIAS and benefitted the learners Teacher 3 suggested that there should be a separate curriculum for deaf learners. This observation stemmed from the fact that while simplifying concepts and tasks made the content meaningful, it compromised the content that had been provided by the curriculum, confirming Raven & Whitman's (2019) proposition that an appropriate curriculum for deaf and hard of hearing learners still needs to be explored.

In addition, the respondents identified that simplifying the content disadvantaged their learners during assessments as they struggled to articulate Science concepts, using the proper terms and scientific language that were expected by the Senior Phase Natural Sciences Curriculum. With regards to assessments, the research found that the respondents would have preferred different forms of assessments that accommodated the way deaf learners conceptualised Science knowledge. Suggestions included assessments tailored to the learning modalities that deaf and hard-of-hearing learners were most comfortable with, including multimedia, more pictures, animations, and other visual cues. These findings make apparent the need for an appropriate curriculum that does not disadvantage deaf learners with assessments that do not cater for the cognitive development of deaf learners (Martin, 2004, pp. 191-193), supporting similar calls by Raven and Whitman (2019).

5.4.2 Research Question 2

What are the experiences of Senior Phase Natural Science teachers in making science content meaningful to deaf and hard-of-hearing learners?

This research question explored how respondents delivered Senior Phase Natural Sciences content to deaf and hard-of-hearing learners, in order to understand how they made Science content meaningful to learners with hearing disabilities. Respondents were asked to consider the teaching approaches they used in the classroom, the instruments they had at their disposal, and the rationale underlying their methods. From the study findings, Theme 2: Reflections on science education for deaf and hard-of-hearing learners emerged as the response to research question 2. Theme 2 composed of three sub questions. Firstly, the respondents addressed issues around the language of instruction. This is an important consideration in Science Education for deaf learners, as it impacts the way learners comprehend Science content. Secondly, the findings addressed matters relating to scientific inquiry and how teachers approach lessons in relation to pedagogies for Science Education. Finally, the findings uncovered the teachers' experiences with interventions, monitoring and evaluation of science content for deaf and hard-of-hearing learners.

Language of instruction

Language of instruction is a high priority in deaf education, and it is frequently identified as a risk factor in learners' ability to assimilate, construct, and communicate knowledge. According to the responses, lessons were taught using a combination of direct and translated instruction, with the method of instruction chosen based on the teacher's sign language ability. Teachers stated that direct translation was the most prevalent style of instruction in the Senior Phase because most Senior Phase teachers, with the exception of some new teachers, could sign. In addition, students in an orally deaf school relied on lip-reading and hearing aids because their teachers did not utilise sign language in their classes. Direct instruction is the method of teaching an educational subject in sign language. In contrast, translated instruction refers to giving the lesson in English and having a sign language interpreter translate from English to sign language. Direct

instruction is more beneficial to deaf and hard of hearing learners as according to Vygostskyan theory on the cognitive development of deaf and hard of hearing children, direct instruction contributes to a richer language environment which in turn benefits cognition than would be achieved with translated instruction (Martin, 2004, pp. 191-193)

The study observed that the translators did not receive any special training to translate Science and STEM-related content. This was concerning because some academics had proposed that sign language interpreters in science classrooms should acquire specialised training in interpreting STEM subjects. Qualified STEM interpreters needed to have a unique set of skills that would allow them to enhance communication on complex Science concepts. Because STEM disciplines all have their own vocabulary, and some of these terms do not have sign language translation, qualified STEM interpreters have specialised knowledge about the subject, providing them with the foundation they need to further the learning experiences of deaf learners (Grooms, 2015; Braun et al., 2018; Vaughn and de Beer, 2020). Scientific and technical jargon could be dense and difficult to comprehend for non-experts, but qualified interpreters would be familiar with the scientific terms and popular concepts, allowing them to better assist communication between the teachers and the learners (Braun et al., 2018; Vaughn and de Beer, 2020).

Science inquiry

Despite the inability to effectively implement science inquiry in their classes, the respondents shared some of the innovative ways they used to promote inquiry with their learners. The findings showed that teachers that handled deaf and hard-of-hearing learners utilised multiple modalities to help their students comprehend Science content. The respondents revealed that the teachers took advantage of technology and multimedia in addition to using physical models (kinesthetics), pictures (visual), and tactile and auditory teaching methods. These are key elements to scientific inquiry; a pedagogical approach to learning and teaching science that is based on the constructivist learning philosophy, states that individuals should construct knowledge on subject matter independently based on prior knowledge, experiences, assimilated knowledge, and the construction of relationships (Eberlein et al., 2008; Erduran & Msimanga, 2014b; U. D. Ramnarain & Rudzirai, 2020; Rundgren, 2018). Science inquiry is regarded as the gold

standard in Science Education because it encourages students to build scientific processes and investigate the essence of Science (Erduran & Msimanga, 2014b; Rundgren, 2018). However, the respondents agreed that scientific inquiry was underutilised in deaf education, and execution was difficult due to the lack of adequate resources like laboratories and science equipment that allowed learners to be involved in inquiry activities such as student-led science demonstrations and experiments. The lack of adequate science resources in schools remains one of the major challenges for implementing inquiry-based science education in South African schools (Braun et al., 2018; Erduran & Msimanga, 2014b)

Interventions, monitoring and evaluation of science content for deaf and hard of hearing learners

In accordance with the SIAS policy, interviewed participants stated that they screened their students on a regular basis to identify individuals who might require additional assistance or specific interventions. Teachers at schools routinely evaluated the functionality of hearing aids for orally deaf and hard-of-hearing students, referring them to an audiologist when necessary. Teachers also used more regular assessments and educational games to test the learners' knowledge and identify learning gaps where they needed to intervene. One of the positive findings of the study was that some of the teachers were gamifying educational content to improve the learners' learning experiences. Gamification is included in some pedagogical frameworks of curiosity-based learning in Science Education (Lindholm, 2018) and has been shown to improve student learning outcomes by increasing motivation, engagement, and curiosity (Kalogiannakis, Papadakis and Zourmpakis, 2021).

While the teachers had largely adopted the guidelines for screening and implementing interventions in accordance with SIAS, the respondents lamented the lack of adequate teacher training and support for how the guidelines could effectively be implemented in line with pedagogies of Science Education, particularly for deaf learners. Respondents revealed that at times during workshops, the curriculum specialists from the District Department of Education were unable to give useful information to help with the peculiar challenges the teachers faced in their attempts to make Science content meaningful for deaf and hard-of-hearing learners. This challenge was significant, given that there are no

standardised guidelines specific to the needs and learning challenges of deaf learners. In addition, the findings highlighted the challenge of the shortage of qualified Science educators, as some of the teachers tasked with teaching Senior Phase Natural Sciences to learners with hearing disabilities were not trained in the subject matter of the subjects they taught. The students were greatly disadvantaged, as some of the teachers revealed that they did not completely understand some of the concepts they were supposed to teach. The shortage of qualified science teachers appears as a consistent challenge for science education not only in special schools for learners with disability, but across all schools in South Africa (Erduran & Msimanga, 2014; U. Ramnarain, 2016; U. D. Ramnarain & Rudzirai, 2020).

5.4.3 Research Question 3

What factors play a role in improving the teaching of Senior Phase Natural Science content to deaf and hard-of-hearing learners?

The study's response to research question 3 addressed two aspects. First, Theme 3: 'Challenges faced in teaching Senior Phase Natural Sciences to deaf and hard-of hearing learners' identified the challenges faced in the teaching and learning of Natural Sciences to learners with hearing disabilities. The second aspect of the response to Research Question 3 was the solutions that were identified in the research findings as embodied in Theme 4: Solutions to the challenges faced in teaching Senior Phase Natural Sciences to deaf and hard-of hearing learners. The following sections present discussions of the main challenges together with the relevant solutions as the main factors that play a role in improving the teaching of Senior Phase Natural Science content to deaf and hard-of-hearing learners.

Specialised training for deaf and hard of hearing education

Deaf and hard-of-hearing learners face huge challenges in public schools when learning Science. Most Science learners experience some challenges, however, there are challenges distinct to deaf and hard-of-hearing learners. Some of these challenges include language deficiencies and delays and limited exposure to science resources. This leads them to endure science misconceptions more than their fellow learners of the hearing

community. In addition to the challenges unique to deaf and hard-of-hearing learners, the research findings highlighted the need for concrete and practical assimilation of the inclusive education programme with the National Curriculum Statement, as well as the need to reconsider training and development for inclusion to address the present physical and psychosocial environment in many schools.

To make inclusive education practical in the context of deaf education, there ought to be a systemic change in providing assistance to learners facing barriers to learning (Brown and Buthelezi, 2019). The importance of training teachers for deaf and hard-of-hearing education cannot be overemphasised. Without proper training, the goals and objectives for deaf education can be difficult to achieve. This lack of training to accommodate children with disabilities challenges the extent to which the South African government has provided priority for deaf children access to quality inclusive education (Ngobaine, Maimane and Rakhumise, 2019). In certain schools, students with hearing loss are taught in a specific environment with other learners with hearing disabilities or with other learners who have different problems or disabilities (Reagan, 2020). For other classes, hearing- impaired students with average hearing abilities are mixed into the classrooms. Teachers may or may not be specially qualified to teach learners with hearing loss. Integrating deaf learners in a traditional school setting is quite problematic and often reveals the lack of sufficient infrastructure and facilities.

In the context of the challenges faced by science teachers when teaching deaf learners, lack of proper training is certainly one of the main challenges. Most universities and colleges do not recognise the need to provide proper training for inclusive education. This also stems from the confusion surrounding whether to integrate deaf learners into mainstream schools or facilitate specials schools meant for deaf learners and other learners with disabilities. The confusion and dilemma also affect how teachers are trained. Most teachers are trained in colleges and universities that do not consider deaf learners or learners with disabilities.

Effective curriculum that addresses the needs of deaf and hard of hearing learners

One of the challenges faced by teachers teaching Science to deaf learners is an ineffective curriculum that fails to accommodate deaf learners and other students with disabilities.

The literature states that learners have differentiated abilities. However, the current curriculum does not seem to recognise this difference among learners and treats all learners as having similar abilities. As a result, the curriculum lacks effective strategies and methods that can be used to teach deaf learners, especially in subjects like Senior Phase Natural Sciences.

Regular reviews, monitoring and assessment of the National Strategy on Screening, Identification, Assessment and Support (SIAS)

One of the ways in which education for deaf and hard-of- hearing learners can be improved is through conducting follow up on the National Strategy on Screening, Identification, Assessment and Support (SIAS). This strategy was launched by the Department of Education for piloting in 2008-2009, and it is also aligned with the International Classification of Functioning (I.C.F.). The approach mainly focuses on guiding the entire process of screening, identifying, assessing (SIAS) and supporting learners who encounter challenges, which includes deaf learners and learners with disabilities.

Sign Language training for teachers

Teacher training provided by the SASL Educators Association Africa should be given before teachers work with hearing-impaired learners. Such initiatives should be followed by ongoing seminars and conferences for teachers to keep up-to-date with new advances in Science teaching and learning at state, provincial and regional levels (Hess, 2020; Kgothule et al., n.d.; Ntseto et al., 2021). Teacher training implementation should focus on how training for teachers can be conducted to ensure that the problems faced by all Science teachers of deaf learners are addressed (Ntseto et al., 2021).

Provision of adequate resources for science teaching

The lack of proper infrastructure is one of the common challenges faced by science teachers of deaf learners (Chiwandire and Vincent, 2019). One of the ways in which some of the challenges facing teachers of deaf learners can be improved is through increasing and sourcing funds to improve the facilities and infrastructures for Science Education for deaf learners. There should be a focus on how various stakeholders can coordinate their efforts to ensure that they increase the pool of resources and bridge the resource gap in deaf schools.

Perhaps one of the issues that should also be addressed is how incentives can be used to motivate teachers of deaf learners. Lack of proper incentives is a challenge. One of the ways in which some of the challenges facing teachers of deaf learners can be improved is through increasing and sourcing funds for the improvement of facilities and infrastructure for deaf schools (Engelbrecht et al., 2016; Rasebopye, 2010).

5.5 Key Findings of the study

At the core of this inquiry, this study explored how educators who teach deaf and hard- of-hearing learners conceptualise inclusive education policies in practice, in their efforts to make Science content meaningful in Senior Phase Natural Sciences lessons. The study found that the implementation of inclusive education policies was ineffective, especially in respect of addressing the peculiar learning needs of learners with hearing disabilities. This was due to three main challenges faced in Science Education for learners with hearing disabilities.

Firstly, the curriculum does not accommodate the special needs of learners with hearing disabilities with respect to content delivery and assessments. Despite making provision for necessary interventions such as simplifying the content and using multiple modes of instruction, the CAPS Curriculum and the SIAS policy failed to provide provision for alternative modes of assessments that accommodated the language deficiencies and delays, and the preferred modes of learning, of deaf and hard-of-hearing learners. The curriculum provided for standardised assessments. Teachers simplified Science content to address the language delays and deficiencies that affected most learners with hearing

disabilities, however, simplifying content compromised the content that was prescribed by the curriculum and disadvantaged the learners during assessments because they then struggled to articulate concepts in the proper terms and scientific language that was expected in the standardised assessments prescribed under the Senior Phase Natural Sciences Curriculum.

The second challenge faced in Science Education for deaf learners was that there was inadequate training and support for science teachers teaching learners with hearing disabilities. Some of the teachers tasked with teaching deaf learners were not trained to teach Science and therefore lacked the pedagogical knowledge to effectively make Science content meaningful. In addition, some of the teachers lacked training in sign language, the preferred and official language of instruction for deaf learners. Although teachers who were not proficient in sign language received support from sign language interpreters, the study noted that most of the interpreters were not trained for translating Science and STEM-related subjects. This posed a risk to the learners because the interpreters did not have the foundational knowledge of the scientific terms and popular concepts that allowed them to better assist communication between the teachers and the learners (Braun et al., 2018; Vaughn and de Beer, 2020). In addition, the subject experts at the District Education Department seemed to not have suggestions for better pedagogical approaches to address the peculiar challenges of incorporating scientific inquiry and making science content meaningful for learners with hearing disabilities.

The third challenge was not unique to deaf education. Science teachers, not only in deaf schools but the whole country, had to contend with the lack of resources like laboratories and scientific equipment to engage learners with inquiry-based teaching. The Senior Phase Natural Sciences Curriculum Statement acknowledges the adoption of inquiry-based learning methods in line with international standards to facilitate scientific inquiry and discovery. However, public schools lacked the resources to effectively implement student-led scientific inquiry activities. Scientific inquiry has been shown to be highly beneficial for learners with hearing disabilities as the approach promotes engagement, motivation and curiosity to compensate for the limited exposure to real-life scientific experiences and language delays and deficiencies that affect most learners with hearing disabilities (Eberlein et al., 2008; Erduran & Msimanga, 2014b; U. D. Ramnarain & Rudzirai, 2020; Rundgren, 2018).

In light of the challenges that hampered the successful implementation of inclusive education, particularly in the domain of science education for deaf learners, this study proposed that Science Education for deaf learners should be prioritised so that more people from the deaf community could be accommodated in science in accordance with the principles of inclusive education. Priority should be given to teacher training and support programs that emphasised adopting pedagogical approaches to accommodate the special needs of deaf and hard-of-hearing learners. Teachers should be adequately trained in the subject matter of the subjects they taught; this was especially true for science teachers, so that they would be equipped with the required knowledge to effectively communicate scientific knowledge to the learners (Cobern et al., 2014; Eberlein et al., 2008; Erduran & Msimanga, 2014a). Notwithstanding, to improve communication in the classroom, teachers and interpreters should be trained in sign language interpretation for STEM-related subjects (Kurz et al., 2015).

In addition, the study proposed that the curriculum should be revisited, especially with respect to content delivery and assessment, to address the special learning needs of learners with hearing disabilities. Assessments should be tailored to the learning modalities that deaf and hard-of-hearing learners were most comfortable with, incorporating multimedia, more pictures, animations, and other visual cues (Cobern et al., 2014). Finally, the provision of scientific resources such as laboratories and science equipment should be prioritised to encourage the adoption of scientific inquiry-based teaching methodologies to enhance the learning experience for deaf learners in science classes.

5.6 Limitations of the study

The researcher is mindful of the factors that could possibly influence the research process and/or the outcomes of the study. The researcher could not study the entire population of specialised schools for deaf learners in the country. Due to time and financial constraints, the study primarily focused on Senior Phase Natural Sciences teachers at a limited number of selected schools in Cape Town. A smaller sampling frame imposed a potential limitation that the outcomes of the study might not be representative of the entire population of teachers dealing with deaf and hard-of-hearing learners, and the

experiences of other teachers practising under different circumstances in other provinces might not be reported on.

Secondly, the study only sampled teachers that were qualified to teach Science in schools. These teachers had already gained field experience at full service and special needs schools and had constructed their own realities through their experiences with deaf and hard-of-hearing learners, thus data on the experiences of students who are undergoing training to become teachers in the future is limited.

Thirdly, the sample comprised only female teachers. While this was not deliberate but a consequence of a smaller sampling frame, this limits the generalisability of the findings as they do not account for the gender differences between the perceptions of male and female teachers.

5.7 Conclusion

Chapter 5 concludes this inquiry on Science Education for deaf and hard-of-hearing learners. The chapter began with a summary of the previous chapters, showing how each of the preceding chapters progressively contributed to advancing this study towards the intended outcome. Following the presentation on how the methodology of the study was designed to ensure valid results to inform the findings, the summary and discussion of the key findings were presented and organised according to the relevant research questions.

The study concluded that the challenges faced by teachers in making Science content meaningful to deaf and hard-of-hearing learners were a stumbling block to the effective implementation of inclusive education policies. A combination of a curriculum that failed to accommodate the special learning needs of deaf learners, lack of teaching resources to promote scientific inquiry, inadequate teacher support and the shortage of qualified science teachers trained in deaf education proved to pose the risk of the exclusion of the deaf community from participating in the field of science. Science Education for deaf learners should be prioritised so that more people from the deaf community might be accommodated in science, in accordance with the principles of inclusive education.

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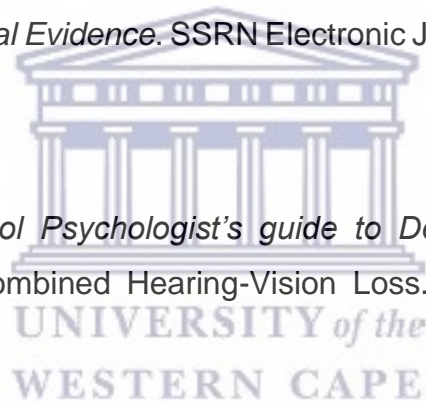
APPENDIX A: Approval by the Ethics Committee

OFFICE OF THE DIRECTOR: RESEARCH

RESEARCH AND INNOVATION DIVISION

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**UNIVERSITY of the
WESTERN CAPE**

10 October 2019

Ms B Khumalo
Faculty of Education

Ethics Reference Number: HS18/5/40

Project Title: Investigating the challenges that Senior Phase Natural Science teachers face in making science content meaningful for deaf and hard-of-hearing learners.

Approval Period: 14 October 2019 – 14 October 2020

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendment, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for annual renewal.

The Committee must be informed of any serious adverse event and/or termination of the study.

FROM HOPE TO ACTION THROUGH KNOWLEDGE.

Ms Patricia Josias
Research   Ethics   Committee   Officer
University of the Western Cape

HSSREC REGISTRATION NUMBER - 130416-049

APPENDIX B: Research Approval letter

Western Cape Government
Education

REFERENCE: 20200120-3223

ENQUIRIES: Dr A T Wyngaard

Directorate: Research

Audrey.wyngaard@westerncape.gov.za
tel: +27 021 467 9272
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Private Bag x9114, Cape Town, 8000
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Ms Buzani Khumalo
PO Box 9
Observatory
7935

Dear Ms Buzani Khumalo

RESEARCH PROPOSAL: INVESTIGATING THE CHALLENGES THAT SENIOR PHASE NATURAL SCIENCE TEACHERS FACE IN MAKING SCIENCE CONTENT MEANINGFUL FOR DEAF AND HARD OF HEARING LEARNERS

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **03 February 2020 till 29 May 2020**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

> **The Director: Research Services**
> **Western Cape Education Department**
> **Private Bag X9114**
> **CAPE TOWN**
> **8000**

We wish you success in your research. Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 21 January 2020

APPENDIX C: Participant information sheet

University of the Western Cape
Faculty of Education

Robert Sobukwe Road, Bellville, 7535

Tel: +27-21-959-3228   **Fax: +27-21-959-3943**

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23 September 2019

Participant Information Sheet

Title of research: *Investigating the challenges that Senior Phase Natural Science Teachers Face in Making Science Content Meaningful for Deaf and Hard-of-hearing Learners.*F

Dear Participant

This letter is an invitation to the principal, teachers, learners and parents to participate in a research study with the title above. The study is being conducted towards achieving a Master's in Science Education degree by Ms Buzani Khumalo, a part-time student in the Faculty of Education at the University of the Western Cape (UWC). The study contributes toward urgently-needed empirical evidence that may be used to inform the school curriculum for Science teachers and learners.

Before you participate, it is important that you understand why the research is being conducted and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish. If you would like clarity or any further information, please do not hesitate to ask. Importantly, please take your time to decide whether you would like to participate in this research. My details are provided at the end of the document.

Purpose of the Research

The purpose of the research is to examine how Senior Natural Science teachers experience teaching science content in a meaningfully way to hard-of-hearing learners at schools. The teachers will be interviewed, and selected classrooms observed in order to explore the strategies that the teachers use in the classroom.

Description of the Research and your Involvement

The research will include interviews and classroom observations with selected teachers. Interviews will be arranged with purposively selected individual teachers at a mutually agreed upon locations. Questions will focus on how teachers teach science content meaningfully   to

hard-of-hearing science learners. The interviews will be following the permission of the participant, to facilitate the collection of information, and later transcribed for analysis.

Similarly, selected teachers' classrooms will be observed, and the classrooms will be video-taped to facilitate the collection of information, and later analysed.

Confidentiality

In order to maintain confidentiality, your name will not be recorded, but coded during the interview, and during classroom observations. The audiotapes and video-recordings will only be seen by the researcher and her supervisor. I will keep all records of your participation, including a signed consent forms that you will need to complete in order to participate. All these records will be locked away safely and will be destroyed once the research has been completed.

Voluntary Participation and Withdrawal

Participation in the study is voluntary and you are free to refuse to participate. If you decide to participate, you may keep this information sheet and you will be asked to sign a consent form. You are able to withdraw from the research at any time without giving reason, and you may also choose not to answer any questions that will be asked.

Benefits and Risks

There will be no direct benefits from participating in the research. Through the information learnt there might be long-term benefits to inform teaching at schools as well as the school curriculum. There will be no costs for participating in the research other than your time. All interviews will be conducted at your convenience, so there are no additional costs for transport or otherwise.

The risks for participating in this study are minimal. Every precaution will be taken to protect all participants from harm in this study. Should engaging in his research trigger any insights or negative affects, please contact the researcher, Ms Buzani Khumalo on the email address, buzani@saao.ac.za who will facilitate support.

Informed consent

Your informed consent in this research is required to proceed in order to give you the interview, classroom observation and questionnaire. I have included the consent forms with this information sheet so that you can review it and then decide whether or not you would like to participate.

Questions

If you have any questions about the research itself, please contact the supervisor: Dr Melanie Luckay (see details below). If you have any questions regarding your rights as a participant, or if you wish to report any problems you may have experiences related to the study, please contact the research ethics committee Tel: +27 21 959 4111; Email: research-ethics@uwc.ac.za.

If you have any further questions regarding the study, kindly use the contact details provided below:

Researcher: Ms. Buzani Khumalo
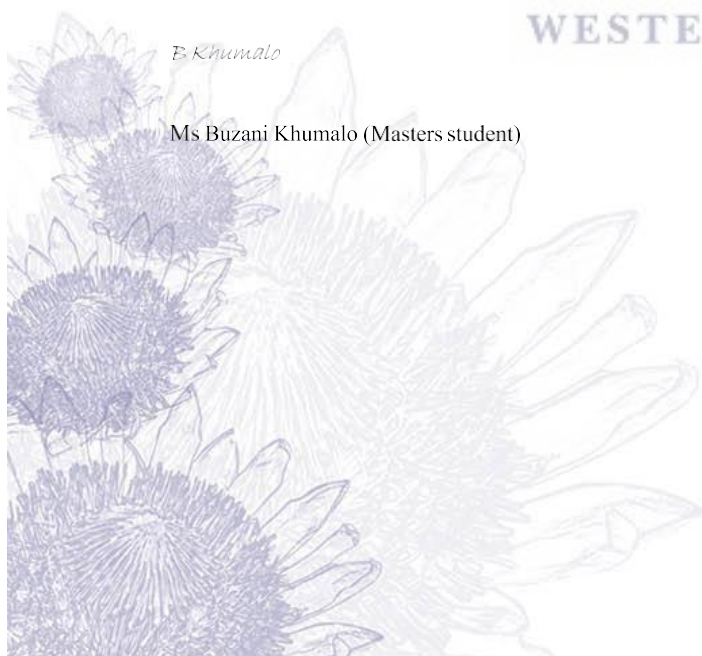Telephone: 0834761131
Email: buzani@saao.ac.za

Supervisor: Dr. Melanie Luckay
University of the Western Cape, Bellville, 7535
Email: mluckay@uwc.ac.za; Tel: 021 9592260

I look forward to speaking with you and thank you for possible assistance in this study.

Thanking you for considering to be part of this research.

B Khumalo

Ms Buzani Khumalo (Masters student)

APPENDIX D: Research Participant Consent Form

Tel: +27-21-959-3228   Fax: +27-21-959-3943

www.uwc.ac.za

Title of research: *Investigating the challenges that Senior Phase Natural Science Teachers Face in Making Science Content Meaningful for Deaf and Hard-of-hearing Learners.*F
F

RESEARCH CONSENT FORM – INTERVIEW

I………………...…………………………………willingly consent to be part of the research.

- I have read the information sheet and I voluntarily agree to participate in this study.

- I have had the opportunity to ask questions related to the research, received satisfactory answers to my questions, and any additional details I needed.

- I agree to take part in the above study by participating in an interview.

- I am aware that the discussion is being digitally recorded.

- I understand that my participation in this research is voluntary and I have the right to withdraw my participation at any time.

- I may also refuse to answer any questions that I do not feel comfortable answering.

- I understand that all information shared must be kept confidential.

Participant's name:……………………………………………………………….
Participant's signature:…………………………………………………………
Date and location:………………………….………………………………
Researchers Name: …………………………….………………………………..
Researchers Signature:……………………………………………………….

.

Ms Buzani Khumalo   Dr Melanie Luckay
Masters student UWC   Room 79, Department of Educational Studies
buzani@saao.ac.za   Faculty of Education, UWC, Private Bag X17, Bellville
Tel: 0834761131   Tel: (021) 959 2260; Fax: (021) 959 3943, mluckay@uwc.ac.za

Research Ethics Committee: Tel: +27 21 959 4111; Email: research-ethics@uwc.ac.za

APPENDIX E: Interview Guide questions

Interview Guide

1. Give your general understanding of existing policies on inclusive education.

2. How are you involved in the handling of deaf and hard of hearing students at the school?

3. Do you think that other educators within your school understand the needs of deaf and hard of hearing students when conducting their lessons?

4. Generally, what are the main challenges that you as science teachers face in conducting lessons?

5. How do the challenges you mentioned affect conducting lessons with deaf and hard of hearing students?

6. Give your opinion on the level of readiness and competence of yourself and your colleagues on including deaf and hard of hearing students to science learning.

7. As a champion of curriculum delivery at your school, how do you monitor that content presented in the science curriculum accommodates learning needs of deaf and hard of hearing students?

8. On the basis of your experience, how do you think teaching of science to deaf and hard of hearing students within your district should be improved?

9. What do you think are the main reasons why deaf and hard of hearing students shun science subjects within your school?

10. Which progress have you made as a school in terms of accommodating learning needs of learners with hearing impairment?

11. What measures are in place at the school to ensure that there are higher retention levels on the deaf and hard of hearing students in science subjects?

12. What is your view on the level and quality of support offered to your school by the District-Based Support team?

Interview Participants Sample

NAME OF FILE   INTERVIEW 5.1

PARTICIPANT:

So can we record it in two parts, is that okay? So I can take a break, I wouldn't like to talk continuously, 12 questions, so we do the first 6 questions and then I'll take a break.

INTERVIEWER:

Okay, give your general understand of [indistinct] policies on inclusive education?

PARTICIPANT:

Okay, so I teach at a special school, so we don't really…we don't need inclusive education where we are because the school is especially designated to be a special school, although I have read some of the policies on inclusive education, I have read it, but it's not really applicable as much to my particular school, because the way I understand inclusive education is that, had I been a teacher at a mainstream school, I would have to make some adjustments for those students that have special disabilities and that those policies govern those adjustments.

INTERVIEWER:

Okay the second one, how are you involved in handling of deaf and hard of hearing students at the school?

PARTICIPANT:

I'm a maths and science teacher to grade 8 mathematics and science, so I'm a classroom teacher, I also teach in the FET phase, grade 10, 11 and 12 life orientation, so how am I involved in handling them, I am a regular…I follow the CAPS curriculum and I'm a classroom teacher.

INTERVIEWER:

Do you think that other educators within your school understand the needs of deaf and hard of hearing students when conducting their lessons?

PARTICIPANT:

Yes I think they do, I think they do, many of them have….except for the teachers that are newly appointed, most of them have years and years of teaching experience, teaching deaf learners, but…I think we understand their needs because we do get trained by audiologists and speech therapists on the premises, so they train us to fix hearing aids and to understand hearing loss, we get in-house training at our school.

INTERVIEWER:

So generally, what are the main challenges that you as a science teacher face on conducting lessons, so when you are teaching in your classroom, generally, what challenges are you faced with?

PARTICIPANT:

I've noted down a few, okay so, I think a lack of understanding in conceptual…things that are more conceptual, rather than concrete, so deaf learners do struggle to understand, when you explain concepts that are more perceptive rather than, you know what they can see in front of them. So for example if I teach atomic structure and they have to visualise atoms and electrons, protons, they don't really understand the meaning of it, so sometimes you know we explain it, and we show them pictures, and we have models and so on, but it's difficult sometimes for them to understand it, you know those kinds of things and then I think one of the challenges that we face also is the resistance to the use of technology, especially by older members of staff, so I think in my particular school there's a great resistance to using learning management systems on-line learning management systems, Google drive, some on-line platforms which will make learning for deaf learners more visual, but some of the older people in the institution, for a long time, kind of resisted it, and they still wanted to do chalk and talk, even…in fact the principal of the school, she insisted, even when we had smart boards put into the school and projectors and we got laptops, she demanded that one class be left, especially for her so she could have a chalkboard and so she taught with chalk and talk right to the end of the retirement.

INTERVIEWER:

Okay so in essence, issues to do with Lexicon, you don't have those?

PARTICIPANT:

Lexicon? What do you?

INTERVIEWER:

In terms of terminology.

PARTICIPANT:

Yes, we do have issues with that.

INTERVIEWER:

Science terminology.

PARTICIPANT:

Yes, we definitely do because deaf learners have a language delay and so the language level, even at high school level would be equivalent to that of primary school children. So their understanding of words and language is very low and we struggle with that a lot, so we have to re-write the text book because the level of the text book is too high and the language is too difficult for them, we have to use ways and means of getting them to understand the meaning of words, before we can teach the content, so that's one of the main challenges, and then another challenge we struggle with is the fact that we have teenagers and they don't like to wear hearing aid technology in public, because deafness, especially oral deafness, deaf students that are oral deaf students, they don't sign, so nobody knows that they are deaf, so their disability is hidden, so they don't want to wear assistive devices because then people will become aware of the fact that they have a disability and they don't want to be thought of as disabled and so they take their hearing aids off in the afternoon when they go home which further reduces their ability to speak and to understand and to learn, and then when they're in the classroom, sometimes they are also not responsible, they leave their hearing aids at home, so some of them don't have batteries in their hearing aids, they're not hearing clearly in the classroom and it's an oral school for the deaf, so that's a real struggle.

INTERVIEWER:

Sorry, your school has a…I can say it's hard of hearing right?

INTERVIEWER:

It's hard of hearing.

PARTICIPANT:

But we also have deaf, we have profoundly deaf students too.
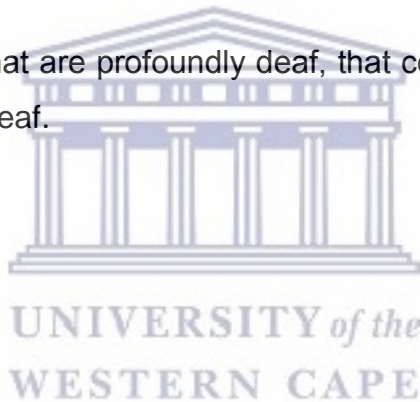

INTERVIEWER:

Okay, this is what I want to check, because I know you guys who are oral, so if you're say you have got the profound deaf, are they also signing?

PARTICIPANT:

No they're not signing, the people that are profoundly deaf, that come to us, are those that are post lingually deaf, so they are not born deaf.

INTERVIEWER:

Okay so there's no signing?

PARTICIPANT:

There's no signing at all, so they are post lingual…the ones that…I mean you'd think it wouldn't make sense for profoundly deaf people to have…to speak orally but it does make sense, because some of them spoke orally earlier in their life when they could hear perfectly, so they get HIV AIDS or they get TB or Meningitis and then it affects their hearing, the medication, the AIDS medication, the TB medication affects their hearing, then they become profoundly deaf, and they don't want to sign because they've always spoken, so that's what we deal with and those are the learners that also struggle because they have language background but they can't go further now, because now they can't hear well. I want to add two more things, also the fact that students get tired because they're listening orally, they're not signing, they're listening orally and their hearing aid devices don't give them 100% hearing, so they're hearing partially and so they have to strain themselves when they're listening to teacher talk and so they get exhausted and I think we talk too much because we've got so much to cover, and so over time they switch off, some of them even switch off their hearing aids, they

get tired. So then they feel frustrated that we're still teaching them and teaching them and they can't any more because it's like hearing halfway and so they have to look for visual queues while you're talking and they're trying to figure out what you're saying and you're also repeating yourself, so those that hear a bit more than the others, they're frustrated because they get frustrated with hearing the same thing over and over because they have better hearing than some of their classmates and then another thing is behaviour management is a problem, so we have Cape Flats children from disadvantaged backgrounds, and they are naughty, they come from dysfunctional families some of them, they have social problems, they exhibit behaviour problems in the classroom, and so some of that also drains our energy, like in any other school.

INTERVIEWER 2:

So would you ensure that you mitigate that as well? That you can actually [indistinct]

PARTICIPANT:

Oh we do, we try our best and because our classes are small, we can manage it, it takes some doing, we've got some tough kids.

INTERVIEWER:

So now to the next one. How do the challenges you mentioned affect

conducting lessons with deaf and hard of hearing students, so these challenges, when you're conducting the lessons, how do they affect your lesson?

PARTICIPANT:

I think they do reduce the strength of our lessons, they do, I'm not going to lie, that's the truth, we're not as effective as we could be. It's true, we're not as effective as we could be, with all those factors that I've mentioned, it is a challenge and we struggle with it on a daily basis, we struggle against those factors on a daily basis.

INTERVIEWER:

In terms of the lesson now, with all these challenges, you as a teacher, you want to deliver this lesson, because of these challenges, how is your lesson being affected in terms of for them to listen to you or

to gain the concept, the science concept or scient content?

PARTICIPANT:

Okay so let's take it one step at a time, can we focus on one challenge at a time? Okay so let's start with behaviour management, so the school has put some, let's say, measures in place, to try and contain those kids that are really not very well behaved, and it's very difficult because they have no…we can't expel them because they have nowhere to go, they can't go to a regular school if they're put out, and they wouldn't get into signing school, so we are the only place they can be, so because we're the only place we've got to accommodate them. So that's a unique problem that we have that no other school has got, and the school I'm at is the only oral school for the deaf in the country, so a child in my school that exhibits behaviour management problems, including smoking marijuana in the toilets or swearing at the teachers or fighting in the classrooms, those students we can take them out of the classroom, call their parents in, have discipline letters and write it up and report it to the department, even suspend them for a few days, but we can't….it's difficult for us to expel them because there's nowhere for them to go, so that's one of the problems.

INTERVIEWER:

When you say the whole country, the whole of South Africa?
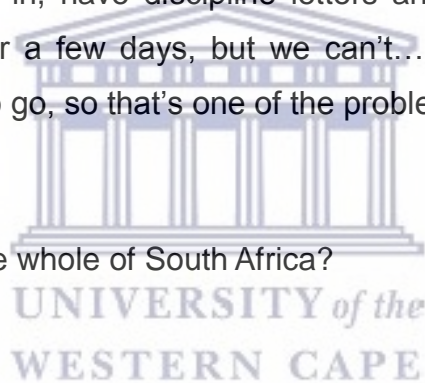
PARTICIPANT:

The whole of South Africa yes.

INTERVIEWER:

Not Western Cape.

PARTICIPANT:

The whole of South Africa.

INTERVIEWER 2:

It's the only school in South Africa?

PARTICIPANT:

Yes.

INTERVIEWER:

Hard of hearing school.

PARTICIPANT:

Yes, besides Delabat, but I think Delabat deals with post school education mainly, but for high school education we're the only ones, and for primary school education, Corel du Doit takes, I think Corel du Doit and Jan Kriel are the only ones that can do early oral education but Corel du Toit only goes to grade 3, so children from grade 4 onwards, once they come to us, they have nowhere to go.

INTERVIEWER:

Alright now the 6th one, give your opinion on the level of readiness and competence of yourself and your colleagues on including deaf and hard of hearing students to science learning.
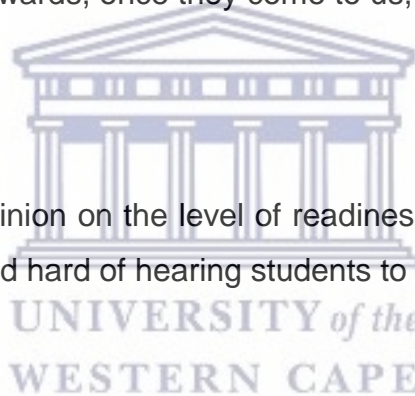
PARTICIPANT:

Okay, so I'm afraid this question is only addressed to me because I'm the only science teacher, well recently in the high school I'm the only science teacher and only this year, another teacher is teaching science, who's teaching it for the first time, yes. So how am I competent to teach it? Well I have completed a science degree.

INTERVIEWER:

It says give your opinion on the level of readiness and competence.
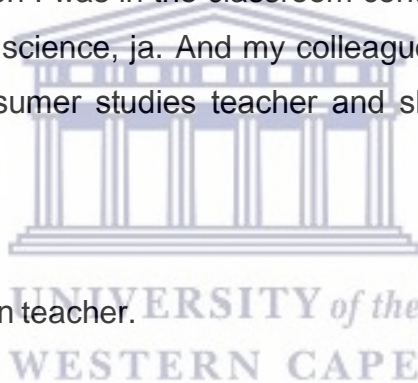
PARTICIPANT:

Of myself.

INTERVIEWER:

And your colleagues. Including deaf and hard of hearing students to science learning.

PARTICIPANT:

Okay so as a…competence of myself, let's start with that, so yes, so I think I'm competent in that I've completed a science degree and my HDE was also in physics and life sciences, so I've done a higher diploma in education and I've done a B-ed Honours in deaf education, so I think in terms of my education, I am competent, but in terms of my experience, after teaching…I think after 13 years of teaching deaf learners, I feel more competent now than when I started, yes, so I won't say that I was always competent, I think it's quite an experience to grow with, I had to grow with the experience, I had to learn how to do it. Because even though I did a B-ed Honours degree in deaf education, I actually only really understood it when I was in the classroom continuously for 13 years, now I really understand how deaf learners learn science, ja. And my colleagues, I only have one colleague and she is not ready, no, she is a consumer studies teacher and she's been…she's learning…she's teaching science for the first time.

INTERVIEWER:

Oh, she's not a science specialisation teacher.

PARTICIPANT:

No she's not a science specialisation teacher, no.

INTERVIEWER:

They just brought her to assist in science?

INTERVIEWER 2:

Under-staffed or what?

PARTICIPANT:

Well I think we are always under-staffed because some of us have to teach subjects that we were not trained to teach and because it's a special school and the numbers are low, the learner numbers are low and so the education department only allocates so many teachers per learner, there's a teacher-learner ratio and so it's not un-common for us to be teaching subjects that we're not trained to teach.

INTERVIEWER:

Alright, so now let us give you a break, you said so.

PARTICIPANT:

Yes please, thank you.

INTERVIEWER 2:

Okay I think we can go ahead with some of the challenges.

PARTICIPANT:

Okay so your question was, how do we address the challenges, is that right?

INTERVIEWER 2:

No, we are not yet on the addressing part.

PARTICIPANT:

Oh, earlier on you said what are the main challenges that science teachers face in conducting lessons, was I answering that?

INTERVIEWER 2:

Yes, you were answering that.

PARTICIPANT:

Oh no, then you asked me how do the challenges you mentioned affect conducting lessons with deaf and hard of hearing students. Okay so the challenge of understanding concepts that are not easily visualised, so I think we're trying to address that with technology, so we're trying to look at some on-line learning resources and interactive activities to have some simulations, to make the learning easier. So that's one of the ways we address it and then resistance to progress to technology, I think what's happening now is that the e-learning managers of the metro central district which we find ourselves in, is starting to put pressure on the schools generally, to have more lessons in e-learning and the use of technology, so I think there is a move towards using on-line platforms, even now that we have the Coronavirus, that schools know the learners are at home, they're looking to having lessons more on-line and because there is a move towards that, I think eventually it will become compulsory to have a learning management system so that teachers post their content on-line, so in my school I'm trying to promote it, I am e-learning trainer so I work for the metro central district, teaching teachers how to use technology

and so I'm trying to promote it at my school to move towards using a learning management system, getting away from the use of paper and having more on-line resources. Then the other challenge about, which I didn't mention earlier on, and that is that because the school does not do science until grade 12, this is one of the challenges I face as a science teacher, because the management of the school cut down the hours that are allocated to science and they contributed to maths and because they're doing that, me as a science teacher, I have less time within which to teach the same content, and I'm following the same CAPS curriculum as other schools, so I have to teach all the content that other schools teach but in less time and also to deaf learners, so how I'm trying to address that is that I'm complaining bitterly to the administration of the school and also to the subject advisors at the metro central office to say that you know I really need a bit of extra time in science. So that's how I'm addressing that and then the hearing aid, the wearing of hearing aids and the reluctance to wear them, we're trying to speak to, in our assemblies, we're trying to speak to our deaf learners about how to think differently about disabilities and to think differently about themselves as being disabled, because that's part of the reason why they don't want to appear in public with those hearing aids because they look down with people with disabilities and they don't want to feel inferior, so we're trying to…we've got a school counsellor that talks at our assemblies, on a regular basis, we bring up this topic of how we should think about disabled people, how we should not think that they are inferior but actually that they are equal to us even though they have a challenge, so that's how we're trying to address that challenge, whether it will work we don't know but we are trying.

INTERVIEWER:

Alright, as a champion of the curriculum delivery at your school, how do you monitor that content presented in the science curriculum accommodates learning needs of deaf and hard of hearing students?

PARTICIPANT:

Well they have regular tests and assignments, they get tested, they have more pieces of assessments than is done in other schools, we do it more regularly, so even in maths for example, instead of giving one test which is required, I would give three tests and then count them together so that they have more regular assessment to check for understanding, and then I made a couple of notes about it, I think for myself I play a game called Kahut, an on-line game and in this game they compete against each other in their knowledge of science, so after I've taught the lesson then they sit with their cell phones and I put the PIN, the numerical PIN on the smartboard and they type it into their smart phones and they play

Kahut with me and it's got all science questions and they play it on-line, so then I can see, with Kahut I can go back and print out their results and see what they understood and what they didn't understand, which questions they were good and bad at, so I use that, and then to ensure that their hearing aids are working, we do Ling sounds in the morning, it's where we go *shh, ooh,* we make certain sounds and they stand with their backs to us, and then they must repeat what we've said and so then we can see if there's a battery in their hearing aid firstly, and we can see if the hearing aid is functional, because we won't know it otherwise, so then if they say the sounds incorrectly, then we ask them have you put a fresh battery in your hearing aid, is your hearing aid working, does the audiologist need to adjust it, you know, like that, so by doing that we're ensuring that at least the hearing aids are working at the beginning of the day, if they have them with on the day. We show YouTube videos with sub-titles so that before we teach, we do, what is called, just in time teaching, so this means you teach concept just before you teach it, so they watch a YouTube video on the topic you're about to teach and then you put the video off and then you teach the topic as if they've never heard it before, and so they…everything they learn, they learn 3 or 4 times, so they watch a YouTube video, learn it there, then the teacher will teach, then we give them a worksheet, they fill in the answers, then we check have they answered it correctly, then after that we perhaps play a game, on the same topic, and try to see in two or three ways whether they understand. So if their worksheet has got poorly answered questions, then maybe when they do the Kahut afterwards, we'll realise no now they've learned it, they didn't know it then but they know it now and we do a lot of repeating, we repeat a lot, that's the thing about teaching at an oral school, you repeat things over and over and you keep asking, what did I say now, or you ask a child to stand up in the class and say tell Mrs Terry what she has just said now and then they always know I will call on them at any time to say what I've just say and so they have to get up and repeat what I've said.

INTERVIEWER:

So the next question, on the basis of your experience, how do you think teaching of science to deaf and hard of hearing students with your district, should be improved?

PARTICIPANT:

The district?

INTERVIEWER:

Number 8.

INTERVIEWER 2:

Within your area.

INTERVIEWER:

Like metro district.

PARTICIPANT:

Ja okay, so I think when they produce exam papers for deaf students, it must be more visual, because you know when the matrics write their exams, or even exit levels, like grade 9, like the Anno exams for mathematics or even standardised tests, if we do write them, and they produce a special one for deaf students, they must have more visual in it, more pictures, I would even consider it to be better if it was on-line, that it's not just pictures, that it's actually animations and sound and multi-media, so I would like the district to have a multi-media test for them, basically, as one of the options and then another thing I've thought about, is…I wrote it here, they should actually employ teachers from both signing and oral schools to develop materials which they haven't been doing, they give us the same materials, learning materials, as mainstream schools.

INTERVIEWER 2:

Okay, so we're dealing with inclusion of the teachers that deal with hard of hearing students or deaf students, into curriculum development.

PARTICIPANT:

Yes. I think they're not including us in their curriculum development at the moment and so the materials that are produced are produced by teachers that are designing them for normal schools, mainstream schools, and then I also think…as I said, the question paper should be more visually stimulating, they should also hold training courses which is specifically aimed at deaf educators because they're not doing that at the moment, there's no training for deaf educators in the district, only people…in my school, I'm the only person trained as a deaf educator and we have a staff of 16 people.

INTERVIEWER 2:

That are trained?

PARTICIPANT:

No, none of them are trained, only one other person on the staff is an inclusive education trained teacher and she's the acting principal at the moment and I'm the only other person that is trained specifically in deaf education, everyone else that comes to work there, only gets….

INTERVIEWER:

You have to train them.

PARTICIPANT:

We have to train them, yes, they get trained, they do on the job training. That is not…I don't think that's right, it's not acceptable actually, I think that all deaf educators should actually do a course and they should qualify to teach at the school as deaf educators, by some university degree or special teacher's training course and I think deaf educators should be paid more than regular educators because we are trained in our subject and we are also trained to teach the deaf and so we're doubly trained and we're doing very hard work.
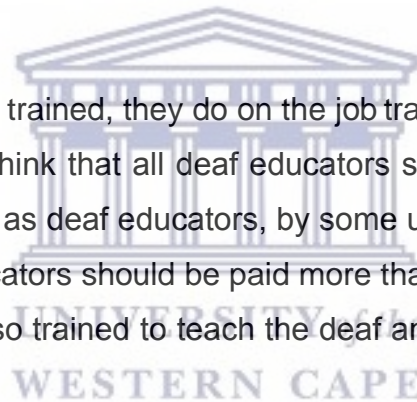
INTERVIEWER:

So what is the teacher that comes to your school and teaches the deaf, you have to train them, but that teacher is not a science teacher, it's not your specialisation, you are in other subject.

PARTICIPANT:

Yes.

INTERVIEWER:

You can manage to do that?

INTERVIEWER:

You can manage to do that?

PARTICIPANT:

We can't manage to do that, because what…that is another problem, also, that the district has not realised it or they've not conceptualised it, that the educators at our school, they are not trained for the deaf and they're also pushed into subjects that they're not trained for. And I mean, on the whole staff of 15 people, if there are 4 people that are actually teaching what they were trained to teach, it would be a lot, so the deaf are being trained by people that are not qualified in their subjects.

INTERVIEWER:

So the next question, what do you think are the main reasons why deaf and hard of hearing students and shunned science subjects within your school or try to avoid science subjects within your school.

PARTICIPANT:

At my school they only teach science until grade 9 level, grade 10, 11 and 12, there's no science and so there's no motivation to be good at it because you're not going to use it after grade 9 and those who do it, everyone has to do it until grade 9 because it's part of the national curriculum and so those who really enjoy it, they have a choice after grade 9, either to leave the school and go into mainstream or to remain there and never follow their passion of doing science, and so they feel disheartened.

INTERVIEWER 2:

Have you had the situation whereby students leave and go to the mainstream and then when they get there they feel disheartened again to do sciences?

PARTICIPANT:

Yes…to do the sciences? No. So far we haven't, very few are in that position, because in order to do FET science, especially physics, you have to have a certain level of maths and those…I mean if there are students that qualify with a really high level of maths, that want to do science, if there have been 2 or 3 or 4 of them, in the 13 years I've been there, there have been about 4 that I've managed to switch over to mainstream and they've stuck with it, they haven't done

remarkably well, but they've passed, like with average or above average marks, but never top marks, never. So the ones that are with me, up to grade 9, that shun science, they do it because they're never going to do it again, after grade 9.

INTERVIEWER:

So now which progress have you made as a school in terms of accommodating needs of learning with hearing impairment?

PARTICIPANT:

I think we've progressed in our use of technology. When I started there 13 years ago, the school only had chalkboards and that's how they were teaching, they were teaching orally, just with chalk and talk. Then a year after I started, the education department put in some interactive white boards, we got some contributions from the education department, so we got document cameras, we got projectors, teachers got laptops, so that was a lot of progress for us, because now we can use…have more multi-media presentation of lessons.

INTERVIEWER:

Okay, number 11, what measures in place at the school to ensure that there are higher retention levels on the deaf and hard of hearing students in science subjects? What measures are in place?

INTERVIEWER 2:

Or in essence you can put, considering that the science ends at grade 9, what thing motivates interests within the learners to take science subjects, what is it that motivates them?

INTERVIEWER:

To continue taking science at a higher level.

PARTICIPANT:

Well I think we…I try to do experiments with them and that does motivate them, it

cultivates some interest, but higher retention levels, is what you are asking about.

INTERVIEWER:

To retain them in science.

PARTICIPANT:

To retain the knowledge of science?

INTERVIEWER 2:

To retain them in science. When they go into grade 10, 11, they will feel like remaining in science.
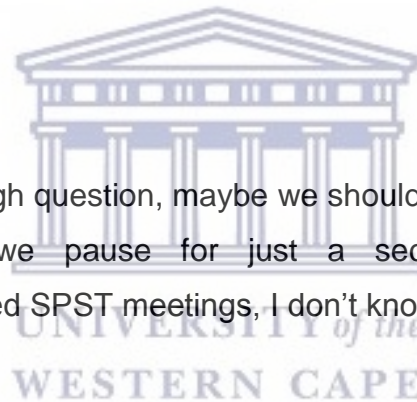
PARTICIPANT:

And 12, okay, that is a tough question, maybe we should pause for a while so I can think about this, can we pause for just a second, are you able to pause?......Something called SPST meetings, I don't know if you know about it?

INTERVIEWER:

SPSTE?

PARTICIPANT:

Yes, something like STSTE meetings, where we meet about learners on a monthly basis, so the staff gets together, early in the morning, at 7:30, before school starts and we discuss each learner and if we see learners with particular potential, I think more than interest, they need to have potential, and there's a possibility that they may be able to be mainstreamed, then we actually meet about it, and if we agree as a team, that this particular learner is good at maths, good at language, good at science, and shows an interest in science, then we start contacting mainstream schools to see if we can move them on, and then we call the parents in and we try to see if there's the possibility for them to be mainstreamed, so that's what we do.

INTERVIEWER:

Okay and then…

PARTICIPANT:

And the interest in science, to remain in science, I guess it's just doing those things that science students love you know, field trips, things like experiments, practical work, hands on, also looking at YouTube videos of other students in other schools, doing practical work, and getting them onto those school TV…you when people are on school TV and they show experiments, getting them to watch those things, hoping that through that they'll take an interest and….

INTERVIEWER:

Do you normally take them to science centres maybe?

PARTICIPANT:

We would like to do it more, we'd like to do it more, but there are…I think there are limitations, money is one of them, ja. So we take them to the cableway and we take them to the aquarium and you know, things like that, and we used to have camps in the past, but the education department has put a stop to that now, and we've gone occasionally to the MTN science centre, but not enough, there is room for improvement in that area.

INTERVIEWER:

Okay, then the last question, what is your view on the level and quality of support offered by your school and by the district-based support team?

PARTICIPANT:

I don't think the district offers us a lot of support, they don't give us a lot of support, they always have empathy and they do sometimes favour us in certain things, like the district recently gave I-pads to our school, Apple Mac i-Pads, so the other schools just got normal tablets and we got Apple Mac i-Pads, so they do favour us in that way because we're small in number, that they can buy more expensive equipment for us, but I don't think there's enough support, I think they can do a lot better.
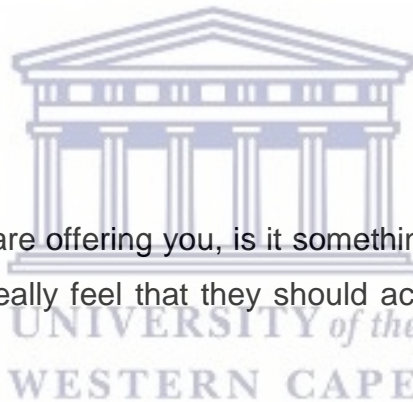
INTERVIEWER:

They still have to do more.

PARTICIPANT:

Yes.

INTERVIEWER 2:

But the support that they are offering you, is it something that is sustaining you or is it something that you really feel that they should actually increase in order to sustain it.

PARTICIPANT:

I think at the moment we're just sustaining ourselves, we don't get; a lot of support from them.

INTERVIEWER 2:

So you mean as a school you have your own intervention measures and intervention strategies in place.

PARTICIPANT:

Yes. We've got all our strategies in place and we function very…I think we've been a bit of an island, because there's no one else, no other school like our school, so you know…they even forget sometimes that we are a normal CAPS curriculum following school, so they don't always send us the information about district meetings and things like that, we struggle to keep on their lists you know to remind them that we're still part of them, so sometimes there are moderation meetings and then all our friends at other schools will know and we won't know.

INTERVIEWER:

I don't understand.

PARTICIPANT:

I don't understand.

INTERVIEWER:

You are the only oral.

PARTICIPANT:

The only oral one, yes. And so we are sometimes forgotten about, they sometimes forget about us and we don't have subject advisor visits very often, and they sort of leave us alone, they don't look…I mean they don't visit us often, they don't check up on us often, that kind of thing.

INTERVIEWER:

Do you have, in the district, or in the Western Cape, do you have a subject advisor that deals with deaf schools?

PARTICIPANT:

Yes we do.

INTERVIEWER:

Do you have a deaf studies advisor specifically?

PARTICIPANT:

We have a special schools subject advisor yes and the principal does liaise with her, yes.

INTERVIEWER:

So thank you so much.

PARTICIPANT:

My pleasure.