TEACHERS' EXPERIENCES OF TEACHING NATURAL SCIENCES AND TECHNOLOGY TO ENGLISH FIRST ADDITIONAL LANGUAGE GRADE FOUR LEARNERS

By

Sizile Charity Gumede

Student number: 216075071

A Dissertation
Submitted in partial fulfilment of the academic requirements for the degree

Of

Master of Education

In

Curriculum Studies

School of Education
University of KwaZulu-Natal Durban, South Africa

2019

ABSTRACT

The purpose of this research was to explore teachers' experiences on teaching Natural Sciences and Technology (NSTECH) to English First Additional (EFAL) grade four learners in South Africa. One of the major challenges is that grade four NSTECH teachers teach an integrated subject in English as a language of instruction to learners who were previously taught in their mother tongue. This study had two cardinal questions to navigate through the trajectory of the research: What are teachers' experiences of teaching NSTECH to EFAL grade four learners? What teaching strategies do teachers employ when teaching NSTECH to EFAL grade four learners?

The study is qualitative in nature and is located within an interpretive paradigm where questionnaires and semi-structured interviews were the key instruments to generate the needed data. Purposive sampling was employed to select four teachers as participants in the study. The sample is made up of female and male teachers' who teach NSTECH using English as a language of learning and teaching (LoLT) to grade four learners with varying years of experience.

The findings of the study revealed that teachers experienced various challenges due to learners having little understanding of English as a Language of Learning and Teaching (LoLT). Teachers' are faced with abstract terms that learners could not even witness with their eyes, and it is difficult to convey the precise meaning of concepts to their learners. Teachers' challenges were also connected with the language policy that introduces English as a language of instruction for the first time to the learners in grade four. It was clear that learning in a new language of instruction is puzzling for grade four learners in South African public schools.

It was recommended that the department of education needs to treat LoLT as a matter of emergency from the initial schooling years of learners. Policy designers need to find strategies of addressing a language that will stimulate the implementation of NSTECH. Increasing the NSTECH teaching periods, equipping classroom with a wide range of technological resources and employing teachers with a special knowledge of the subject matter might address the current and future challenges of EFAL learners, and thus improve the quality of teaching NSTECH to grade four second language English speaking learners in South Africa.

ii

DECLARATION

I, Sizile Charity Gumede, declare that this dissertation is:

1. My original work except where it is otherwise indicated.
2. It has not been submitted to any other university.
3. The views expressed do not reflect any policy of education but are intended to shape the teaching profession towards an effective curriculum delivery of the Natural Sciences and Technology to grade four learners in public schools.
4. It does not have other persons' data and pictures. Any writings from other researchers used is acknowledge as the root of knowledge and they appear in the reference.
5. This is done with a special reference to learners who are introduced to English as the Language of Learning and Teaching in grade four for the first time.

Signed: …………………   **Date……………….**
Sizile Charity Gumede

DEDICATION

This work is dedicated to all teachers' who have dedicated entirely in teaching African learners' in English First Additional Language especially at grade four level. I also pay tribute to all learners who did not use their mother tongue at school yet succeeded with their education.

ACKNOWLEDGMENTS

LIST OF ABBREVIATIONS

ACE	Advanced Certificate in Education
CAPS	Curriculum Assessment Policy Statement
DoE	Department of Education
DBE	Department of Basic Education
EFAL	English First Additional Language
ESP	English for Specific Purposes
ESD	Education for Sustainable Development
ENSTECH	English for Natural Sciences and Technology
FET	Further Education and Training
LoLT	Language of Learning and Teaching
NS	Natural Sciences
NSTECH	Natural Sciences and Technology
PPN	Post Provisional Norm
PCK	Pedagogical Content Knowledge
PTD	Primary Teachers Diploma
SA	South Africa
TECH	Technology
UKZN	University of KwaZulu Natal

TABLE OF CONTENTS

CHAPTER THREE: RESEARCH METHODOLOGY

CHAPTER FOUR: PRESENTATION OF FINDINGS AND DATA ANALYSIS

CHAPTER FIVE: SUMMARY OF FINDINGS, SUGGESTIONS, RECOMMENDATIONS AND CONCLUSION

LIST OF FIGURES

CHAPTER ONE
OUTLINE OF THE STUDY

1.1 INTRODUCTION

This study is focused on teachers' experiences in teaching Natural Sciences and Technology (NSTECH) to English First Additional (EFAL) grade four learners. In South Africa, teachers are faced with learners who cannot read with understanding across all curriculum subjects, especially the grade four learners in public schools (Spaull, 2013b). The learned conception is that, English as a first additional language used for instruction is a serious concern for grade four teachers. It is important to realize that these pressures are not disconnected with the fact that these learners would have started learning English language later than when they were in the foundation phase. Consequently, this poses a major language adjustment challenge at grade four (Singh & Rapetsoa, 2012). It is at the grade four level where teachers begin to use English as a language of instruction. This makes it difficult for learners to assimilate instructions through an otherwise alien communicative medium since they were taught in their home language in grade three. It is therefore imperative to understand from grade four teachers' experiences, whether they teach learners who are sufficiently ready in their English literacy to be taught NSTECH meaningfully.

Natural Sciences is not taught up to the expected standards in South African schools as many schools have no science laboratories, while those that have them are poorly equipped (Probyn, 2015). It is also important to realize that in South Africa, the medium of instruction in the foundation phase, from grade one to three currently, is learners' home language in public schools. While it is necessary for NSTECH grade four teachers who teach in the medium of English language to communicate with learners who should be able to understand and make clear verbal presentations during teaching and learning. While reading and learning with understanding is still difficult using English as a language of learning and teaching (LoLT) to grade four learners, teachers serving in urban townships are expected to use various and relevant strategies to teach and inspire learners in NSTECH.

The current chapter will describe the following: Location of the study, Background of the study, Rationale, Significance of the study, Critical research questions, Focus of the study, Definition of the terms, Chapter outline and Conclusion. The study comprises five chapters.

1.2 LOCATION OF THE STUDY

My study will take place in four schools. These schools are situated in the KwaDabeka Township under the Pinetown District. The location has mixed communities and most of the inhabitant's experience unemployment, poverty, malnutrition, drug addiction, violence and alcoholism. Three of the four schools are located very close to the public hostels and one is where there are informal and rental houses. Public hostels provide residence to many families who come from other parts of the country and are in the urban areas for jobs. Therefore, the four selected schools provide education to learners who have multilingual backgrounds.

The living conditions of the learners are represented in figure 1 below where majority of the learners reside. Thus, indicate that most of learners are multilingual as they can speak more than one African languages. Multilingualism is where learners are able to speak two or more languages (Sun, bin Sallahuddin & Kaur, 2016). The researcher has included a picture of where most of grade four learners come from. The picture is taken from google maps South Africa.

Figure 1: Representation of grade four learners living conditions in kwaDabeka KK Hostel Clermont. Picture taken from KZN – Photos (google maps. KK+ Hostel@29.777997,30 co.za.).

1.3 BACKGROUND OF THE STUDY

After the 1994 elections, the education system in South Africa underwent drastic changes as there were various education policies with an aim of redressing the education status, which had gaps between the South African learners of different racial groups (Cross, Mungadi & Rouhani, 2002). The first curriculum policy that emerged was the Outcomes Based Education (OBE). This policy ensured that learners should be more active regarding their learning in the classroom. In accepting OBE, it meant that teachers were to teach topics that learners would best understand, and concepts and content would come from their immediate environment. This curriculum was popularly known as C2005 and it also referred to subjects as learning areas. Even though OBE received support in its principles from teachers, it failed to respond to the needs of the education in South Africa (Botha, 2002). Another challenge with the OBE policy was the language issue, which according to Spreen (2004) was very complicated and borrowed from other countries. However, the National Curriculum Statement (NCS) was implemented to deepen and improve the curriculum. With the NCS, the Natural Sciences and Technology disciplines (NSTECH) were integrated in one subject. One of the main reasons was to allow sufficient time to cater for English language as learners were still challenged by the language.

The addition of natural sciences and technology in the primary school facilitates the development of teachers in each discipline. This ensures that teachers are well functioning, and they are not outdated with the knowledge (Velthuis, Fisser & Pieters, 2014). Generally, teachers' encounter certain experiences during their teaching sessions of NSTECH using English to EFAL grade four learners. These experiences vary from teacher to teacher and can be both positive and negative. These experiences are not disconnected with the position that transitioning from the foundation phase to the intermediate phase carries a learning overload for learners of which learning English is one (Roth & Jornet, 2013). Identifiably, one of the primary causes of poor results in academic subjects for South African (SA) learners is related to EFAL (Manyike & Lemmer, 2014). Teachers were also loaded with adjustments regarding their teaching in a First Additional Language of learners' who were not used to that language. The main aim of this study is to explore teachers' experiences in teaching NSTECH to grade four EFAL learners.

Exploring grade four NSTECH teachers' experiences will provide an understanding of the challenges teachers face using EFAL while bridging the gap between the foundation and intermediate phases. NSTECH grade four teachers need to develop learners' English vocabulary

so that learners become competent in understanding NSTECH subjects (Benson, 2013). In the foundation phase, learners were less challenged regarding the language of instruction since in South Africa all languages are accorded equal status. Perhaps, it could be possible that teachers experience complex problems when teaching NSTECH to grade four learners as they are expected to understand and teach in English as a first additional language. Teachers are to apply English language skills and assist learners to satisfy their curiosity by allowing them to make experiments and present their findings in EFAL in accordance with the NSTECH grade four context that was adapted from the Curriculum Assessment Policy Statement (CAPS) 2012.

1.4 RATIONALE

It may appear that the field of Natural Sciences and Technology remains in crisis, in that many learners do not excel in natural sciences and technology studies at the senior phase (Fitzgerald, Dawson & Hackling, 2013). This is also observed in the small numbers of learners pursuing these studies at the Further Education and Training (FET) phase.

The study is developed from the researcher's passion, empathy and a strong sense of moral purpose of excellent teaching as a career, as well as the love of Natural Sciences and Technology subjects. The study might draw attention to language policy makers in South Africa to revisit English as a language of instruction from the foundation phase. It may also alert the department of basic education to prioritise the teacher subject specialisation at the primary schools.

Having been in the field of teaching young minds for the past twenty-seven years, I have observed the tension of teaching learners without achieving the most valuable results because of the language barrier (Zohrabi, Torabi & Baybourdiani, 2012). As a grade five NSTECH teacher, I have experienced teaching learners who lack understanding of concepts and who fail to interpret what is taught or are challenged with translation of simple sentences because English is their second language. This is a big challenge that the contents of this study will try to address. It will continue to contribute to the optimistic success of understanding the NSTECH curriculum, developing teacher-teaching skills and managing learning through the maximum language of instruction. It is therefore a great opportunity to explore grade four teachers, as they are the first recipients of learners from the foundation phase, to introduce English as a language of instruction and to introduce the NSTECH as a subject. Findings will reflect the true meaning of the holistic experience of grade four NSTECH teachers as they introduce the subject in EFAL for the first time to transition learners.

1.5 SIGNIFICANCE OF THE STUDY

South Africa require citizens that will respond well to the needs of the economy and its social development. Therefore, being a grade 5 NSTECH teacher, I fully understand that natural sciences and technology are subjects, which offer learners the opportunity to carry out practical projects, experiments and real-life tasks to prepare them for the world (Harlen, 2017). The study aims to understand the deep-rooted challenges faced by teachers during the laying of the foundation in grade four in a classroom, which might prevent them to translate NSTECH content to meaningful knowledge.

The study will also complement those competent teachers who are motivated with the good work and share their experiences with other teachers. It will thus increase teachers' commitment to ensure that they teach to meet the goals and objectives of the NSTECH curriculum. Findings from the study will provide sufficient knowledge that might enforce grade four teachers to re-evaluate their teaching practice and take more pride and care in teaching NSTECH in the elementary phase (Lederman, 2013). It may trigger the department of education to take deeper interventions in a language of instruction that will equip teachers to improve learner performance. There is a possibility that after reading grade four teachers' experiences, education stakeholders might seriously begin to better understand the issue of language in public schools. Gathering teachers' experiences might assist policy makers to use the findings of the study to expand and innovate more meaningful teaching skills for NSTECH to EFAL grade four learners (Sadler, Sonnert, Coyle, Cook-Smith & Miller, 2013).

This means that teachers can actively involve learners in their learning and make them practise science and technology tasks in spite of the language of instruction thus contributing to the nation (Torrey, 2012). The NSTECH curriculum objective that teachers must teach learners so that they are eager to participate in the world and value other human beings, might be achieved through the findings of this study (Motshekga, 2011). The good intentions of the study would be achieved by answering the following research questions.

1.6 CRITICAL RESEARCH QUESTIONS
- What are teachers' experiences of Teaching NSTECH to EFAL grade four learners?
- What teaching strategies do teachers employ when teaching NSTECH to EFAL grade four learners?

1.7 FOCUS OF THE STUDY

The focus of the study is to explore teachers' experiences of teaching NSTECH to EFAL grade four learners. What is worth noting that, grade four teachers are teaching learners that have transitioned not only to the new phase, but to a new grade and new subjects. Most remarkably, they are also introduced to a new language of instruction, which is English as a first additional Language (FAL). It is expected that South African grade four learners are to be introduced for the first time to English as a language of instruction in all academic subjects (Msimanga & Lelliott, 2014). This may create compounding challenges for teachers in that they are expected to teach NSTECH, a new subject in EFAL to learners who are still expected to acquire more English vocabulary (Zwiers, 2013).

The main focus of this study is to understand precisely the teachers' experiences during their intervention with the NSTECH content, EFAL and learners in the classroom. The purpose of the study is also to strengthen grade four teachers so that they continue to provide a strong foundation of NSTECH to learners, as they are accountable for learner performance. The study will further focus on the wide range of teaching strategies that teachers employ when teaching NSTECH to grade four EFAL learners.

1.8 METHODOLOGY

The current study gathered data from four grade four NSTECH teachers as potential participants. The participants represented both genders and were chosen through purposive selection as they both teach NSTECH to grade four learners and were also interested in participating in the study. Questionnaires and face-to-face semi-structured interviews were used as data generating methods. Therefore, this is a qualitative research study as the researcher visited teachers in schools where they teach (Creswell & Clark, 2017). The study employed the interpretive paradigm as it explores teachers' experiences, which involves attitudes and beliefs about teaching NSTECH in EFAL to grade four learners (Cohen, Manion & Morrison, 2011). The rationale for the paradigm is to gather content data from the participants answering questions about their experiences, which will lead to the multiplicity of realities in teaching NSTECH to EFAL grade four learners. This paradigm allowed the researcher the process of observing the non-verbal behaviours of the participants during the conversation in the interviews which increased the understanding of data gathered (King & Horrocks, 2010).

1.9 DEFINITION OF TERMS

The study uses the following terms as they are the fundamental concepts. Their definitions are below:

1.9.1 TEACHERS' EXPERIENCES

Teachers' experiences are built by an individual teacher's ideas about his or her teaching practice through his or her intervention with the people he or she teaches or encounters. The teacher then undertakes what he encounters in the classroom with his or her beliefs and values and others and justifies whether they meet certain specific and daunting challenges drives (Beane, 2016). Teachers acquire their experience by the reality they gain during their classroom practice as well as the continuous professional development regarding the subject they teach (Qablan, Mansour, Alshamrani, Aldahmash & Sabbah, 2015). Therefore, the key idea to grasp is that, teaching experience is the most required expertise in the teaching profession as it is accompanied by valuable teaching-practice in teaching NSTECH in this study.

1.9.2 TEACHING

Teaching is an activity whereby the teacher has to be creative in imparting knowledge to the learners and inspire them to like the subject he or she teaches (Laurillard, 2013). It is an act that requires some accountability involving other education stakeholders that are interested in the education sector (Pachler, Evans, Redondo & Fisher, 2013). When teaching, teachers use a skill that they have gained through observing their learners in class and then plan to teach accordingly (Morrow, 2007). This also includes the process of developing the teaching services through responding to the needs and goals of learners and the society through being effective and efficient in teaching NSTECH to EFAL grade four learners who are still at the most crucial stage of receiving the fundamentals (EL-Deghaidy, Mansour, Aldahmash & Alshamrani, 2015).

1.9.3 ENGLISH FIRST ADDITIONAL LANGUAGE (EFAL)

English is the second language that learners learn at school other than their mother tongue (Strand, Malmberg & Hall, 2015). English is an essential second language that learners in South Africa must possess and understand to be able to understand other content subjects offered at school (Saville-Troike & Barto, 2016). This study is based on English as a First Additional Language that is used by grade four learners to learn NSTECH. According to CAPS policy, it was redefined with an effort to equip teachers with NSTECH knowledge needed for both teachers and learners. The idea of learning the academic subjects in EFAL was imposed by the collaboration of education stakeholders, political domination and the community (Leung, Davison & Mohan, 2014).

1.9.4   NATURAL SCIENCES AND TECHNOLOGY (NSTECH)

NSTECH is one of the subjects that was introduced by the Department of Basic Education (DBE) through South Africa's National Curriculum Statement in 2005. As challenges in teaching learners continued in South Africa even when apartheid was over, it was refined to meet the required level (Kanjee & Sayed, 2013). According to Munje (2018), CAPS was intended to assist teachers with NSTECH knowledge to accommodate learners in their day-to-day challenges as well as their language of instruction whilst using least resources.

NSTECH is an integrated subject as it combines Natural Sciences and Technology as a single subject for the grade four learners (Dillon, 2016). Grade four teachers are required to develop scientific understanding and increase learners' skills and apply technology in solving problems in their society. This requires teachers to teach this subject in a more structured way.

1.9.5 STRUCTURE OF THE STUDY

This study is presented in five chapters. Each chapter conveys a sense of grade four teacher experiences in teaching NSTECH to EFAL grade four learners. All chapters are organised within the main research problem: Teachers Experiences of Teaching Natural Sciences and Technology (NSTECH) to English First Additional (FAL) grade four Learners. Each chapter is briefly described below:

CHAPTER 1: Serves as the introductory chapter as it introduces the study and provide the rationale and the background of the research study. The chapter proceeds to discuss the focus and the location where the study takes place. There is provision of the research questions, which are to be answered as the research unfolds. The chapter also describes the important terms that are frequently used in the whole study.

 CHAPTER 2: This chapter discusses the literature review based on teaching Natural Sciences and Technology in the curriculum studies that are related to the present study. The literature highlights the imperative reasons for pursuing the study. This chapter draws attention to the challenges of teaching in a foreign language in different perspectives. There is also the outline of the conceptual theoretical framework of Pedagogical Content Knowledge (PCK) that frames the study and assists in addressing grade four teacher experiences. Teachers' experiences are defined through this theory. The chapter highlights the role played by English as a language of instruction in teaching NSTECH to grade four.

CHAPTER 3: Chapter three discusses the qualitative research design using questionnaires and interviews as data gathering methods. Interpretive research designs are aimed to make sense of data gathered. The selection of the participants and the type of the sample they represent is discussed. There are biographical details of each participant presented in a table and participants are given pseudonyms. There is a discussion of how data gathered from each participant will be analysed. Ethical issues are also considered in this chapter.

CHAPTER 4: This chapter presents data, themes and a discussion of findings from the participants. Themes that emerged during data gathering will be analysed and transcribed carefully. The data helps to respond to teachers' experiences in and the strategies they employ when they teach NSTECH to EFAL grade four learners. The theoretical framework will also be used in clarifying the findings and interrogating assumptions that underpin grade four NSTECH teachers' experiences.

CHAPTER 5: This is the last chapter with the summary of the study and themes. It also presents the recommendations based on the recent study and outline the gaps, which might be bridged by the recommendations of further research. It ends with the concluding comments based on the teachers' experiences in teaching NSTECH to EFAL grade four learners.

1.10 CONCLUSION

The chapter outlines the necessity and the significance of a study of this nature. All the key terms and innovative methods towards the success of the study are more carefully scrutinised and presented. Other factors that are crucial to the progress of the study which include literature review and theoretical framework will be presented in the next chapter.

CHAPTER TWO
LITERATURE REVIEW

2.1 INTRODUCTION

In the first chapter, the research study was introduced and outlined the location of the study. Understanding the background of NSTECH as a subject curriculum and the language in which the subject is taught in grade four, underpins this study. Therefore, the study explores teachers' experiences of teaching Natural Sciences and Technology (NSTECH) to English First Additional Language (FAL) grade four learners.

In an effort to ensure that the study gains relevance and momentum, chapter two focuses on literature review which will bring more insight into teachers' experiences relating to the teaching of Natural Sciences and Technology (NSTECH) to English First Additional Language (EFAL) grade four learners. The literature review will assist to guide and strengthen the study by identifying the gaps and acknowledging local and international contexts and those areas that shaped the teaching of natural sciences and technology in previous studies. Therefore, data from literature review will provide sufficient published evidence that also assists the researcher to draw conclusions and make informed recommendations about teachers' experiences. It will provide a wide range of strategies that teachers' employ when teaching Natural Sciences (NS) and Technology (TECH) and screen teachers experiences of teaching grade four learners and other grades in EFAL (Hart, 2018). Silverman (2013) agrees, literature review allows the researcher to examine a wide range of data. Data will also inspire the researcher to explore teachers' experiences in teaching learners in English which is a language that is neither theirs nor their teachers' home language.

Limited studies have been done on how South African EFAL teachers implement a subject such as NSTECH, and notably what their experiences are when implementing such a curriculum. Those studies that describe teachers' experiences of implementing an NSTECH within the South African classroom, stringently focus on the experiences of Maths and Science teachers who teach an integrated curriculum, more especially in a high school context (Wei, 2009). However, this study is focussed on experiences of South African NSTECH teachers who teach EFAL Grade 4 learners, who are involved in the implementation of NSTECH as opposed to studies that have been done on policy documents (Rohaan & van Keulen, 2011).

The impact of the literature review will be to chart a new manifestation of teachers' experiences in teaching NSTECH in English as a language of instruction to grade four learners who are new to this language of instruction. The literature review will be categorised into different sub-topics which are related to the study (McClellan III & Dorn, 2015).

2.2 THE TRAJECTORY OF NSTECH CURRICULUM

This section presents how NSTECH as a combined subject was trisected in the curriculum after natural sciences and technology were considered essential parts of the curriculum after the apartheid policy was repealed. The pressure in any curriculum is exacerbated by the downturn in learners' results (Fomunyam, 2014). When the teachers' competitiveness for using Outcome Based Education (OBE) declined, the education department took that into account and proposed National Curriculum Statement (NCS). To strengthen NCS, NSTECH was then implemented in different grades and years after teachers were retrained. Any curriculum is the account inspired by the official response of what the society and political unions have found to be good for learners (Khoza, 2015). Hence, natural sciences and technology also had higher trajectories to be taught to learners in the democratic South Africa beginning from grade four (Motshekga, 2011).

Previously teachers taught Natural sciences (NS) as an independent subject to grade four learners in the intermediate phase. According to the literature review findings, teachers were to teach NS content with an aim to heal the gaps regarding the knowledge that was taught to grade four learners in general sciences before 1994 (Motsekga, 2011). Therefore, Natural Science (NS) was to include Technology (TECH) parts that were considered efficient and would add productivity in the subject (McLaughlin, 2013).

Unfortunately, the NS curriculum failed to revive the education of intermediate phase learners as the situation was worsened by the fact that TECH content was imposed haphazardly in the subject. The following are the reasons which contributed to the failure of NS:

Teachers were to teach NS content and concentrate only on the learners' three learning outcomes (LO's) at the end of the topic. Learning outcomes were that learners should know science concepts and should be able to use methods of carrying investigations following scientific rules (National Research Council, 2000). That meant grade four NS teachers were to assess learners' progress by checking whether learners were good in process skills and were also able to achieve a high mark in their assessment standards (McClellan III & Dorn, 2015). Assessment standards (AS) came with levels which were represented in numbers from 1 to 7 that were intended to show learners' progression. Even though these levels were each analysed according to learners' achievements,

teachers were confused with these numbers and could not really diagnose learners' performance in NS (James, 2012). This resulted in a negative impact in the standard of teaching learners in South Africa. Therefore, this called for the restructuring of the curriculum.

The remoulding of the National Curriculum including NS as a subject in South Africa received all the rage to advance the interest of the society and to maintain collective humanity (Erduran & Msimanga, 2014). Thus, the curriculum was refined in 2012. It was an explicit curriculum, which gave sufficient content curriculum for teachers to teach NS and TECH respectively. Eventually, strengthening NS and TECH was essential for teachers to have a more coherent NSTECH curriculum to teach to grade four learners in SA (James, 2012). Consequently, in 2013 NS and TECH were combined as one subject, which was made official for all learners from grade four to grade six with an aim of proving that the two disciplines complement each other (Appleton, 2013).

The department of education in South Africa had a challenge to develop learners' who were to be enriched with meaning for their broader worldview and other holistic human knowledge. Therefore, the NSTECH trajectory manifested arising from true scientific knowledge and true understanding of technology (Holbrook & Rannikmae, 2007). As a result, it is essential for grade four NSTECH teachers to understand the curriculum content and how they contribute towards creating an enabling classroom environment during teaching EFAL grade four learners (Shrum & Glisam, 2015). This could be achieved by exploring teachers' experiences during implementation of NSTECH at grade four EFAL level (Hart, 2018). In exploring teachers' experiences, it is important to understand the current manifestations of the existing NSTECH curriculum as it was issued to grade four teachers.

2.3 CAPS CURRICULUM FOR GRADE FOUR NSTECH CONTENT

This section explores the main curriculum that grade four NSTECH teachers use to teach grade four learners. This is the curriculum that teachers have to understand and be able to plan their daily activities using the content in the study (Ramrathan & Mzimela, 2016). According to Shulman (1986, p.10), "a professional teacher must be familiar with the curriculum materials under that subject and what his or her students are studying in other subjects".

The present grade four NSTECH curriculum comprises knowledge strands that organise and manage the curriculum content. The NS strands according to Green, De Jager, Bredenkamp, and Van den Heever (2013) are: Life and Living, Matter and Materials, Energy and Change and lastly, Planet and beyond. The NSTECH strands include Structures, Processing and Systems and Control. These strands form the framework for the NSTECH content to be taught in grade four. Grade four

NSTECH Strands are used as prerequisites for Physical Sciences, Life Sciences, Earth Sciences and Technology components in later grades (Green, De Jager, Bredenkamp, & Van den Heever, 2013).

The current NSTECH grade four CAPS curriculum comprises three specific aims that teachers must endorse when teaching grade four learners. This was different from the AS in the other curriculum. These aims are briefly outlined as follows; **Specific Aim1:** 'Doing Science and Technology. This indicates that teachers have to teach learners to perform minor investigations to be able to solve problems that require practical skills.

Specific Aim 2: 'Understanding and connecting ideas. This involves teachers' ability to communicate with a view to imparting knowledge that will assist them in making connections between ideas and concepts. **Specific Aim 3:** 'Science, Technology and Society'. The central idea here is that teachers should equip learners with practical skills (Kriek & Stols, 2010). Effective teachers' have to give projects that learners will perform in order to make them caring and creative citizens. Projects encourage a relationship between the applied knowledge of NSTECH as a subject and the language.

However, Tomlinson (2014) argues that teachers should design curriculum as they are the ones who understand what is essential regarding the type of learners they teach. He further argues that, when teachers enact the curriculum as intended by its designers, they have to provide learners with rich experience, which can improve learners' abilities. Tyler (2013) states that planning a curriculum should take into cognisance the vast experiences of the teachers as well as the tools used for evaluation. It is important to understand that those dealing with grade four NSTECH curriculum designing might consider consulting grade four teachers who are directly experiencing the teaching of grade four learners who are new to English as a language of instruction. That is the main reason Stuckey, Hofstein, Mamlock-Naaman and Eilks (2013) suggest that Sciences subjects must correspond with learners' personalities and their social environment. This statement indicates that grade four NSTECH content must relate to both teachers and learners in a language they both clearly understand.

Thus, the question is; are teachers able to implement the NSTECH curriculum effectively in the teaching of grade four learners in South Africa? On the contrary, in grade four teachers are to teach a new NSTECH curriculum content in a language of instruction that is also new to learners. These are experiences that this study anticipates exploring from teachers who are the curriculum

implementers. Therefore, the overriding objective of the curriculum is to innovate better education for learners (Le Roux & Evans, 2011). Currently, it is not explicit how teachers manage optimal teaching of EFAL grade four learners using the current NSTECH curriculum. This study seeks to, inter alia, find solutions to such challenges.

2.4 TEACHERS' EXPERIENCES: CULTIVATING A PLATFORM TO TEACHING NATURAL SCIENCES AND TECHNOLOGY

While the learner's role is prioritised, the role of the teacher in understanding the NSTECH curriculum is extremely vital to properly implement such a curriculum and it ultimately deciphers the outcome of learning (Park, 2008). Therefore, the experiences of teachers who implement NSTECH are rather important and equivalent to learners' ability to learn such a curriculum (Park, 2008). Teachers' experiences contribute to new professional teaching and learning as they create the opportunity for self-discovery amongst teachers (Dewey, 1963). Acknowledging teachers' experiences will lead to the understanding of the present experiences in teaching NSTECH (McLaughlin, 2013). A number of theorists such as Whitaker (2013), Appleton (2013), Angelle and Teague (2014), Laurillard (2013), Sharp, Peacock, Johnsey, Simon, Smith, Cross and Harris (2017), Van Hoorn, Monighan-Nourot, Scales, and Alward (2014), state that teaching experience in classrooms gives more insight to teachers than attending educational workshops. They further point out that experiences encourage teachers to be active, reasonable and make sense of the curriculum they use for teaching.

Within the classroom context, teachers are often faced with numerous contextual challenges. These challenges being limited time, lack of resources, and the inadequate content knowledge and skills amongst NSTECH teachers (Guzey & Roehrig, 2009). Izci (2017) elucidates that this makes the diffusion of such a curriculum rather difficult for teachers. Additionally, in this way the NSTECH curriculum may not attain the outcome of providing a sound foundation for learners in later grades. The role of the teacher is key, nevertheless, since didactic approaches of teachers vary, it in turn affects learning and teaching in schools (Kelly, 2004). There is arguably a need for improved practices and methods on the part of universities, when imparting the NSTECH curriculum to pre-service Foundation Phase teachers who are in training so that they are well prepared to implement such a curriculum in the classroom (Kok & van Schoor, 2014). A curriculum such as NSTECH can only be properly executed if it is communicated to learners in a meaningful way, therefore, teachers

themselves need to acquire ample knowledge on the subject, in practice and theory, whilst being furnished with essential resources to carry out the NSTECH curriculum (Yildiz-Dubun, 2014).

Part of the strategy towards exploring teachers' experiences is to study literature on teaching natural sciences and technology separately in South Africa and other countries outside South Africa. The rationale behind this literature is that there isn't much studies, which are done in teaching NSTECH as an integrated subject. This will further intensify the current study in exploring teachers' experiences in teaching NSTECH to EFAL grade four learners (Spaull, 2013). The following sections to be discussed are as follows: Teaching Natural Sciences in South Africa (SA), Teaching Natural Sciences outside of South Africa (SA) and Teaching Natural Sciences and Technology as an integrated subject.

2.4.1 TEACHING NATURAL SCIENCES IN SOUTH AFRICA

This section examines teachers' experiences in teaching Natural Sciences (NS) in SA and focuses on what happens when knowledge is rendered in English as a language of instruction. The literature highlights teachers' engagement with natural sciences as a subject and with learners during teaching and learning.

A study by Lee, Quinn and Valdés (2013), acknowledge the relationship in teaching and learning natural sciences using English as a medium of instruction. They therefore assume that the ability for learners to understand English as a LoLT form the foundation to understand the subject. A study by Lee et al. (2013) determines the relationship between learners learning natural sciences in English as a medium of instruction in SA with their academic performance. The study used learners' results. The findings indicated that learners did not perform well and required assistance in terms of language development, which would make them understand the subject content. It is therefore critical that teachers develop learners' English efficiency to assimilate new knowledge of natural sciences (Cummins & Swain, 2014). Thus, bilingual learners have to master a variety of English language words to be able to understand concepts for natural sciences.

While, according to Lee et al. (2016), grade four teachers are intimidated to teach natural sciences as a subject to learners who have limited English vocabulary. Hence, this is particularly true as teachers would find it difficult to give meaning to all bits of words, they use during teaching NS using English as a language of instruction. According to Lee et al. (2016), the teachers' concern is that learners would not capture the understanding of NS because of the language barrier. In their findings, they also viewed that teachers in the intermediate phase lacked natural sciences knowledge that would equip learners with the necessary information for the subject. These

researchers proposed that teachers should first build and decide what leaners will be capable to learn in English as their second language. That would assist teachers to teach learners that would understand the natural sciences content knowledge. However, it is important to remember that timetable does not provide teachers with time allocation for scaffolding learners to expand their English vocabulary. In addition, teachers are required to complete all intended NS topics by the end of the term.

The literature raises concerns about the need to explore grade four teachers' experiences about teaching in a critical and sensitive phase where learners are unfamiliar with NSTECH knowledge as well as EFAL as a language of teaching and learning (Cummins & Swain, 2014). According to Appleton (2013), sciences teachers need to utilise their experiences to address any challenges they face in the classroom. The research findings also indicated that teachers confuse bilingual learners when they translate one natural sciences concept into two different languages. Further, it is suggested that teachers anticipate providing a better teaching of natural sciences for learners' personal enrichment and to transform them into more profound citizens (Bills, Kulkari & Hart, 2017).

Within the literature of teachers' experiences, Ramnarain (2013) found another challenging factor, which he claims impacts negatively on South African learners NS results. He identified that teachers teach learners who lack parental involvement. This becomes clear as teachers notice that they teach learners who receive minimal assistance at home regarding EFAL and the other subjects. This is based on the assumption that parents understand that grade four learners are changing the language of instruction and are acquiring a new subject. As a result, the demand is so great that parents also have to assist teachers by getting involved in the education of their learners. Hence, Jita and Mokhele (2014) described teaching NS as a subject with a variety of disciplines. They claim NS integrates agriculture, life science, geography and physical science. The focus of this literature review is to indicate that grade four teachers have multiple and distinctive experiences in teaching NS and facing learners who rarely understand that the language of instruction is demanding.

A study done by Brígido, Borrachero, Bermejo, and Mellado (2013) on teachers teaching natural sciences in the elementary phase indicates that those teachers have negative emotions based on teaching hard natural sciences. The findings revealed that teachers' low self-efficacy was based on the learners who are not active during teaching sessions in class. This is vital in this study as it

explores specifically the grade four NSTECH teachers' experiences in South Africa since there is low achievement in natural science studies (Reddy, Visser, Winnaar, Arends, Jaun, Prinsloo, Isdale, 2016 & Spaull, 2013b). The study might reveal more from what teachers experience when teaching NS which is integrated with TECH and this is done in EFAL.

Probyn (2015) states that in South Africa the overwhelming challenge of the language barrier in the classroom experienced by teachers and learners is not taken into serious account. The researcher views language barrier as preventing successful teaching and learning in the classroom. His research study was on the observation of teachers teaching natural sciences in the rural schools and in townships of Western Cape. Furthermore, Oyoo (2017) pioneered a research study based on challenges that are faced by SA high school teachers during the teaching and learning of physical sciences in English as a language of instruction. He also claimed that teachers explained natural sciences concepts with ordinary English words instead of using the specific natural sciences terms (Oyoo, 2017). Based on this data, there is a contradiction on whether SA teachers concentrate on developing the language usage rather than teaching the real content of the NS curriculum. It is therefore necessary to understand teachers' experiences as they are the drivers of the subject curriculum as they engage with EFAL grade four learners.

Okebukola, Owolabi, and Okebukola (2013) encourage teachers to use learners' local language in order to help learners master natural sciences concepts. They posit that, language of teaching natural sciences should symbolise the culture of learners to balance the demands of their home and the society at large. Therefore, there is a need for teachers to assist grade four learners to understand scientific knowledge by incorporating in their teaching the learners' contextual environment within NSTECH.

It is preferable that NSTECH should be taught by teachers who are subject specialist especially those in the early grades. This point is extremely vital to the understanding that when learners enter school, they possess informal knowledge and are still very curious about natural sciences (Luce & His, 2015). Van AalderenSmeets and Walma van der Molen (2015), Beni, Stears, and James (2017), Stears and Mpanza (2015), Nowicki et al. (2013) and Saka et al. (2013) recommend that natural sciences teachers and policy designers might manage the subject well by advancing learners with more scientific and technology skills.

The major focus for teachers in the classroom is to make efforts to create a magnificent journey in implementing curriculum knowledge and arouse interest amongst learners to proceed with natural sciences as a subject when they exit the primary school in SA (Narmadha & Chamundeswari, 2013). Therefore, grade four NSTECH teachers are to execute the CAPS curriculum for NSTECH with professionalism in order to plan and teach the content in a manner that will fulfil its targeted audience (Westbury, 2013). Grade four NSTECH teachers are laid with a task of translating for learners, from less contextualized English language skills attained by learners in the foundation phase to a more conceptualized and abstract language skill in NSTECH (Van Laere, Aesaert & van Braak, 2014). The success of the curriculum depends on teachers' commitment to increase learners' language skills while providing NSTECH knowledge and skills. An important fact to underscore in this study is that, it might raise other teachers' awareness of the subject so that they can adopt more suitable measures in teaching grade learners using English as a language of instruction (Zwiers, 2013).

Natural sciences in South African primary schools is taught by teachers who are not subject experts, although that cannot be ascribed to all NS primary teachers. Data indicates that most of the teachers did not specialise in natural sciences when they were training to be teachers previously (Bantwini, 2017; Bianchini, 2013; Clements & Sarama, 2016; James, 2012; Koh, Chai & Tay, 2014; Nowicki, Sullivan-Watts, Shim,Young & Pockalny, 2013; Ollerenshaw & Ritchie, 2013; Saka, Southerland, Kittleson & Hutner, 2013; Stears & Mpanza, 2015; van AalderenSmeets & Walma van der Molen, 2015). The mentioned researchers have each recommended that natural sciences should be taught by well-equipped teachers especially as they teach in the primary school.

The literature review attempts to provide valuable national and international benchmark information to intensify this study. It was also fundamental to gather literature on teachers' teaching natural sciences in other international countries. The following discussion will focus on literature concerning teachers' experiences in teaching NS outside of South Africa.

2.4.2 TEACHING NATURAL SCIENCES OUTSIDE OF SOUTH AFRICA

This section will capture teachers' experiences in teaching NS outside of South Africa. This information will be ideal to shape the researcher's understanding of how teachers teach NSTECH to EFAL grade four learners in SA. It will also assist teachers in SA to navigate teaching NSTECH to grade four learners and what teaching strategies can be used to teach NSTECH effectively.

Şahin (2014) states that in Asia, teachers acknowledge that learners come to school with acquired natural sciences information and concepts which they receive everywhere in their surroundings. Therefore, when natural sciences teachers teach learners, it becomes imperative to determine what learners know, and have previously understood and experienced about the topic (Harrell & Subramaniam, 2014). The benefit is, teachers are able to correct any distorted information and encourages them to explore more relevant resources which enriches teaching natural sciences. However, the study did not consider the learners' grade.

According to Andersson and Gullberg (2014), NS as a subject should begin at preschool. The researchers recommended that teachers have to teach and provide tasks to begin equipping learners with natural sciences vocabulary from preschool. Hence, providing a solid foundation of NS is paramount to learners and it will facilitate the teaching of new knowledge and skills in the next grade. Therefore, teachers in the intermediate phase would experience teaching learners who are familiar with NS as a subject and some concepts of natural sciences.

A study by Wilson (2013) conducted in the United States, revealed that natural sciences teachers required professional development to ensure that the subject is appealing to learners. The literature claims that the main NS curriculum implementers in the classroom, viz teachers and heads of department should accumulate appropriate skills, which will provide them with opportunities to develop sciences skills. Hence, this data might alert education stakeholders to collaborate and revisit the language of instruction in SA schools that will assist grade four teachers to involve learners cognitively in NSTECH.

An article by Luna, Rye, Forinash, and Minor (2015) indicate that in the United States (US) more instructional time in the curriculum is allocated to English Language Arts (ELA) and mathematics. The authors claim that increasing the teaching time of English that is the language of learning and teaching across all subjects will assist teachers to teach learners. According to Bradbury (2014), when teachers link natural sciences with EFAL content in the early years of learners schooling, there is a positive influence for NS teachers in the intermediate phase. Teachers use this information in order to determine their teaching strategies. In the interest of successful teaching as English is LoLT, it seems fair to develop learners' language as they use it to think and make decisions, as well as retaining and understanding the information they learn.

The teachers' success in teaching natural sciences largely depends on attending to the learners' curriculum needs. The current study is central to South African grade four teachers who teach

NSTECH as a combined subject to learners who are experiencing both the subject and English as a language of instruction for the first time.

2.4.3 TEACHING NATURAL SCIENCES AND TECHNOLOGY AS AN INTEGRATED SUBJECT

This section will focus on the teaching NS and TECH as an integrated subject. Literature in this section will provide solid information for the current study. Technology as a discipline is integrated with natural sciences to motivate learners to think creatively and to understand the link between activities in their natural world and be able to solve problems (Motshegwa, Wright, Sithole, Ngolwe & Morgan, 2018).

According to Ellington (1993), Yanez, Khalil and Walsh (2010) and Januszewki and Molenda (2013), education technology is the teaching method or a strategy that teachers employ to enhance educational knowledge or skills. Watson and Tinsley (2013) emphasised the combining of teaching and the use of technology in the classroom. Their recommendation was that, teachers require time to examine their teaching experiences. Hence, the study is providing such an opportunity for teachers to share their teaching experiences, opinions and feelings about the teaching of NSTECH to EFAL grade four learners.

The Education department for Sustainable Developmental (ESD) anticipated to reach their goals of developing the technology for the whole country by year 2030 in South Africa. Therefore, schools and districts supported the integration of natural sciences and technology in the intermediate phase in 2012 (Giordano, 2014). Hence, teachers accepted to teach NS and TECH as an integrated subject in South Africa to bridge the shortage of experts such as technicians (Ludger, 2015). According to Nielsen and Hoban (2015) teaching natural sciences infuses technology. The use of technological skills to prepare teaching aids or tools to clarify natural sciences concepts and information increase the quality of teaching and learning (Kim, Kim, Lee, Spector & DeMeester 2013; Eady & Lockyer, 2013).

Cobern (1996) stated that NS as a subject needed to be integrated with another subject which will widen learners' intellectual development. However, Anohina, (2005) warned that TECH include many abstract terms that teachers need to assist learners to understand. According to Ritchie (2013), teachers teaching technology must encourage learners to be innovative in generating new ideas that they will use to design tools to overcome shortfalls in the society. The researcher also

revealed that teachers also have a challenge in associating with the concepts of technology, which causes frustration in their teaching. In general, teachers are regarded as people who are able to make sense of the curriculum by interpreting and teaching it successfully (Barrow, 2015). NS and TECH should be taught by well-equipped teachers especially those in the early grades. This point is extremely vital to the understanding that when learners enter school, they possess informal knowledge and are still very curious about natural sciences (Luce & Hsi, 2015). Van Aalderen. Smeets and Walma van der Molen (2015), Beni, Stears, and James (2017), Stears and Mpanza (2015), Nowicki et al. (2013) and Saka et al. (2013) recommend that natural sciences teachers and policy designers might manage the subject well by advancing learners with more scientific and technology skills.

It is for this reason that CAPS assert that NSTECH teachers employ various teaching strategies including verbal explanations, written tasks, and projects as well as graphs to convey meaning to learners. Hence, these teaching strategies require that both teachers and learners can use English as a LoLT prudently with the purpose of NSTECH objectives (Tang, Delgado & Moje, 2014). Language of instruction challenges learners to perform well in natural sciences and even affects their problem-solving abilities in SA (Grosser & Nel, 2013). Hence, the researchers even challenge teachers' implementation skills whether they are professionally capable to prepare or support learners to learn new information. The National Sciences Foundation (NSF) refer to activities as multimodality, which caters for the improvement and modification to strengthen and solve any challenges that might arise during the teaching and learning of natural sciences through the inclusion of technology. Therefore, technology serve as a manmade object constructed to solve problems in natural sciences (Tang et al., 2014).

Bilingualism is often considered as the most conventional form of multilingualism, and it is argued that about 80 % of information can successfully be communicated in two languages (Kharisov & Kharisova, 2014). This study is motivated by the fact that NSTECH as an integrated subject is taught to grade four learners who experience English as LoLT for the first time. The study not only aims to provide teachers with teaching experiences in the classroom but also their critical sense of meaning and other extension strategies of communicating with grade four learners (Osborne, Simon & Collins, 2003). The exposure to English as LoLT in teaching NSTECH to grade four learners will form a detailed study. Indeed, according to (Stanley, 2013) the use of technology provides a stable growth of language that can assist in oral and written tasks in the classroom. The introduction of technology to some teachers means a paradigm shift because it was never there in

the previous curriculum. Hence, the main responsibility for teachers is to embrace NSTECH knowledge and provide effective instructional technological skills, which will make learners, develop mechanisms to cope with their developing world. Hence, the study deals with teachers' experiences in teaching an integrated NSTECH in EFAL to grade four learners. It is clear that these teachers are faced with a heavy task of ensuring that they present the new NSTECH curriculum effectively in EFAL that grade four learners were not familiar with as a language of instruction.

2.5 ENGLISH AS A LANGUAGE OF INSTRUCTION

One of the major transformative goals by the Department of Education (DoE) after 1994 was that all languages received an equal status in South Africa (Romaine, 2017). In recognition of learners' home languages, it was the primary objective for the department of Basic Education that teachers instruct learners in their mother tongue from grade one to grade three (Johnson, 2013). Hence, teachers from grade four were to provide effective teaching for the first time in English as a medium of instruction. The language of learning and teaching in the classroom is important as it is a mode to deliver the content of the curriculum successfully. Hence, a research study that will explore teachers experiences in using English as a LoLT to teach NSTECH to grade four learners to understand and to determine the strategies they use to teach content subjects in South Africa.

This research study anticipates a range of teachers' experiences from teachers who teach natural sciences which is combined with technology to learners who are taught in English as a language of instruction for the first time. Although the literature above considered the teaching of natural sciences and technology separately since NSTECH is a newly integrated subject with limited research thereof. As such, the focus in the study is based on exploring teachers' experiences in teaching NSTECH as an integrated subject to learners who are being taught in English as a language of instruction for the first time at grade four level. Thus, a challenge is to understand the power of the English language as it is used for teaching NSTECH.

2.5.1 TEACHERS' EXPERIENCES OF TEACHING IN ENGLISH AS LANGUAGE OF LEARNING AND TEACHING

English as a language of instruction is a primary tool that teachers use for teaching to grade four learners (Algeo & Butcher, 2013). However, English as a language of instruction causes challenges in South African classroom as it is not the learners' home language.

The issue of EFAL being a language of instruction from grade four is sensitive as it is regarded as one of the causes of poor translation of knowledge, which affects both teachers and learners (James, Garrett & Candlin, 2014). This causes much of the challenges, which are framed upon learners who have just transitioned from being taught in their mother tongue (Hoadley, 2012). The transition of learners from mother-tongue to EFAL as a medium of instruction hinders shared conversations between learners and teachers in the classroom (van Wyk, 2014).

However, according to Shrum and Glisan (2015), proper teaching in EFAL is being delayed in SA schools as it begins in grade four. English as LoLT in SA schools are only given much priority and more time allocation as it is used across all curriculum subjects from grade four to grade twelve (Leung et al., 2014). Due to the gap that learners experience in English as a language of instruction between foundation and intermediate phase, they are reported to reach grade four not fully ready in their English language skills (Larsen-Freeman & Long, 2014). Hence, according to Ovando and Combs (2018) teachers will be successful imparting knowledge in English as a language of instruction if learners are familiar and used to the language they are taught with at school. Kaschula (2013) prefers teachers to teach all subjects using learners' home language regardless of the phase at school. He further says that it promotes active learning in the classroom and teachers can quickly diagnose whether learners understand the new concepts, or they still require more explanation.

A key component is that even the language policy for the country in SA has recommended that English should become the Language of Learning and Teaching (LoLT) commencing in grade four (Larsen-Freeman & Long, 2014). Exploring grade four NSTECH teachers' experiences will identify the challenges and complement teachers' efforts. It might also contribute important language amendments through relevant programmes of assistance to NSTECH grade four teachers (Kini & Podolsky, 2016). Childs, Markic, and Ryan (2015) identified and described the importance of mastering language of teaching and learning in the sciences classroom. They argue that without learners basic proficiency in English as a learner's first additional language, teachers cannot convey sound knowledge of natural sciences and this will lead to inactive learners who cannot think creatively as the language has not been fully developed. They go on to say that the lack of sufficient English language impacts negatively on teachers who have to teach abstract natural sciences concepts to learners. In essence, grade four teachers are the first teachers to teach learners with a lack of proficiency in the English language, and as a result they still battle to decode during learning activities (Makoe & McKinney, 2014). Possibly, these teachers face the greatest

challenge when teaching the new NSTECH curriculum and using teaching strategies to translate English as a second language to learners.

According to Vygotsky (1978) and Christy (2013) in the theory of cognitive development, learners acquire the opportunity to learn new knowledge if their language skills have been   fully developed. In addition, a number of theorists like Brock-Utne (2014), Bunch (2013), James et al. (2014), Williams (2014), Lee et al. (2013), Pinter (2017), Marshall, Smart, and Alston (2017) and Zwiers (2013) acknowledge that the exchange of the language of instruction at school in Africa creates barriers for teachers during teaching and learning in the classroom. An international   research study by Ali (2013) concluded that a change in the paradigm of the medium of instruction among Malaysian students did affect learners' performance. Thus, it can be expected that grade four learners as they experience a new language of instruction can be faced by a wave of disconnection in the classroom (Childs, 2015). Also, Noom-Ura (2013) found that the use of English language as a medium of instruction among Thailand teachers created problems. This was because teachers were teaching learners in English language which is not their home language.

Whereas in South Africa, research studies conducted by Janks (2014) based on the effects of globalisation, diversity, and education; as well as studies by Makoe and McKinney (2014) on linguistic ideologies in multilingual South African suburban schools, concluded that a new language as a medium of instruction challenges teachers and has an effect of learners' performance. A study by Seabi, Seedat, Khoza-Shangase, and Sullivan (2014) on experiences of students regarding transformation in South Africa, also had similar findings. Another research in SA indicates that the education system is still failing to bridge the gap between the post-apartheid language and the existing school language (Jimenez, David, Fagan, Pacheco & Gonzales, 2015). To maximise any gaps that can be caused by English as a language of instruction and ensure that teachers teach at the best of their abilities there should be a platform where teachers share their challenges. As such, it is imperative that the study delves to understand the experience of grade four NSTECH teachers teaching EFAL learners.

Teachers are the foundation for a successful curriculum implementation. The success of the study will acknowledge and encourage the efforts that grade four NSTECH teachers make. It is for this reason that teachers who teach in English as their first additional language to EFAL learners require to be sensitised with professional development (PD) that will assist them to improve   teaching and learning (Noom-Ura, 2013). Improving quality teaching of EFAL teachers would assist them

to be motivated and be highly professional when they obtain English language skills (Richards, 2017).

However, successful teaching of content subjects depends on a dominant English language for most of all content subjects commencing from grade four. It is then essential to understand what the literature proclaims regarding the interaction between teachers and learners when they both engage in English as a first additional language during teaching and learning in the classroom.

2.5.2 LANGUAGE OF INSTRUCTION AFFCTS THE QUALITY OF TEACHING

The main priority for teachers is to teach learners to develop critical thinking skills, which require them to respond to their new subjects in English as LoLT (Magno, 2010). English as a language of instruction moves across all curriculum content subjects that teachers teach beginning from grade four. The language of instruction is indispensable as it connects the learners, teachers and the subject. The range of teaching strategies cannot have an effect if learners cannot use LoLT to connect with the new ideas. Poor development in the LoLT affects negatively quality of teaching in the classroom (Taylor & von Fintel, 2016).

The contradiction appears when teachers' language of instruction is different from the learners' home language. This impacts negatively on the learners' academic progress as they cannot use the concepts to deepen their understanding (Childs, 2015). At the same time, the failure of learners to actively participate in their own learning amounts to poor education. It is therefore not surprising that language inefficiency contributes to a large number of learners performing unsatisfactorily in all content subjects. It is for this reason that Heugh (2013) raises his concern about the equal status of all languages in SA. The problem is that teachers are still bound to teach in English, which is the learners' second language and assess with it through writing. Learners are also expected to answer with their second language without using their home language as it is also official. Pluddemann (2015) asserts that in South Africa it is still evident that there are unequal power relations when it comes to languages, as all content subjects and books are written in the English language. Therefore, language of instruction and books do not cater for learners to work independently which hinders their academic progress.

English as language of instruction is fraught with challenges, one can imagine the frustration and complications like pronunciation of concepts and limiting ideas which harm the second-language learners (Brock-Utne & Qorro, 2015). According to the UNESCO (2014), and Sibanda (2017), teachers should teach all content subjects in the learners' mother tongue in conjunction with EFAL from the beginning of primary school grades. This can result in promoting self-reliance learners in

grade four in terms of their vocabulary enrichment, verbal communication and the ability to construct sentences, which can lift the performance of all subjects (UNESCO, 2014).

It remains debatable what characteristics the African teacher should possess in order to successfully teach grade four learners to master EFAL so they can comprehend their subject content (Makoe & McKinney, 2014). Hence, it is important to explore teachers' professional knowledge, energy and vitality regarding the demands of teaching SA learners content subjects in EFAL. Literature further reveals that grade four teachers do not pay much attention to EFAL skills like reading which prepares learners for their subject content (Sibanda, 2017). According to CAPS, teachers must develop language skills during teaching NSTECH to grade four learners. As teachers are responsible for the purposive quality instruction to grade four learners who lack proficiency in English as a language of instruction and learning in order to achieve the objectives of the curriculum (Dearden, 2014).

Teaching learners to read in English is an instructional tool to assist learners to learn better, according to Hsu and Ou Yang (2013). For Braine (2013), the success of teachers in their teaching practice depends on teachers' home language, professional development, teaching strategies and how much the teacher is exposed to the language of instruction in his community. One of the major barriers in English as a language of instruction is that, any subject content has an unlimited number of abstract words which require the understanding of English in general (Hsu et.al., 2013). Learners are faced with a variety of new words, which are not frequently used in their society. These barriers are also aggravated if teachers are not the first speakers of the language of instruction and cannot use the language of instruction to plan the curriculum according to learners' level and use appropriate concepts. This means teachers differ in their teachings and even in their English language proficiency (Braine, 2013).

Literature works has repeatedly indicated that language of instruction is a pillar that teachers use for improving learner achievement and to strengthen communication relations during teaching and learning in the classroom (Park, 2013; Plüddemann, 2015; van Wyk, 2014; Weninger and Kiss, 2013; Zohrabi et al., 2012; Vygotsky, 1978). While, Barrow and Markman-Pithers (2016), Espinoza Jaramillo (2015), Lo and Lo (2014), and Msimanga and Lelliott (2014) draw us to the attention that, language of instruction can either contribute towards success or constraint in learning. Again, studies by Braine (2013), Chen (2013), Dang, Nguyen, and Le (2013) and Early and Norton (2014) found that communities do not fully favour the use of English as the medium

of instruction among non-English speaking learners, because they fear that, this will cause barriers to learners' successful learning.

A study by Levis, Sonsaat, Link, and Barriuso (2016) investigated effectiveness between native and non-native teachers when teaching in English in the classroom. The research study justified how teachers pronounced English concepts to learners in the classroom. The results of the study revealed that, the more non-native teachers are well developed in the subject they teach, as well as in the language they use for instruction, coupled with the ability to choose effective teaching strategies, the more they can offer the best teaching practices. The researcher further argues that English native teachers are at an advantage when teaching using English as a language of instruction as they are very fluent in the language, use the correct grammar and can employ a variety of words for explicit meaning.

According to Azian, Raof, Ismail, and Hamzah (2013) every teacher who teaches in English as a language of instruction requires to be equipped with teaching English language skills as well as the proficiency in the language. These skills will equip teachers to clarify and ensure proper teaching of the subject content in English as LoLT (Özgün-Koca & Şen, 2006). It is therefore critical that teachers develop themselves and the learners' efficiency in the English language to increase the important role of teaching and learning new knowledge of natural sciences (Cummins & Swain, 2014). Thus, bilingual learners have to master a variety of English language words to be able to understand concepts for natural sciences. However, being bilingual is somehow advantageous for both teachers and learners since two languages increase ones' cognitive skills (Baquedano-López, Alexander & Hernández, 2013).

Sadly, Ramnarain (2013) points that South African teachers teach learners who lack parental involvement in the education of their children. The researcher claims that parents are not taking full charge in assisting learners especially with English as the LoLT, which is not the learners' mother tongue. This negatively influences South African learners' results. According to Spolsky (2004) society too is responsible to develop the language competency of learners at school. This can be possible if parents and other businesses in society work along with teachers to overcome language barriers and meet the new educational demands. From the above perspective it is clear that, if social forces can collaborate when it comes to teaching by assisting learners with English as a second language, this will in turn have a productive outcome for all stakeholders (August & Shanahan, 2017). Pluddemann (2015) is of the similar opinion that parents and the school should engage in discussing matters regarding the best language of instruction for their learners for quality

education. However, as language policy still favours home language in the foundation, it would be wise if parents establish a mutual relationship with teachers to assist and encourage learners in a new language of instruction (Baquedano-López, Alexander & Hernández, 2013).

2.6 TEACHERS' SUBJECT KNOWLEDGE FOR ESTABLISHING SUCCESSFUL TEACHING

Contrary to the traditional curriculum where subjects were taught in isolation, teachers now have innovative and pivotal roles and responsibilities in an integrated curriculum in the achievement of educational practices for a curriculum such as NSTECH (Gecer & Ozel, 2012). The outcome of education is to advance curricula so that South Africa is on par with education systems and curriculum of leading countries globally, and implementation is a crucial aspect in guaranteeing a successful outcome (Oloruntegbe, 2013). Therefore, the essence of this section is the understanding of teachers' professional knowledge of the subject as it raises a major concern during teaching and learning in the classroom. The rationale behind this discussion is to provide consistency in the teaching of NSTECH in the primary schools. Teachers remain the main resource in teaching as they can develop quality lifelong learners (Criticos, Long, Moletsane, Mthiyane & Mays, 2009).

Teachers need to be equipped with the special knowledge of the subject they teach as it adds value and a strong focus on effective and meaningful teaching (Van der Berg, Burger, Burger, de Vos, du Rand, Gustafsson & Taylor, 2011). Correspondingly, Hoadley (2012) also suggests that teachers need to be armed with specific adequate knowledge and expertise which are aligned with the subject and the policy guidelines for their teaching. Possessing professional knowledge for the subject will equip teachers in demonstrating best practices for curriculum implementation. Competent teachers understand all aspects of the curriculum and are able to contextualise each topic according to the understanding of the learners they teach (Hoadley, 2012). Hamid, Shahrill, Matzin, Mahalle, and Mundia (2013) conducted a study based on a reciprocal relationship between subject teachers' enthusiasm and their qualifications. The study was conducted by matching teachers' qualifications with their mathematics learners' results in the primary school. The findings in the study indicated that the fundamental value of instructional discourse in the classroom largely depends on the teachers' adequate knowledge and his/her confidence in the subject.

Another study was based on grade eight learners who did very well in their assessments in Singapore (Shannag, Tairab, Dodeen & Abdel-Fattah, 2013). Learners' top results were also matched with their teachers' subject knowledge background, preparedness, continuous academic

development and their teaching experiences. The research showed that learners' good performances were associated with their teachers' subject knowledge rather than their qualifications. Hence, teachers' adequate subject knowledge emerged as a greater resource aligned with the best high achievement of learners' results.

A key component is that a sound teachers' subject knowledge overcomes any potential obstacles associated with teaching learners in the classroom. Teachers are to create a learning classroom environment that is appealing and encourages learning. Such literature review underscores the need to explore teachers' experiences between their level of competency and their understanding of NSTECH subject knowledge to EFAL grade four learners. Therefore, this current research study has the potential and means to navigate the essential data from grade four NSTECH teachers. Therefore, this study will provide the information that might imbue teachers with the power to be more accountable in their daily teaching practice of EFAL grade four learners.

Within the context of subject knowledge, research by Feza (2014) located that teachers' skills, knowledge and competences contribute towards teachers being significant in their academic performance in the school. The author emphasised that teachers should ensure that their social status, self-esteem as well as adequate knowledge of mathematics meet the required standard regarding teaching the subject. In Feza's findings, he emphasised that teachers should constantly verify and develop adequate knowledge of the subject they are teaching order to guide and direct their actions to select suitable methods and tasks that will increase learner's performance. Since the goal of teaching at a school level is to fulfil the objectives of the intended curriculum. Khoza (2015a) and Feza (2014) recommend that the department should attend to the issues of teachers' academic knowledge in the subjects they teach to eliminate learners' poor results.

Brookfield (2017) also agrees that teachers' adequate knowledge of the subject is the key to equip them with skills and strategies to accommodate learners' abilities and to respond to their needs. The researcher extends his argument by adding that teachers' professional knowledge of the subject promotes teachers to apply prompt decision-making based on other general knowledge that will be sufficient for progressive implementation of the subject. Furthermore, Cavanagh and McMaster (2017) adhere to addressing teacher capacity in obtaining professional knowledge of the subject. These scholars also made it clear that teachers need a solid understanding of a subject, so that they can plan their lesson topics mindfully using other relevant alternatives to make it more explicit to learners as per their needs. The research confirmed that when teachers have a sound knowledge of

the subject curriculum, they become flexible, confident and can capture any challenges prevailing in the essence of the subject they teach (Catling, 2014).

Through the literature, it has been noted that there is a significant potential need for primary schools to allow teachers to teach according to their specialisation of subjects. When teachers develop their subject proficiency, they become professional teachers who master their subject, eager to teach and always look for the best interest of the learners. This may address some of the challenges regarding the teaching of the content subjects and increase the efficacy aligned with English as the language of instruction.

2.7 TEACHING STRATEGIES TO ENGAGE MORE DEEPLY WITH NSTECH CURRICULUM CONTENT AND EFAL

This section focuses on the role of strategies that teachers employ to improve their teaching performance. Gathering this data is important to strengthen the current study by exploring strategies other teachers use in teaching subject content using English as a language of instruction. Teaching strategies are to co-ordinate the language of instruction and the subject content, and assist teachers to teach learners to attain the relevant knowledge and skills in the classroom (Cohen, 2014).

Martin (2012) and Richards and Rodgers (2014) argue that teaching in the classroom can be a very exciting or frustrating experience. This includes a responsibility that teachers have to collaborate many domains to create an effective classroom environment for productive academic outcomes for learners. While all domains are important, it can be a tricky situation if the language of teaching and learning is not familiar in the classroom. The success to make an improved teaching performance is when teachers are able to deliver the content knowledge employing suitable strategies to fulfil its objectives and increase learners' abilities and creativity (Stronge, 2018). It is for this reason that Cohen (2014) endorses that the success of the lesson depends on the strategies that are chosen by the teacher.

Choosing teaching strategies is a complicated task as it is accompanied by teaching experiences, personal skills and accountability for teachers (Pachler et al., 2013). Rohaan, Taconis, and Jochems (2012), in their work maintain that teachers have to possess the adequate subject knowledge, knowledge of learners' language background and be empathetic towards young learners in order to choose the relevant teaching strategies. Without range of these pedagogical skills, these researchers claim that teachers cannot choose and use strategies that best assist them to convey

valuable meaning of the content. Hedgcock and Ferris (2013) claim that teaching strategies employed by teachers who teach in English as a language of instruction are defined in terms of their relationship with the subject content that is taught in the classroom. Teachers have to decide on the resources that will be used in the classroom in order for learners to use EFAL to gain insight of the subject.

Tarone, Gass, and Cohen (2013) mentioned six effective teaching strategies used by teachers when teaching content subjects using English as LoLT. These are the following strategies that they mentioned: retrieval strategy, copying strategy, communication strategy, cover strategy, behavioural strategy, and memorisation strategy. In the next paragraph, each strategy is explained to emphasise its effectiveness:

Retrieval Strategies are used by teachers when they want to check whether learners can remember what they were taught through asking questions. **Copying Strategies** allows learners to make connections with the content through various ways, either by making simplifications or re-writing the work. **Communication Strategies** assists teachers and learners to convey academic and non-academic messages in the classroom. Teachers can assess whether learners master the content, or they are still struggling. When learners have gained the skill of expressing, they become fully engaged to the lesson that is taught in the classroom. Teachers can then equip learners using the **Cover Strategies** if they realise that learners have not fully mastered English as LoLT. Learners are taught to ask for help or utter one word that could be in line with the content learned. **Behavioural Strategies** offer teachers a chance to improve their teaching practice as they observe the behaviour of learners during a lesson presentation. The last strategy is when teachers use **Memorisation Strategies** to enforce learners to master concepts with an aim of memorising them as they read. Teachers might write the words on the charts and display them in the class for learners to learn them. These are part of the vital strategies, which give opportunity to all learners to reveal what they have been taught (Tarone et al, 2013).

Through the **inquiry-based teaching strategy**, teachers allow learners to be the main inquirers, which boosts their self-esteem and sustains their NS knowledge (Hassard & Dias, 2013). Learners are involved in a variety of NS and TECH activities with an aim of encouraging them to exercise their cognitive abilities for new inventions (Abdi, 2014). The inquiry-based teaching relates with Problem-Based Learning (PBL). According to Savery (2015), PBL also allows learners to perform scientific activities individually without the teacher providing any knowledge of the outcome.

Learners discover knowledge and extend to new concepts (Glynn, 1991).

According to Council (2000), inquiry methods cannot serve to equip learners with the communication skills, but they are effective with scientific content knowledge. Therefore, the research has questions about inquiry whether it is able to fulfil the curiosity of young learners who still need to enquire by talking and asking questions and present before solving a problem through designing. However, Gillies and Nichols (2015) indicated that primary school natural science teachers face challenges using an inquiry-based teaching strategy. Consequently, most primary science teachers have insufficient science knowledge and lack skills for using the inquiry-teaching strategy.

Chiang, Yang, and Hwang (2014) state that using Mobile Teaching Devices (MTD) is an appropriate teaching strategy teaching NS. MTD uses teaching devices like Geographic Point System (GPS). Teachers were to instruct learners to use GPS. According to Chiang et.al. (2014) MTD increases learners' interest in NS and TECH and support effectively the inquiry-based strategies. Teachers are able to show reality versus pictures during teaching and learning in class. Though the study was conducted internationally where teachers were using MTD, the researchers indicate that learners showed great success in their pass rate. According to the current research, the researcher feels this method can be challenged by the financial costs in the schools where these technology devices cannot be afforded. In addition, parents cannot afford to provide such expensive devices for their learners because of economic challenges.

Byram and Hu (2013) and Tarone et al. (2013) conclude that teaching strategies has to be appropriate with learners' age. Therefore, teachers have to be wise and consider learners level of development, language barriers as well as the learning styles when choosing a teaching strategy.

2.7.1 CODE-SWITCHING: BRIDGING THE LANGUAGE BARRIER

The intention of this section is to alert the reader to the strategy of code-switching accompanied by its core features of utilising it in the classroom. Code-switching as an approach that teachers use to transfer subject content knowledge in a language that learners understand better (Sturmer, Konings & Seidel, 2013). This means that teachers can divert from using the main language of instruction to other languages with an aim of developing leaners towards curriculum goals. Since all languages received equal status in a democratic SA in 1994, this approach is more than welcomed (Romaine, 2017). Code-switching revolves around the fact that teachers need to be involved in a dialogue between learners and themselves in a classroom.

Teachers resort to code-switching in the classroom with an aim to make English abstract concepts more explicit. Misunderstanding caused by language barriers between teachers, learners and the subject content block the clear teaching and learning in the classroom (Auer, 2013). Therefore, code-switching creates a more meaningful teaching and learning situation and creates a sense of transparency in the classroom. Code-switching as a strategy aims at putting clarity to any misconception learners might have during teaching and learning sessions (Modupeola, 2013). Code-switching makes it possible for teachers to transform the language of instruction to be accessible to learning rather than a teaching resource for the specific subject content (Janks & Makalela, 2013). This allows teachers and learners to have a flow of information and increase communication levels, which would have been blocked by misunderstanding caused by the language barrier. Literature from Chivhanga and Chimhenga (2013), Dearden (2014), Lo and Lo (2014), Nyika and Van Zyl (2013), Msimanga and Lelliott (2014), Sefotho and Makalela (2017) insist that 'code-switching' decreases pressure among teachers in that teaching becomes more interesting and encourages a feedback process from learners. From the previous studies, it is clear that code-switching develops an essential skill when there is a language gap.

According to Yeong and Tan (2014), another code-switching strategy to ease the language barrier is Language Identification (LID). This strategy analyses language words in written text or in speeches. Hence, the researches separated LID into two functions: Intracentential and Intersentential code-switching. Intracentential works by code-switching one word in the whole text while intersentential code-switching includes the whole sentence. However, this code-switching is not very easy and the use of multi-structural word information fast gives more clarity (Yeong et al, 2014). Multi-structural word information teaches learners to understand even what punctuations mean in a text or syllables and encourage the ability to pick any abstract words for meaning. Gardner-Chloros and Weston (2015) resonate with Yeong & Tan (2014) that code-switching happens in different contexts which are: oral form, conversation form and written form. They agree that there is co-ordination across each form of code-switching. Kummerling-Meibauer, (2013) also extends code-switching to pictures. He states that the language or concepts that describe the pictures must relate with the viewer to make meaning. Hence, code-switching in using words that will co-ordinate the real meaning of the picture will help learners with explicit meaning. This will assist in making sense of the subject matter and relevance of the picture.

Code-switching as a strategy lies with the teacher in the classroom, who has to primarily understand the learners' language barriers and code-switch where it is appropriate to promote the understanding of the literature. Code-switching unveiled more productive strategies to deal with the language barrier to minimise teaching and learning difficulties.

2.7.2 TRANSLANGUAGING

The main aim of this section is to discuss the notion of translanguaging to convey meaning to the curriculum. In relation to discourse, translanguaging creates a platform that empowers teachers to have a wider vision and a broad knowledge of conceptual and analytical skills for deeper meaning making (Garcia & Wei, 2014). Translanguaging moves across code-switching between languages to a variety of languages to translate meaning (Childs, 2015). Translanguaging relates to this study to understand what teachers' experiences are when implementing the NSTECH curriculum to grade four EFAL learners. The framework draws on the relationships that exists between Translanguaging and teachers' experiences.

According to Garcia and Wei (2014), teachers have to avoid unnecessary pressure regarding language barrier amongst language usage in the classroom. The main priority is to allow all learners to grasp content knowledge of the lesson rather than to suffocate with the language of instruction. In other words, teachers using translanguaging concentrate on "deeper understanding rather than just translating words since it moves from parallel words to processing and relating meaning and understanding" (Williams, 1996, p. 644). Multilingualism in South Africa manifested the equal status of all languages after the apartheid era (Republic of SA 1996). Therefore, translanguaging will support all learners without discrimination, which is a true meaning of a democratic country. It also operates with a multitude of components rather than the common practice of code-switching which might be a solution to the language challenges in the classroom (Madiba, 2014). Translanguaging creates a class where teaching and learning is within everyone's jurisdiction (Makalela, 2014).

The freedom of exchanging all languages establishes a broad and meaningful understanding of the subject content, compliments well with learners adjustments to the first additional language, establishes relations between learners social background and school, and serves as an integrated approach to develop new learners with proficiency in the language of instruction (Beres, 2015; Banda, 2018)). Thus, teachers can reap positive results regarding what is called regulative registers and instructional registers. Beres (2015) describes regulative registers as any language preference to

promote or illuminate positive objectives for teaching and learning. While instructional registers are any language alternative used for specific content, this strategy allows a smooth flow of all languages in the classroom during teaching and learning in the classroom. Banda (2018) cited that language of instruction in SA is the major cause of deteriorating results in schools. This affects even teachers, as they cannot meet their teaching objectives. The study is also concerned about the issue of the language of instruction to grade four learners which learners are introduced for the first time.

However, despite the possibilities the real breakthrough for translanguaging as a teaching strategy depends upon the teachers' experiences in the classroom (Demm, 2016). It is impossible that teachers can understand a variety of languages in a multilingual class, but they can exhaust a range of strategies to deliver meaning to learners (Herrera, 2017). However, the selection of teaching strategies through teachers' efforts will always yield fruitful rewards as miscommunication impedes subject content knowledge (Kafata, 2015). It will always be a misfortune that any LoLT creates a barrier towards the success of the education of an African child (Babson, 2014).

2.8 WHAT UNDERPINS NATURAL SCIENCES AND TECHNOLOGY TEACHERS TOWARDS THE SELECTION OF THEIR TEACHING STRATEGIES?

The main aim for teaching NSTECH is to develop both natural scientific and technological literacy that will equip grade four leaners to participate fully in their society as it is envisaged in the CAPS in 2012. The purpose of this section is to understand what makes teachers choose and employ their teaching methods when teaching natural sciences (Hodson, 2014). Teachers' relevance in their teaching methods and approaches suggests learners' quality education (Hoadley, 2012). It is without a doubt that teachers have a significant role in feeding learners' mind with educational knowledge (Tharp & Gallimore, 1991; Ward & Roden 2016).

The essential goal for the natural sciences curriculum is to equip learners to be able to use scientific knowledge to ask questions and interpret their findings before they reconstruct solutions using technology (Tandogan & Orhan, 2007). Therefore, teachers who are enthusiastic about NS choose teaching approaches and design that enhances learners to use scientific knowledge to perform practical tasks (Laurillard, 2013). Teaching natural sciences as part of the curriculum is rooted in multi-perspective strategies that include inquiry-based teaching, learning-for use model, problem-based learning and mobile teaching devices. These strategies will be discussed in terms of the meanings they have since they are attached with the teaching of NSTECH and EFAL. Hence, teachers' methods and approaches in teaching natural sciences predominate in assisting a young

learner in his/her journey of finding answers to questions in his/her natural environment. Bruna, Vann, and Escudero (2007) accepted the idea that language plays a huge role in teaching and learning the natural sciences.

Human beings are always curious to find answers and natural scientists are also keen in searching for answers. Therefore, without teachers choosing appropriate teaching approaches and inculcating correct methods that will be used by learners, it will be impossible for learners to find answers and satisfy their curiosity. The combination of natural sciences and technology seeks opportunities so as to achieve excellent results. Ward and Roden (2016) argue that the priority of teaching science is to increase learners' knowledge in all possible ways.

These were the fundamentals for teachers in choosing the methods and approaches in science teaching: It is better to teach learners to perform science tasks using the correct methods and approaches, than to teach facts and theories that were confirmed by other people (Abdi, 2014). Teachers must be able to engage learners in the topic of the lesson in order to encourage them to be active participants. It can, therefore, be assumed that a major teaching method of teachers in maximising the teaching of natural sciences and technology is inquiry-based teaching. This research study is to explore strategies teachers employ towards achieving objectives during teaching NSTECH.

2.9 TEACHERS' EXPERIENCES UNDERPINNED BY PEDAGOGICAL CONTENT KNOWLEDGE (PCK) AS A CONCEPUAL FRAMEWORK

Exploring grade four teachers' experiences in teaching NSTECH to EFAL grade four learners will be underpinned by Shulman's (1986, 1987) Pedagogical Content Knowledge (PCK) theory. Shulman (1986) developed PCK to assist teachers to explore their teaching practices. The focus was on developing teachers to discover what knowledge they possess about the subject, learners and their inputs that would equip them to successfully impart knowledge to learners. PCK is parallel to this study as each grade four teacher will narrate his experiences and strategies around teaching NSTECH to EFAL grade four learners. There is a deep vital engagement with teachers' subject content that influences their teaching strategies used to implement the curriculum, and with the learners during the process of teaching and learning (Shulman 1987; Geddis 1993; Loughran, Milroy, Berry, Gunstone & Mulhall, 2001).

According to Shulman (1986, 1987) and Grossman (1990), PCK has four components, which are all an immediate concern for every teacher. These are as follows:

1. Interpretation of the curriculum towards teaching the subject content to achieve goals and objectives of the subject;

2. Understanding of the subject content knowledge and topics to be taught accompanied with resources to be used;

3. Being understanding of learners' academic background, learning barriers and the language of instruction and

4. Selection of the teaching strategies that are appropriate for the learners.

Each of these areas relates to teachers' teaching experiences in the classroom (An, Shuhua, Kulm & Wu, 2004; Ball & Thames, 2008). PCK as a conceptual framework is aimed at creating a platform where the researcher will map data gathered against the precise teachers' professional competences. PCK in this study is used to answer the research questions, and to gain an understanding into the implementation of NTECH to second language grade four learners. Shulman (1986) allude that it was good that teachers were given a chance to vent out and share their valuable teaching experiences. Therefore, PCK works well with understanding teachers' experiences when teaching NSTECH to EFAL grade four learners.

The best interest of learners lies on the instructional core of teachers in the classroom. Hence, the innovation of PCK was a kind of intervention with an aim of sustaining and improving teaching and learning. According to Shulman (1987), the real challenge is that teachers only possess the knowledge to teach without the necessary knowledge of the subject they teach. In such circumstances, the quality of teaching in its holistic form is compromised.

2.9.1 RELATING PCK TO TEACHERS EXPERIENCES

According to Shulman (1986), teachers' lack of adequate content knowledge in the enacted curriculum is the impediment that hinders effective teaching. While NSTECH and English as LoLT is new to grade four learners in SA public schools, teachers are still expected to teach to the best of their ability, and they are accountable for learners' results.

Noteworthy, is the conception that teachers' play a crucial role in the classroom and this is meaningfully grounded by their experiences instituted in the conceptualisation of teaching, learning and training by the school and teachers (Comas-Quinn, 2011). It is problematic to envisage the bearing of curriculum change on teachers as they try to modify their pedagogy to meet the requests of the changing curriculum and overcome the increasing pressure on implementation of such a curriculum (Scholtz et al., 2004). Teachers require support in adapting to curriculum changes, so they are best able to meet the requirements of the classroom and learning contexts in

which they teach (Scholtz et al., 2004). Curriculum is said to shape the professional growth of teachers and is shaped by the results of professional growth. Therefore, if teachers attain appropriate training to implement the NSTECH curriculum in teaching grade four second language learners, it can be conveyed and acknowledged by learners' and teachers in a constructive way.

In spite of teachers' unsurpassed intentions to implement the NSTECH curriculum successfully, it is most often inadequate due to their unpreparedness to properly implement the subject; lacking knowledge, skills and understanding when teaching, which in turn stifles the NSTECH model (Dowden, 2014). Teachers within South African schools agree on the possible benefits from the Department of Education addressing the dearth of professional development afforded to teachers' and the development of favourable teaching and learning environments (Chigona, 2010). In a study conducted in a New York university, pre-service teachers indicated insufficient training for the implementation of an integrated curriculum, however, once prepared, these teachers were forthcoming and displayed a confident attitude (Zhou & Kim, 2010). Hence, the necessary training and support offered to teachers could enhance their experiences and be beneficial to the implementation of NSTECH.

With NSTECH and teachers having to teach an integrated subject to grade 4 EFAL learners, teachers now teach outside their subject specialisations leaving lessons dominated by non-practical, information-rich lessons. For NSTECH to be effectively implemented, sufficient preparation for teachers is a prerequisite. However, teachers in the Intermediate Phase of schools are allocated to teach subjects that they are not qualified to teach, which additionally hampers the success of implementing NSTECH (Harrell, 2010). This questions teachers' PCK, which eventually resorts to teachers coping when teaching NSTECH rather than implementing the subject for its intended purpose of acquiring lifelong learning and allowing for social transformation through integration (Department of Education, 2011). Consequently, teachers display a low morale and in turn become vulnerable when implementing NSTECH as they are insufficiently equipped with the pedagogical skills to effectually teach a subject such as NSTECH (Chigona, 2010).

PCK offers the opportunity for all teachers even new to the profession to unpack their teaching experiences of the curriculum (Kind, 2014). PCK will enrich this study, as experienced and new teachers will provide new and innovative data for teaching an integrated NSTECH curriculum. The data will be covering the most important domains of teaching, which are the curriculum, learners, subject content and teaching strategies. The theory will raise important issues regarding strategies

and approaches that teachers employ when teaching NSTECH to EFAL grade four learners. PCK and data from the grade four NSTECH teachers on their experiences is essential to build the foundational analysis from other teachers' experiences (Shulman, 1987). According to Gudmundsdottir (1990), PCK stretches from the content knowledge to the values that teachers possess which promote the enacting of the curriculum. Thus, PCK framework is aligned in exploring teachers' experiences of teaching NSTECH to EFAL grade four learners.

A number of theorists like Appleton (2003), Van Driel and Berry (2012), Gudmundsdottir (1990), Gess-Newsome and Lederman (2001), Grossman (1990), Loughran, Berry, and Mulhall (2012), Nilsson (2014), Shulman (1986), Voogt, Tilya, and van den Akker (2009) and Zeidler (2002) have pointed out that PCK theory prioritises the teacher as having the right degree of central control in using the curriculum content and establishing methods and procedures to enhance and develop learners' knowledge. The findings of the above research studies attribute that teachers' PCK contribute towards successful teaching. Shulman's theory purports to equip teachers with the understanding of their subject, so that they can plan their lesson topics to cater for the interest of learners (Guzey & Roehrig, 2009). Similarly, Mecoli (2013) noted when he explored PCK as theory to understand the synergy between learners' knowledge, language of instruction, teaching strategies and curriculum knowledge.

Therefore, PCK will manifest in a deep and widening study of grade four NSTECH teachers' experiences that will each indicate their strengths and vulnerability when enacting the curriculum in EFAL. Shulman (1986) PCK, still has a major role in strengthening the capacity and effectiveness of NSTECH teachers. With the aim of gaining a deeper understanding, the use of PCK will enable the researcher to analyse NSTECH teachers' experiences. PCK will also orientate teachers' strategies in terms of whether they are able to form a link between English as a language of instruction and the knowledge of the subject.

Teaching in general is rooted in a number of multi-perspectives and acts to successfully impart learners with knowledge (Buzzelli & Jonston, 2014). Therefore, grade four NSTECH teachers must be able to develop a deep understanding of their teaching profession. Teachers as NSTECH curriculum implementers in grade four qualify to teach in the best interest of the curriculum goals, in spite of learners limited English language vocabulary (Mecoli, 2013). PCK is the fundamental knowledge that NSTECH grade four teachers must attain towards the success of their teaching.

2.10 CONCLUSION

The purpose of this chapter has been a reflection of the relevant literature with regard to teaching experiences in teaching natural sciences and technology to second language English speaking learners. It also acknowledges fundamental elements of English as a first additional language used as a medium of instruction. The chapter also discussed PCK as the conceptual framework for this study, and it draws on the pivotal teachers' experiences regarding the teaching of NSTECH to EFAL grade four leaners. The theory will increase a better understanding of how South African teachers use English as a second language to teach integrated subjects. The next chapter will document the research design and methodology with an alignment to exploring teachers' experiences of implementing the NSTECH curriculum to EFAL grade four learners.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 INTRODUCTION

The previous chapter dealt with the literature review that is at the centre of this study. It has been important to study and provide context literature with reference to what other teachers have practised in the classroom. This chapter will narrate the research methodology and data gathering methods that were employed in the execution of the research determined by the objectives of this study. For the success of the study, multi-perspective research methods were chosen and defined (Flick, 2015). In order to respond to the rationale and meet the objectives of the study, different techniques of research such as the research paradigm, methodology, sampling and selection of participants, data generation, trustworthiness and ethical issues, with the purpose of making sense, will be clearly defined with their functions and responsibilities (Denzin & Lincoin, 2011).

Stemming from the work of Punch (2013), a paradigm is a strategy chosen by the researcher to accomplish the research venture. While Mackenzie and Knipe (2006) and Creswell, Plano Clark, Gutmann, and Hanson (2003) believe a paradigm is a 'set of beliefs based on that particular phenomenon'. Hence, the main research paradigm of this study is the interpretive research paradigm. Much discussion on the paradigm with reference to the teachers' experiences of teaching NSTECH to EFAL grade four learners will be analysed.

3.2 QUALITATIVE RESEARCH APPROACH

The study would not be successful without the researcher engaging fully with four NSTECH grade four teachers for rich data gathering. Schurink (2009) acknowledges that qualitative researchers need to be fully prepared when going to gather data from the participants as they might face different attitudes. Emphasis on the qualitative approach is that it draws thick responses from face-to-face interactions with participants and that is why the researcher opted to interview teachers teaching NSTECH to EFAL grade four learners (Goldkuhl, 2012).

Personal interaction with each teacher resulted in the gathering of quality data. The main advantage is that researcher listened to the participants' concerns, observed attitudes and behaviours as well as reflected on their culture (Niewhuis, 2007). The researcher transformed the raw data from teachers into meaningful sense by coding it into different themes (Creswell, 2013). The research interpretivist paradigm attributed towards a positive decision during data analysis (Thanh & Thanh,

2015). Rich data was gathered by balancing the same questionnaires and semi-structured interviews conducted on all four teachers (Erlingsson & Brysiewicz, 2013; Rehmat & Bailey, 2014).

Mertens (2014), and Merriam and Tisdell (2015) support the gathering of data using different participants. The adequacy of different teachers is that each participant gave an account of their personal teaching experiences in the classroom (Mayer, 2015 & Smith, 2015). Visiting participants in different schools facilitated the gathering of interrelated experiences from each participant (Eisner, 2017). This is advantageous to the qualitative researcher as the information is genuine (Berkowitz, 2013). In other words, there is quality data, which matches the researchers' projections in answering the two research questions.

This study made use of a case study design as it involved a real-world phenomenon that comprises of a detailed exploration of Intermediate Phase grade 4 teachers' experiences of implementing the NSTECH curriculum. The case study is based on real life experiences of teachers as they implement the NSTECH curriculum to grade four EFAL learners, allowing the reader to see the situation through the experiences of the participants. Case study designs make use of questionnaires and interviews in order to afford in depth account of the phenomenon; which is the experiences of teachers who implement NSTECH to grade 4 EFAL learners. This case study systematically provides a thorough analysis of the data, generated through in-depth descriptions rather than generalisations, thereby allowing for entirety and truthfulness of the study with particular focus on understanding teachers' experiences of events to reveal the depth of the case (Yin, 2013). The boundaries of this case study are confined to four schools located in KwaDabeka Township under the Pinetown District.

3.3 INTERPRETIVIST RESEARCH PARADIGM

The interpretivist research paradigm is most suitable for qualitative data gathering. The interpretivist research paradigm provides an opportunity to gather genuine lived experiences from the participants from people in their usual settings (Cohen et.al, 2007). The researcher then had a better chance to ask questions that would allow a meaningful understanding about teachers' experiences of teaching NSTECH to EFAL grade four learners. All data gathered from each teacher chosen in the study was integrated and every opinion related to the study was analysed (Goldkuhl, 2012; Thanh & Thanh, 2015). Any assumptions gathered by the researcher during the interviews and answering of the questionnaire were not part of the analysis (Katz, 2015). Interpretive research paradigm made the

researcher meet the objectives of the study through gathering rich data from participants during their interviews (Maxwell, 2012). That is, the findings were interpreted with the focus on teachers' experiences when teaching NSTECH teaching with English as a language of instruction.

The interpretivist approach was worthwhile as it facilitated understanding teachers' responses (Bertram & Christiansen, 2014). Thus, this suggests that the researchers' views are not intended to shame or exaggerate teachers' performances but to provide the reader with true evidence of the teachers' experiences and classroom practice of implementing the NSTECH curriculum.

3.4 SAMPLING

A set of four grade four NSTECH teachers who teach in English as a language of instruction in public schools were the intended participants for the study. They were specifically chosen as a small sample within a specific context (Acharya, Prakash, Saxena & Nigam, 2013). The researcher decided to select four teachers for the study as they were to provide a wealth of data, which in turn provide insight that will answer the research questions (Bertram et.al, 2014; Padilla-Díaz, 2015). These teachers are special because they are teaching NSTECH as an integrated subject to EFAL grade four learners (Etikan, Musa, & Alkassim, 2016). Interested teachers willingly availed themselves to participate in the study. It is imperative to choose and work with a sample of teachers who are interested to share their experiences and become part of the study. It was recognised that some participants may be hard to reach which might lead to insufficient or distorted data gathering (Orcher, 2016). Hence, the selected teachers were a purposive sample chosen from the larger population of grade NSTECH teachers teaching EFAL grade four learners (Oppong, 2013).

Purposive sampling allows researchers to exercise a degree of control as they can only use those participants suitable for the study and who are they think are able to sufficiently answer the research questions (Flick, 2014). In the quest to accomplish the current study, using purposive sample is advantageous, as participants will reveal their reflective experiences without any fear of conflict with their superiors since the conversation is between the researcher and the participants. That meant gathering the in-depth data from teachers teaching NSTECH to EFAL grade four learners. Ritchie, Lewis, and Elam (2013) and Creswell and Clark (2017) recommend the choosing of a sample that poses the true representation of the study that is conducted.

The exception of using the purposive sample is when a researcher become biased in making generalisations (Acharya et al., 2013). In order to control the kind of bias that is an obstruction to

the quality of the data gathered, the researcher concentrated on the important elements of the study without personal inputs (Roulston & Shelton, 2015). By understanding the position of being a researcher and not that of a dictator in the study through making assumptions, the sample used is in a better position to give the required information (Montibeller & Von Winterfeldt, 2015). Setting the objectives of the research study from the beginning of data gathering shaped the tone and assisted in focussing the researcher (Israel, 2014).

Table 1 below reflects the biographical information of the four chosen sample of teachers who were participating in the study. The information indicates that all teachers were qualified in their teaching profession. That is confirmed by the number of years in the teaching career except for one teacher with the least number of years in the teaching profession. Thus, the challenge is the number of years in teaching NSTECH as an integrated subject to EFAL grade four learners. All of the four teachers were African teachers with IsiZulu as their home language.

Table 1: GRADE FOUR NSTECH TEACHERS'BIOGRAPHICAL INFORMATION

Teacher	Gender	Age	Number of years in teaching NSTECH	Highest Qualification	Number of years teaching	Home language
Mbally	Female	42	2 years	Honours Bachelor of Education	2 years	IsiZulu
Cindy	Female	46	5years	Advance Certificate in Education	21 years	IsiZulu
Sanele	Male	48	4 years	Honours Bachelor of Education	10 years	isiZulu
Bussy	Female	50	5 years	Honours Bachelor of Education	30 years	IsiZulu

3.5 DATA GENERATION INSTRUMENTS

The study uses four instruments for data gathering (Guthrie, 2010). These are questionnaires and semi-structured interviews, follow-up contacts and field notes. This permitted participants to implore and understand information without restrictions (Yin, 2011). Semi-structured interviews and questionnaires were used to acquire knowledge, beliefs, preferences and attitudes about teaching NSTECH to grade four EFAL learners (Creswell, 2009). The data generation instruments were used to obtain information as stated by the research objectives and providing the results of the study thereof. The use of semi-structured interviews also aided the researcher to probe for information and authenticate the data gathered from the questionnaires.

Hence, the questionnaires and semi-structured interviews became the major instruments for exploring and gathering teachers' experiences (Scott & Morrison, 2006). Furthermore, the variety of data gathering instruments will enhance the study in attaining validity (Cohen et al., 2007). It is important, however, to understand that all participants were treated with respect and kindness during data gathering as they were to provide important data for the study (Merriam & Tisdell, 2015). The teachers experiences when teaching NSTECH to grade four EFAL learners as established from the interviews and questionnaires will therefore provide invaluable feedback on teachers' experience implementing an integrated NSTECH curriculum within a South African classroom.

3.5.1 QUESTIONNAIRES

Although questionnaires are naturally intrusive instruments that delves into the lives of participants within this study, participants were given an informed consent letter, which communicated their acceptance and preparedness to take part in this study whilst assuring their anonymity (Cohen et al., 2007). Issuing of the same questionnaire in a written paper gave the opportunity for each teacher to grasp the real objectives of the current research (Wilcox & Keselman, 2012). Questionnaires served as the initial data gathering method with questions based on exploring teachers' experiences in teaching NSTECH to EFAL grade four learners. Each teacher freely responded without pressure in answering the questionnaire before the in-depth interviews (Romm, 2013 & Zohrabi, 2013). The questionnaire had closed- and open-ended questions that the participants were able to understand, and they were able to provide straight forward responses and their own views freely (Friborg & Rosenvinge, 2013; McGuirk & O'Neill, 2016). The questionnaires and interviews for each participant made it easier for the researcher to be able to acquaint herself with the data collected from the questionnaires and interviews, and to analyse and categorise the data into themes that emerged (Friborg & Rosenvinge, 2013; Wilcox & Keselman, 2012). As the participants were

responding to the questionnaires, the researcher was available so she could help clarify questions in case there was a need (Dörnyei, 2014). The first part of the questionnaire was about teachers' biographical information. Teachers' biographical questions were provided for a better understanding of how the various themes were developed.

Biographical information in the questionnaire was followed by questions relating to teaching NSTECH to EFAL grade four learners. That was to heighten the sentiments in exploring teachers' experiences of teaching NSTECH to EFAL grade four learners (Wilson, 2017). It was noted that all teachers responded comfortably without the any challenges. The following section discusses the second data gathering instrument, that is, the semi structured interviews.

3.5.2 SEMI-STRUCTURED INTERVIEWS

The interviews are a flexible data generation tool and an instrument where the researcher and participants meet and chat to each other for the purpose of understanding each other by exchanging views on a topic of common inerest (Cohen et al, 2011). During the in-depth semi-structured interviews, the researcher had face-to-face conversations with each of the grade four NSTECH teacher participants (Cohen, Manion & Morrison, 2002). After the first session of answering the written questionnaires, the researcher maintained professional ethics by acknowledging and appreciating each teachers' input. Moreover, the semi-structured questions permitted the researcher to examine responses from participants for completeness about intricate issues, deeming it a powerful tool for the researcher (Kothari, 2004). During the semi-structured interviews, the researcher develops a sense of observing teacher identity and may intervene positively (McMillan & Schumacher, 2010). The researcher encouraged honesty and reassured the teachers about confidentiality and non-judgement as they responded to questions during the face-to-face interviews.

The researcher maintained effective communication by using open-ended questions that allowed the NSTECH teachers to respond about their teaching experiences to EFAL grade four learners. The researcher sought every detail not only to their responses but also on teachers' actions (Jamshed, 2014). The teachers were also guided by probing questions to facilitate understanding so that they could give more details relevant to the questions asked (Behr, Braun, Kaczmirek & Bandilla, 2013; Van Teijlingen, 2014). Engaging with the participants in the semi-structured interviews added the richness of data gathered as the researcher had a chance to observe personal details of the sample chosen.

An audiotape recorder was used to record and capture every conversation between the researcher and participant (teacher) during the interviews for data gathering in the study (Wilcox & Keselman, 2012). Recording interviews allowed for accurate data transcription. Leedy and Ormrod (2005) and Irvine, Drew, and Sainsbury (2013) alert researchers that conducting semi-structured interviews has its own challenges. They encourage researchers to be proactive and cautious during the process conducting interviews. Necessary preparations were carefully considered before and during the interview sessions (Morse, 1997). Hence, an application containing the message about conducting a semi structured interview were sent through formal channels in getting authority from the school principal to the teachers chosen for the study. Minimising time constraints, the face-to-face semi-structured interviews were conducted immediately after the answering of questionnaires (Creswell, 2003).

3.5.3 FOLLOW-UP CONTACTS

The researcher had follow up contacts with the participants after data was gathered for any further clarifications. The possibility for follow-up contacts was to acquire more substantial data relating to the exploring teachers' experiences of teaching NSTECH to EFAL grade four learners. Necessary arrangements were discussed after the interviews with the participants to allow the researcher to perform follow-up contact sessions for more clarification (Seidman, 2013). Cell phone numbers were exchanged on mutual agreements between the researcher and teachers. Participants were later contacted through cell phone for more honest responses based on the data gathered and other questions related to the study. There were no personal aspects discussed except on issues of clarity that was required by the researcher and those sessions lasted for not more than ten five minutes (Drew, 2014; Vogl, 2013).

3.5.4 FIELD NOTES

Field notes were taken by the researcher during the interview sessions (King, 2012). There was a notebook for jotting down any built-in attitudes, which were observed to add or distort the data gathering process (Mueller & Oppenheimer, 2014). Semi-structured interviews permitted the use of verbal, non-verbal, spoken and auditory sensory channels. During the interviews the researcher was interested with the concepts used by the teachers, their verbal and non-verbal cues, as well as the attitudes that were portrayed.

Other observations that were noted was the facial expressions of the participants when answering questions. These reactions and observations were jotted down during the interview sessions. For example, one participant valued smiles when answering questions. When this positive reaction was appreciated by the researcher, the teacher supplied more information, which added to the rich data (Gentles, Charles, Ploeg & McKibbon, 2015). Spradley (2016) and Cohen et al. (2011) endorse taking field notes as they claim that these provide more meaning of what was said by the participants and what was observed by the researcher.

3.6 DATA ANALYSIS

A successful analysis and interpretation of data stemmed from a variety of the researchers' explicitness of data (Marshall, Cardon, Poddar & Fontenot, 2013). Cohen et al. (2007) states data analysis require that the researcher critically reads and recognises the relationship between statements made by the participants to make data more meaningful.

Questionnaires, semi structured interviews, follow-up contacts and field notes responded well with interpretive paradigm and qualitative research approach, and data analysis (Taylor, Bogdan & DeVault, 2015). The data collected from the semi-structured interviews were transcribed verbatim, the data collected was analysed and interpreted, which was later conveyed into a narrative report (Smith, 2015). The following thematic analysis steps were used by the researcher to analyse and interpret the data to produce a detailed report of teachers' experiences of teaching NSTECH to EFAL grade four learners. Below are the steps that were adapted from (Braun, Clarke & Terry, 2014).

Step 1: **Researcher getting acquainted with data gathered**

After data gathering, it was important to get familiar with it by extensively listening to the interview recordings and rigorously reading the participants' responses from the questionnaires. It then became easier to transcribe data into notes (Braun et al., 2014). Silverman (2016) suggests getting acquainted with the data gathered by stating that analysing data requires good listening skills and a critical mind to transform data into meaning. Analysing and sorting data is about narrating the story relating to the research questions (Clarke & Braun, 2014).

Step 2: Data coding

There was a constant re-evaluation of data in order to eliminate that which does not correspond with the questions. The interviews were transcribed with the participants' responses according to each

question asked by the researcher. A table was drawn up and all data that seemed to have the same idea were under one code (Cohen et al., 2011).

Step 3: **Creation of themes**

The data from the NSTECH grade four teacher participants was then collected into meaningful themes (Wilkinson, 2011). Themes were derived from comparing all common data given by participants (Leininger, 1985).

Step 4: **Re-evaluation**

It was essential to re-evaluate themes to check that they all represented teachers' experiences in teaching NSTECH to EFAL grade four learners (Turner & Thompson, 2014). Vithal and Jansen (2012) acknowledge that the researcher must first screen and categorise data before presenting it to the participants.

Step 5: **Report**

The final step was the production of the report based on the findings explored on teachers' experiences in teaching NSTECH to EFAL grade four learners. The analysis was based on inductive reasoning. According to Gibbs (2018) inductive analysis is gathered from similar data supplied by different participants from the situation that teachers were faced with when teaching NSTECH to EFAL grade four learners. Therefore, the analysis began from analysing the data and identifying themes emerging from the data. The findings of the teachers' experiences of teaching NSTECH to EFAL grade four learners were then related to PCK for further understanding, which was more specific to teachers' knowledge of the subject and everything related to their teaching (Eriksson & Kovalainen, 2015).

3.7 ISSUES OF TRUSTWORTHINESS

The success of the research study depends upon the stability of the research norms that have been applied (Loh, 2013). Seizing the opportunity of using questionnaires and in-depth semi-structured interviews to generate data addressed teachers' experiences in teaching NSTECH to English FAL grade four learners (Bryman & Bell, 2015). To uphold the trustworthiness of the study, the researcher used thick descriptions from the data collected from the face-to face interviews of the NSTECH teachers to present the findings in the next chapter (LoBiondo-Wood & Haber, 2014). All findings were supported by actual words spoken (quotations) by the teachers regarding their experience in teaching NSTECH.

Data was not confused by being biased with any participant who had baseless claims during data gathering. The researcher avoided biasness by being engaged in the research, using probing

questions which aligned the participants with the objectives of the study (De Vos, Delport, Fouché & Strydom, 2011). Hence, confirmability was attained through the research findings, similar questions were administered to all teachers teaching NSTECH to EFAL grade four learners in the study (Lincoln & Guba, 1985; Zhang & Wildemuth, 2016). The researcher recognised that the bond of trust between the researcher and the participants should not interfere with data gathering as this may spoil data (Berger, 2015). Therefore, the researcher refrained from using prejudgment, making exaggerations or taking for granted the responses that participants gave, to avoid rendering the study invalid (Cohen et al., 2011).

It was important that the researcher had to maintain the status of being a qualitative researcher and make it a priority from the beginning of data gathering until the end (Cohen, Manion & Morrison, 2013). The use of a diary to make notes and other observations during data gathering increased the truthfulness of the data (Janesick, 2015 & Saldaña, 2015). Credibility in this study was addressed by the researcher acknowledging teachers' experiences of teaching NSTECH in English as a language of instruction to grade four learners who were taught in their home language in the Foundation Phase. The challenges expressed by teachers when teaching reflect on grade four learners who had just transitioned from being taught in their home language (Cope, 2014).

3.8 ETHICAL CONSIDERATIONS

Research ethics is when the researcher confirms and honours the dignity that is accompanied by rights of the participants in participating in the study (Christiansen, Bertram & Land, 2010). Roberts (2015) acknowledges that research ethics extend further than sensitising participants but also help researchers in their preparations to undertake the research study. Thus, application letters were first written to the respective gatekeepers asking permission to conduct research (Cohen et al., 2013). Letters were sent to the following: The Chief Executive Officer for KwaZulu-Natal Department of Education (KZN DoE), principals of the schools and the teacher participants. The researcher also obtained ethical clearance approval from the University of KwaZulu- Natal (UKZN). The researcher obtained the authority to gather data from teacher participants in their respective schools.

As a way of maintaining respect of the school principals and teachers, written letters, which stated the purpose of the study were sent to their respective persons. It was crucial that the researcher negotiated with principals and teachers during the introduction while letters were delivered as a way of building a relationship of trust with gate-keepers and participants. The passion of undertaking the study was also discussed with an aim of alerting participants about how the study

would benefit the field of education. Participants voluntarily agreed to participate in the study, and they knew that they had a right to withdraw at any time and at any stage during data gathering if they felt uncomfortable (Gopal & Marimuthu, 2014).

The principals and teacher participants were assured that they would not be exposed to any harm and would be treated with high respect (Pawley, 2014). The last issue that was shared was protecting their personal identities as their names and schools were kept anonymous and confidential completely (Gray, 2013; Rezai-Rashti, 2013 & Johnson, 2014). Having discussed all research ethics, the consent forms were signed voluntarily by the principals and the participants (Gopal & Marimuthu, 2014). The ethics procedures add to the positive construction of a successful research study (Lichtman, 2013).

3.9 LIMITATIONS OF THE STUDY

The data was gathered from a small number of participants based in KwaDabeka in an urban area. The aim of this qualitative study was not to make generalisations for all teachers based on the four findings from the study. Constant social changes due to different life worlds contributed to the change of participants' moods, which might affect data gathering and sometimes interfere with the researchers' methodologies (Flick, 2014). Participants failed to be punctual for data gathering appointments. Some complained that they had other commitments after school. Even though the findings do not represent all grade four teachers experience in South Africa, they contain firm representation of the issues of language challenges with grade four learners in the South African schooling context (Botwe-Asamoah, 2013; Dhillon & Wanjiru, 2013).

3.10 DELIMITATIONS OF THE STUDY

As a qualitative researcher, it was important to be skilful during data gathering and one of those skills was to be a great observer of any behaviour and apply a positive attitude that would not interfere with the data (Merriam & Tisdell, 2015). Being patient and having a reminder of our appointments with the participants was a virtue that drove towards the success of the study. Time was not a major issue to the researcher as long as the participants had considered to participate in the research. Therefore, waiting for my participants did not affect data gathering because when they were available and ready, the researcher managed to gather rich data. Another participant who seemed to be challenged with the English language during the interview, was professionally encouraged that code-switching was acceptable.

3.11 CONCLUSION

This chapter presented the qualitative research methodology used in the research process of data gathering. The answering of the questionnaires and semi-structured interviews collected provided explicit data regarding teachers' experiences in teaching NSTECH to EFAL grade four learners. The chosen teachers for the study was purposively selected and reflected their teaching practice and behaviours. The issue of trustworthiness, ethical considerations, limitations and delimitations, data analysis, field notes and follow-up contacts were discussed as they are essential elements for the study. The next chapter represents the findings and the analysis and interpretation of the data collected in the study on teachers' experiences in teaching NSTECH to EFAL grade four learners.

CHAPTER FOUR
PRESENTATION OF FINDINGS AND DATA ANALYSIS

4. 1 INTRODUCTION

The previous chapter presented the detailed research methodology used in the study. The current chapter reflects on the presentation of data categorised in themes that are supported by teachers' experiences in teaching NSTECH to EFAL grade four learners as well as discussion of findings. Data gathered seeks to answer the two key research questions:

- What are teachers' experiences of teaching NSTECH to EFAL grade four learners?
- What strategies do teachers employ when teaching NSTECH to EFAL grade four learners?

Direct quotations are there as the main proof to support or disagree with the argument discussed (Pareti, O'Keefe, Konstas, Curran & Koprinska, 2013). In this chapter, the participants' diverse direct quotations are written in italics. Data presented in this chapter is mainly from the questionnaires and interviews and other data gathering instruments that were used in the study. The true reflection of data is derived from teachers' teaching NSTECH to EFAL grade four learners in the study. The selection of grade four teachers had a clear rationale to fulfil a specific purpose (Cleary, Horsfall & Hayter, 2014, p. 473). Shulman's (1986) Pedagogical Content Knowledge (PCK) framework served as a guide that assisted the researcher to analyse and understand the NSTECH teachers' experiences in the study.

Biographical information for teachers chosen in the study is discussed in this chapter. It is important to understand participants' biographies (Olsen, 2016), as they are in the frontline of the implementation of NSTECH to EFAL grade four learners in this study. This understanding will also assist in relating teachers' experiences in implementing the curriculum to generate the findings (AlarioHoyos, Perez-Sanagustin, Delgado-Kloos & Munoz-Organero, 2014).

4.2 GRADE FOUR NSTECH TEACHER PROFILES

The participants involved in this study are briefly described to understand who they are, their home language as well as their educational background (Danielewicz, 2014). Another important factor for understanding teachers' biographies is to assist the researcher and the reader to gain a deeper understanding of who the teachers are rather than only concentrating on the study (Kridel, 2013). Teacher qualifications were also discussed in their profiles to assess their academic

pathway to the implementation of the NSTECH curriculum (Eckert, 2013; Harris, Jensz & Baldwin, 2014). Pseudonyms have been used instead of the real names of participants. This is done to ensure participants' anonymity and confidentiality in accordance with agreed research ethics before data gathering (Vainio, 2013). The names allocated to the participants were **Mbally, Cindy, Sanele and Bussy**.

Mbally is teaching grade four NSTECH as a combined subject for the first time. She obtained an Honours Bachelor of Education (Hon BEd) degree and has two years of teaching experience. Her work experience started with the private sector and gradually she furthered her studies and she is now a teacher. Her home language is isiZulu and she admits that she has never had any background knowledge of Sciences and Technology in her formal studies. She revealed in her responses that Natural Sciences and Technology were never her major subjects at the university.

Cindy has been in the teaching profession for twenty-one years and has five years' experience in teaching NSTECH to grade four learners. She obtained a Primary Teachers' diploma in education (PTD) and upgraded her studies, and later got an Advanced Certificate in Education (ACE). She too admits that she never had any knowledge of Science and Technology in her studies. She started teaching grade four long before NSTECH was introduced in grade four.

Sanele is a male teacher who also teaches NSTECH as a combined subject to the grade four learners. He possesses an Honours degree with a specialisation of teaching in the senior phase. He was placed at a primary school through the system of Post Provision Norms (PPN). This is a process, which removes teachers who are in excess and places them in schools where there is a need. He agreed to teach grade four at a primary school because the school was nearer to his home and now, he confesses that he is used to the subject. He also never received formal education in the subject as well as in teaching grade four which is in the intermediate phase. He is also an African teacher using isiZulu as his home language.

Bussy has accumulated 30 years of teaching experience in the primary school. She got her primary teachers diploma years ago. She taught grade four before NSTECH was introduced. She is teaching NSTECH to grade four because she had no option as it was imposed by the CAPS policy in 2012 while she was teaching at grade four level. She does have an issue about the absence of specialisation of subjects in the primary school. She is also exploring the teaching of English as a FAL.

The emerging findings from teachers' biographies in the study indicate a lack of formal training or specialised knowledge and training that is relevant to teaching NSTECH successfully. However, they have good teaching qualifications and their teaching of NSTECH can be attributed to teaching-out-of-field.

According to Hobbs (2013, p. 274) teaching out-of-field compromises the "teaching competence" and can harm teachers' identity, self-efficacy and well-being. The concept of teaching out-of competence was designed for teachers to be able to meet the challenges of their profession. This meant that, teachers would have fun in and discover more about themselves while using the content of the subject they teach as they are fully developed. They will be more professional teachers who have a vision and purpose of teaching. Therefore, if teachers' barriers are not fully addressed regarding their subject knowledge and pedagogical content knowledge, they may not apply knowledge and skills meaningfully.

The personal details and each teachers' professional identities were important to in the study. However, acknowledging teachers' biographies raises concerns about their pedagogical content knowledge of NSTECH, particularly as they teach learners who are still challenged by the language of instruction.

Having a better understanding about NSTECH grade four teachers' academic profiles will assist to answer the two research questions. The next section responds to answering the first research question about teachers' experiences in teaching NSTECH to EFAL grade four learners.

4.3 WHAT ARE TEACHERS' EXPERIENCES IN TEACHING NSTECH TO EFAL GRADE FOUR LEARNERS?

This section comprises several main findings that emerged in response to the first research question. These are: Challenges of teaching NSTECH in English as the language of instruction; EFAL grade four learners struggle to grasp NSTECH concepts; Limited instructional time affects learning; Imposition of NSTECH CAPS policy on grade four NSTECH teachers; Inadequate subject knowledge which comprises teaching and learning and possibilities for teaching NSTECH to EFAL grade four learners.

Teachers expressed their responses according to their personal, societal and professional experiences. Teachers' experiences were guided by their skills, knowledge and competences which they possess in teaching NSTECH in English as a second language to grade four learners (Fomunyam, 2018). These and other factors provided meaningful descriptions on how teachers

as 'real-attributing' participants manage and direct their teaching in the classroom (Elbaz, 2018 & Kolb, 2014).

4.3.1 CHALLENGES OF TEACHING NSTECH IN ENGLISH AS A LANGUAGE OF INSTRUCTION

Teachers experienced various challenges when they were teaching NSTECH in English as a language of instruction to grade four learners. These challenges are narrated appropriately and even supported by direct quotations from teachers. Most of the NSTECH grade four teachers' challenges are the result of grade four learners who lacked the understanding of English as the language of instruction. The fact that teachers encountered different leaners whose language proficiency levels were at different stages, does indicate challenges in the classroom when teachers teach in the language of instruction. Some learners had little understanding of the language, while others had not grasped it at all. It was even worse when others failed even to express themselves in English as LoLT (Lee, Quinn & Valdes, 2013).

Mbally explains; "*It is very difficult to engage grade four learners and make them understand NSTECH because most of them they don't understand English language as their second language*". **Cindy** also attests to the challenge of teaching NSTECH in English as LoLT to grade four learners; "*It is a big challenge to teach NSTECH to in a second language to grade four learners as they still struggle with concepts in English language. These learners are from grade three where they were taught in isiZulu which is their home language*". This shows that the challenge confronting NSTECH teachers with the language of instruction. English as a second language disconnects teachers from their learners and it causes teachers to lack clarity around implementing NSTECH.

According to Strand et al. (2015), English can be an effective language of instruction if learners have fully adapted to it. The lack of proper adaption of English as the second language by grade four learners lead to ambiguity and uncertainty amongst teachers. Pedagogical Content Knowledge (PCK) accentuates the importance for teachers to understand the learners' barriers when teaching in the classroom. Knowledge is vital in keeping the teachers' professional conduct alive during teaching in the classroom, and when teachers' identified learners' challenges, they will be able to design programmes to support learners (Shing, Saat, & Loke, 2018).

Teachers' challenges are also caused by the fact that NSTECH has abstract terms and concepts that learners find difficult to grasp. The little English language spoken by grade four learners restrains their understanding, and the effective teaching of NSTECH in the classroom by creating unstable situations that may negatively manifest in grade four learners' performances. Teachers were challenged with conveying the precise meaning of the subject content to their learners. **Sanele** also confirms these challenges that they faced when teaching NSTECH to EFAL grade four learners by stating that, "*The language I use in teaching NSTECH is a challenge as grade four learners have not yet developed a good understanding of English language*". He talked about the language being detrimental to the content of NSTECH as it has abstract terms and learners even struggle with the phonics of the words. **Bussy** shares the same thoughts as **Sanele** when she states that:

> *NSTECH concepts are very abstract for grade four learners and really challenging to teach the content especially during the first term. I encourage my grade four learners to listen carefully when I teach.*

It is clear that teaching in a new language of instruction is still a new experience for grade four learners. Grade four NSTECH teachers spend vast time explaining abstract concepts and are only disappointed when their grade four learners cannot understand the lesson. This is what **Mbally** explained "*I get frustrated when I discover that most of learners don't understand the lesson*".

Grade four teachers should ensure that they keep up with being role models of both the NSTECH as a subject and English as a language for both teaching and learning. In teaching content subjects using English as a language of instruction challenges teachers to practise good pronunciation, intonation and to provide a best support for the language to transfer all the necessary skills to their learners (Leung et al., 2014). Learners can easily adapt and understand the content of the new subject when they are familiar with the language of teaching and learning. Therefore, teachers might find it easy to extend learners' knowledge of NSTECH so that learners will be able to use it effectively in their own real-life situations (Kaschula, 2013).

Based on exploring teachers' experiences in teaching NSTECH to EFAL grade four learners, the next paragraph offers what grade four NSTECH teachers also recount as another challenge regarding learners during their teaching practice.

4.3.2 EFAL GRADE FOUR LEARNERS' STRUGGLE TO GRASP NSTECH CONCEPTS

Teachers in the study indicated that grade four learners struggle to master NSTECH concepts in English as the second language. This becomes worse as some of NS concepts cannot be matched with learners' real-life experiences. Most of the teachers claim that learners suffer because of

their limited English vocabulary, which limits their reasoning while they are required to practice their NSTECH knowledge and skills learnt, like reflecting on what they learnt, synthesising knowledge and making presentations. **Cindy** and **Bussy** shared a similar experience in that *"Learners cannot easily make sense of what they are learning and understand scientific and technological terms taught in English"*. Teachers found learners passive and not absorbing what they had been taught. This indicates that learners' inadequate English proficiency deprived them of adequate power to achieve meaningful learning. Learners must learn English for a Specific Purposes (ESP) at school (Basturkmen, 2014). One of the purposes is to grasp new knowledge. The key issue is, if learners have not developed English as a language of instruction sufficiently, they struggle in their learning.

Many of NSTECH concepts are new and abstract to learners. Therefore, the new language that learners are using limits them from relating with science and technology that they know. Due to learners' lack of English proficiency in grade four, it affects learners' zone of proximal development (ZPD). According to Vygotsky (1978) ZPD is important as it allows learners to access new knowledge or extend on it as they are being taught by teachers. Therefore, the knowledge of English in grasping NSTECH concepts is essential to grade four learners. **Sanele** revealed he used pictures when he was teaching different forms of energy. He said even though learners were able to relate pictures with what they knew, *"they struggle with the NSTECH concepts"*. **Sanele** added to this theme by stating that learners struggled to make a list of objects that produce light because of their limited language vocabulary. He supports his argument by saying:

> *Learners are new in the phase, NSTECH is also a new subject and moreover NSTECH is taught in a language that is not familiar to grade four learners. Words like potential energy are very abstract for them. They know the car but extending to car headlights is a struggle to them.*

Furthermore**, Mbally** expanded by saying *"Learners take longer time to read books and write notes in NSTECH as they are written in English"*. These findings, presented by participants in the study, are in line with Alqahtani's view (2015) that limited vocabulary-concept knowledge either orally or in writing compromises teaching and learning of subjects. The main problem facing learners is how to match what they are writing with NSTECH content.

Learners require much time to be prepared for their reading and writing. Teachers need to teach reading first with the whole class paying attention to pronunciation, tempo, phrasing and other related work. However, the problem is that there is no time in the timetable that is allocated

specifically for such activity. Therefore, learners need all the necessary help with the language itself as well as with understanding NSTECH concepts. This situation opposes the NSTECH CAPS objectives on reading which emphasises that the ability to read well is key to effective learning and writing and works as a influential means of communication. According to Shulman (1986, 1987), and Rollnick and Mavhunga (2017), PCK stresses that teachers can enrich their teaching by being able to link learners' previous knowledge together with their language of communication. Teachers' quality performance of laying the foundation of NSTECH that takes into consideration the learners' contextual, social and educational background is compromised because of the language barrier. Hence, the development of NSTECH concepts is inspired by English as a language of instruction and this remains the main prerogative of the grade four teachers in the introduction of NSTECH (Ngcobo, 2015). However, NSTECH grade four learners find it difficult to grasp NSTECH concepts in English as the second language.

If teachers are able to recognise learning difficulties, they will be able to give direction by employing objectives that move beyond classic goals of NSTECH through PCK (Van Driel, Verloop & De Vos, 1998). Learners require much time to be actively involved in both NSTECH content and the LoLT to assist them and to remove the unnecessary struggle in their learning.

According to the above teachers' experiences it highlights that there must be enough time for teaching and learning between teachers and learners to achieve a deep academic understanding of NSTECH concepts and content in the grade four classroom. The next subtheme discusses the complexity caused by instructional time to teach NSTECH to EFAL grade four learners.

4.3.3 LIMITED INSTRUCTIONAL TIME COMPROMISES QUALITY TEACHING

This section describes the limited time allocated with the teaching and learning periods for NSTECH is limited and does not take into account the issue of teaching second language learners in English as a LoLT. Teachers feel that the limited instructional time allocated is limited, which compromises their quality of teaching NSTECH to EFAL grade four leaners. When exploring teachers' experiences, data indicated that teachers find their quality teaching was compromised with the notional time. **Cindy** alluded to this when she said, "*With this limited instructional time, I cannot really meet the needs of my individual learners*". She insisted that instructional time compromises her quality teaching because the time allocated to deal with NSTECH content in English as LoLT requires enough time for implementation. She supports her statements through her reflective teaching experience of NSTECH to EFAL grade four learners with these words "*teachers need to have enough time to fix learners memory by allowing learners to utter and*

repeat concepts and sentences". These ideas confirm that grade four NSTECH instructional time does not allow teachers to use their teaching time to cater for EFAL grade four learners' needs. The combination of two disciplines which are Natural Sciences (NS) plus Technology (TECH) with English as a new medium of instruction requires suitable time to be thoroughly presented in the classroom. NSTECH grade four allocation time in accordance with the CAPS policy is 3, 5 hours per week. This can be simplified to mean that teachers have three periods and thirty minutes in a week to teach NSTECH to grade four learners. The contact time in each period is one hour. **Mbally** also concurred that instructional time was indeed the enemy of the most essential activity of teaching as she revealed in the following statement:

> *I have to sacrifice and find more time to teach NSTECH, because the allocated time by the subject policy is not enough to cater for all the work as these learners grasp very slowly.* It *is difficult to teach and cover all the topics unless I use extra time.*

During instructional conversations, teachers use vast time trying to make NSTECH concepts explicit, assisting learners to gain understanding of new concepts in a new subject. Data indicated that teachers were over weighted by multitasks for curriculum coverage and their attempt on imparting skills and knowledge of NSTECH. Morrissey (2000) insists on teachers embarking more on contact time in order to engage learners actively during instruction. Therefore, it is an anomaly situation that quality teaching is affected by the limited time against the willingness of teachers to support and improve the teaching of NSTECH to EFAL grade four learners.

Mbally further elaborates on this matter by adding another challenge by saying, "*also the large number of learners in the classroom compromises the quality of teaching".* Teachers experience difficulties to implement the curriculum with the large numbers of learners in the classroom and it becomes even worse if the subject they teach has poor teaching resources (Gibbs & Jenkins, 2014). Indeed, as Mbally has mentioned about the large number of learners in her class, the challenge is further increased by the fact that grade four learners are having a language barrier.

Ideally, teachers are having constraints in achieving the objectives of the NSTECH curriculum policy as well as that of implementing the curriuclum. This is because teachers have pressure in engaging learners in the subject, while at the same time making progress with their English language vocabulary teaching and learning. **Mbally** explained in the above excerpt.

The insufficiency of instructional time limited teachers from completing what they intended to teach. They could not even revise the lesson immediately if they diagnosed that learners needed repeated investigations to allow scientific and technological knowledge learning. Hence, **Sanele** declared, "*instructional time for teaching NSTECH doesn't suit grade four English second*

language learners and this compromises the effectiveness of teaching the subject." The limited instructional time deficiency caused NSTECH grade four teachers to fail to attend to the individual needs of learners' levels to grasp knowledge is not the same in the classroom (Pinter, 2017). **Cindy** had the following to share; "*Usually I don't finish teaching all NSTECH topics with the grade four learners, because time is consumed in the introduction and presentation of the content*".

Time is consumed because teachers have to redress the slow pace of the learners. In addition, **Sanele** revealed this: "*I taught the concept "photosynthesis" and ended using more words in isiZulu which consumed more instructional time*". It is clear that the allocated time for instructional activity does not match the wide range of teaching methods and teaching resources necessary for the EFAL grade four learners. **Bussy** also lamented the insufficient instructional time by saying:

> *Teaching NSTECH to grade four learners is time consuming as the concepts that I teach need more clarity, and I have to take enough time teaching them in a way that will assist learners to understand and our periods for teaching are very limited for really reaching to learners.*

Shulman (1986) realised that sometimes teachers are faced with situations which make their teaching service impossible. As teachers in this study realised that limited instructional time compromises their quality teaching of NSTECH, at the same time it also affects learners in their assimilation of new knowledge. The following section further clarifies teachers' experiences on how limited instructional time impacts on learners learning.

4.3.4 LIMITED INSTRUCTIONAL TIME AFFECTS LEARNING

The above dimension of limited instructional time is not only affecting teachers, but learning is also genuinely affected by the notional time. These two revelations, explored by teachers, provide an understanding of the challenge's teachers are faced with in teaching NSTECH using English as LoLT to EFAL grade four learners. As grade four NSTECH teachers are curriculum implementers, the success of their efforts will also depend on the commitment of learners performing well in their activities. It sends a message that they have received good instruction from teachers (Rivkin & Schiman, 2015). However, teachers argued that EFAL grade four learners are affected by limited time in learning NSTECH as they are still struggling with their English as LoLT. Teachers noticed that learners ended up not finishing their classwork and their workbooks could not be marked in the classroom in their presence because of time constraints. **Sanele** even confessed that he ended up asking learners to complete their workbooks

alone at home as homework. Data indicated that learners were left to struggle alone with their NSTECH tasks at home without getting assistance from their teachers. This raises many questions about what happens if they did not understand what they were taught in the classroom and what if they have no one to assist them with their homework at home. That means they are left behind having missed out on important NSTECH knowledge.

Learners being deprived of the many opportunities to receive quality teaching and learning from their teachers in the classroom indicate gaps from the initial grade where they are to learn NSTECH and acquire the basic knowledge. **Mbally** concretely declared that "*I don't finish all the topics intended by grade four NSTECH curriculum in each term because time becomes limited*". Such a declaration from teachers communicates that learning are affected too. Realistically from this data, EFAL grade four learners in the township cannot compete with other grade four learners in the private or semi-private schools in their acquisition of NSTECH knowledge. Academic performance cannot be really monitored during the limited instructional time in the classroom. It should be remembered that EFAL learners need more time to be managed carefully but sometimes teachers end up encouraging learners to memorise concepts without a deep understanding. This was again revealed by **Mbally** when she says, "*limited time force me to teach what will be assessed only*". These findings are extremely important to indicate that time is an important tool for effective teaching and learning to take place. EFAL grade four learners require an optimum allocation of time to improve their learning of NSTECH.

PCK advocates for the understanding of how learners behave when taught in class and to raise issues that will reveal what needs to be improved in the education system (Berry, Friedrichsen and Loughran, 2015). Therefore, teachers used their PCK to curb poor learner achievement caused by inefficient time. Teachers indicated that they even use their extra time just to improve learning performance.

Other teachers admitted that they are behind with their curriculum implementation, they engage in positive experiences of making adjustments in taking control of their NSTECH daily programme and negotiating with other teachers to use their contact time. Extracting from grade teachers' experiences teaching NSTECH to EFAL grade four learners, there was much – talked data about NSTECH CAPS policy as a challenge in their practice. This is illustrated below.

4.3.5 IMPOSITION OF NSTECH CAPS POLICY ON GRADE FOUR TEACHERS

This section recognises that NSTECH CAPS came forward with the NS and TECH as an integrated subject from grade four to grade six. In this respect, teachers in this study felt that the Department of Basic Education (DBE) imposed NSTECH policy to be taught in English to grade four learners in the primary school.

Mbally and **Cindy** indicated that they never had any formal education, which qualifies them to teach NSTECH as they are teaching the subject. **Cindy** revealed that she had no option because NSTECH was introduced in 2012 and she was already teaching the grade four learners. She concluded by saying, "*I have to teach it anyway*". **Mbally** testified to this theme by revealing that, "*since there is no specialisation in the primary school, I therefore have to teach NSTECH as it was imposed by the department since I was teaching grade four*". According to the Council of National Academies of Sciences, and Medicine (2016), most teachers teaching sciences studies in the primary schools are unlikely to have received proper sciences education. This implies that NSTECH grade four teachers are also not properly qualified or trained to teach the subject. This qualifies for further research into the reasons why and how decisions into planning and implementing an integrated curriculum was decided, especially taking into consideration the issue of English as a LoLT when teaching specialised subjects such as NSTECH to second language learners.

The introduction of Technology (TECH) was included in the South African school curriculum nd introduced in primary schools after apartheid. That meant teachers who were in the primary schools were left with no option but to teach the subject. Good teachers are always willing to adapt to the change in their education system because they understood that they are lifelong learners themselves who are committed to their work (Ingram, 2014). Teachers were issued with the NSTECH CAPS document, which had the limited time allocation of the content and topics to be taught in each term. The policy was imposed without necessary requirements to address barriers that might arise from teaching with English as the language of instruction, which was new to grade four learners. According to NSTECH CAPS policy, all grade four teachers were to teach NSTECH in the primary schools and teachers had to abide with the policy. Hence, all teachers raise concerns about the NSTECH CAPS document as they teach the subject. **Sanele** clarified his shortcomings that came with NSTECH CAPS policy:

> It *is hard to carry out all NSTECH tasks from the policy document. Grade four learners still battle to understand NSTECH in English, since they are coming from grade three where they were taught in isiZulu which is their home language. The*

worst part is that my school cannot cater the resources which will really assist learners.

This introduction of NSTECH by the Department of Basic Education led teachers to struggle with their PCK as the language created some friction towards the effective implementation of the subject. Teachers felt the NSTECH curriculum is a bit inflexible as it did not recognise teachers specialised professional knowledge designated to teach the subject.

The more complex part experienced by grade four NSTECH teachers is detailed in the following section.

4.3.6 INADEQUATE SUBJECT KNOWLEDGE COMPROMISES TEACHING AND LEARNING

An accumulated data in the study indicated that teachers lacked special subject knowledge of NSTECH and that compromised teaching and learning of EFAL grade four learners (Kunter et al., 2013). These data raised concerns about the content teachers use to teach NSTECH concepts. This also include the strategies grade four teachers use to accommodate integration of NS and TECH to EFAL grade four learners.

Abd-El-Khalick (2013) and Sadler et al. (2013) also state that when teachers lack the desired "Science knowledge" they often develop anxiety and complain about some extrinsic factors, which cause poor teaching results. **Mbally** commented about teaching NSTECH in the primary school. She said, "*At the primary school there is no specialisation of subjects, so I teach NSTECH even though I don't have much knowledge of both discipline*". She also revealed that teaching NSTECH was not her choice. NSTECH was introduced while she was already teaching grade four. **Cindy** also raised concerns regarding this theme by saying, "*I teach NSTECH to my grade four learners even though it was not my major at the university*". This data raised concerns about desirable teachers' educational qualifications and PCK for teaching NSTECH to EFAL grade four learners. However, Appleton (2013) recognises the productivity of teachers who possess a rich knowledge and information from their past and ongoing experiences.

However, in this study the teachers' morale was boosted by their on-going experience in implementing the NSTECH curriculum rather than their subject knowledge and the support from the subject advisors. It is clear from the teachers' responses that they lacked that special adequate natural sciences and technology knowledge. In response to NSTECH in-adequate subject knowledge, **Sanele** expressed these words, "*I am now used to teaching NSTECH to grade four*

even though I'm not properly qualified". Indirectly, this statement can be construed to mean that the teacher did not possess specific NSTECH knowledge. However, the experience he has gained over time has helped him gain the necessary knowledge and confidence. **Bussy** was also concerned about her self-directed knowledge of NSTECH with a view to adapting and improving her teaching. She says:

> *As a grade four NSTECH teacher, I need to be familiar with both Natural Sciences and Technology knowledge. Sometimes this creates challenges as I did not have a formal training for Technology, but I teach it because it is mostly practical.*

It would seem though that in some black primary schools the issue of specialisation based on acquired competency to teach a particular subject is not considered. The current study has established that NSTECH at grade four level in African schools is taught by teachers who obtained the training for the primary teachers' diploma long ago and even though they upgraded, they did not specialise in the science or technology subjects. Hoadley (2012) insists that teachers must possess adequate conceptual and content knowledge of the subject they teach, as this improves their understanding of the subject matter. This is central to the teaching practice and performance standards. Stronge (2018) emphasises that the process of globalisation puts pressure on our education system, which requires teachers to be ahead in their knowledge of teaching. Therefore, grade four NSTECH teachers need to develop a more detailed PCK for Natural Sciences (NS) and Technology (TECH) as the two are equally important (Mehta & Doctor, 2013). This will mobilise and empower teachers with the relevant knowledge for NSTECH and encourage them to take a more active role in their professional development.

Issues of specialisation in teaching NSTECH to EFAL grade four learners require an acute consideration for teachers to be more reflective. Nevertheless, teacher experiences shape the strategies and thus influence behaviours and decisions about teaching NSTECH to EFAL grade four learners. Possibilities for teaching NSTECH were extremely vital to understand how teachers lay a solid foundation for the teaching of natural sciences and technology in English as a language of instruction.

4.3.7 POSSIBILITIES FOR TEACHING NSTECH TO EFAL GRADE FOUR LEARNERS

During the gathering of data between the researcher and grade four NSTECH subject teachers, the researcher was able to discover the richness of how teachers made it possible to teach NSTECH to EFAL grade four learners. Furthermore, the researcher's view from data shared through teachers' experience were fulfilling and enriching and they included the following conclusions: teachers' experiences lead to more comprehensive teaching, discipline, warmth and caring are what enabled

teachers to teach NSTECH to EFAL grade four learners. The main features will be described below in three sections:

4.3.7.1 TEACHERS' EXPERIENCES LEADS TO IMPROVED TEACHING

Possibilities for improved teaching were increased by teachers' experiences in teaching NSTECH to EFAL grade four learners. As teachers' experiences increased, their teaching of grade four also improved because they became aware of how to bridge the learners' gaps of language with the new content of NSTECH. Experience increases teachers' PCK regarding every possibility to improve better service (Kraft & Papay, 2014). Teachers in the study mentioned that as they adapted with the subject, it became possible to foresee and understand learners' problems regarding language and NSTECH content demands. **Sanele** alluded to his experience by saying, "*experience made me to provide appropriate solutions in the classroom*". Teachers experience even resulted in making suggestions, which might strengthen teaching of NSTECH to EFAL grade four learners. He made the following suggestion, "*DoE must provide EFAL grade four teachers with potential resources, like computers with internet so that teachers can use it while teaching NSTECH to grade four in our primary schools*". Creating a conducive grade four NSTECH classroom by installing internet sites and installing computer scientists might boost teachers' ego and bring excitement to learners (Linn, 2013).

Echoing teachers' experiences, **Mbally** indicated this, "I *wish the Department of Education can provide NSTECH dictionaries that teachers can refer grade four learners too so as to check the meaning of concepts themselves*". This clearly indicates that she made this statement from her experience regarding learners' challenges with concepts. Batool and Mahmood (2016) mention that schools should provide proper teaching resources so that Science becomes more meaningful to young learners in the primary school. **Cindy** explained that as she taught NSTECH to EFAL learners it would assist to make it official that two languages were allowed. She said that both languages were used in class during the teaching of NSTECH. However, with charts and books learners are deprived to understand content because they are written in English only. She lamented this situation in this statement:

> *I would appreciate if the school can provide picture charts and flash cards written in both English and isiZulu meanings so that grade four learners will easily understand NSTECH concepts; this will make it simple to grade four learners.*

Bussy interpreted her acquired experience with this suggestion:

> *I wish the subject advisors can provide enough orientation and monitoring to grade four NSTECH teachers. There is little communication between the grade four NSTECH advisors and teachers teaching this subject.*

Teachers' PCK as well as their accumulated experience became specific tools for assisting teachers to teach NSTECH to EFAL grade four learners effectively. Important is for teachers to relate well with the subject content, the way they teach, and the learners they teach (Linn & Hsi, 2000).

4.3.7.2 CREATING A DISCIPLINED CLASSROOM ENVIRONMENT

This section describes a lively, disciplined classroom environment that teachers create which also make teaching and learning of NSTECH to EFAL grade four learners possible. Teachers should encourage and maintain discipline amongst learners. In this climate, teachers encourage an authentic behaviour amongst learners. This is what **Cindy** does to maintain and encourage a good morale for teaching and learning NSTECH:

> *I explain from the beginning to EFAL grade four learners that they will be learning NSTECH in the language that most people use in the world, this makes them understand the importance of mastering English language as well. I encourage learners to practice science in class and at home, as part of their everyday life. During teaching and learning, I discourage funny remarks or laughter, if there is a learner who has difficulty in expressing his ideas in English during class presentations.*

Sanele stated that he maintained a strict control in the classroom; "*as much as I understand that they are still very slow in their operations, I command learners to accomplish their necessary tasks*". He said that even those learners who sometimes shied away, were asked to talk in their mother tongue to indicate what they wanted to express. According to Childs, Markie and Ryan (2015) the main language can be used as a bridge to the required school language. **Sanele** also stated that "*It is a must that I give grade four learners notes because as they write, it helps them to learn therefore, I have to monitor their writing*". Whereas **Bussy** accomplished maintaining discipline by stating, "*I make sure that all learners are engaged in NSTECH lesson in one way or other*".

Finally, effective classroom discipline should be achieved if it facilitates the achievement of the goals of teaching NSTECH to EFAL grade four learners. This is one of the most important benefits of PCK, as it ensures that teachers use every suitable method to make their teaching service more possible. PCK channels direction to teachers in terms of unfolding subject content and guides teachers' behaviour to control the curriculum and achieve good results (Appleton, 2003; Berry & Van Driel, 2013; Hoadley, 2012; Khoza, 2015; Nilsson, 2014 & Shulman, 1986).

Further, eliminating a barrier-free classroom environment provide support between integrating the English as a LoLT and NSTECH to accommodate grade four learners is important. Discipline is also a goal and a tool for achieving NSTECH objectives associated with EFAL grade four learners.

4.3.7.3 SUSTAINING A CONDUCIVE AND CARING CLASSROOM ENVIRONMENT

This section focusses on teachers support service to strengthen teaching, learning and management of NSTECH curriculum to EFAL grade four learners. Teachers co-ordinate a conducive and caring environment for both PCK, content knowledge and learning difficulties in teaching NSTECH with English as a language of instruction to grade four learners. Teachers' ability to create a warm and caring atmosphere resulted in learners becoming more inclined to their work (Hannah, 2013). **Cindy** stated that she tried to be patient with her learners and explained concepts, keeping with learners' slow pace. She supported her statement by indicating, *"I don't rush my lessons during teaching because learner become confused and it is shown with poor results in the assessment"*. Teachers in the current study had a strong focus on building a caring classroom environment designed to promote effective teaching of NSTECH. **Mbally** outlined how she created and maintained a conducive atmosphere to enhance the mood of teaching and learning in a progressive manner. This is what she said:

> *I use English language skills to teach NSTECH spelling concepts and reading in my lessons. I give them NSTECH concepts spelling test every Friday. It helps them master the art of writing the correct spelling of NSTECH.*

According to Ward and Roden (2016) primary school teachers need to realise that as they teach NSTECH at the primary school level, they are also equipping primary school learners with scientific literacy. Therefore, it is interesting to note that teachers adhere to what they are responsible for in terms of teaching and how they are going to achieve their goals. **Cindy** reflected on this theme by emphasising patience with learners since she knows that they are challenged by the language barrier. She said, "*I try to keep resources and charts in the classroom that will always remind them of the work we learned and make them read often*".

The prospect of natural sciences and technology education for learners as they progress to Further Education and Training (FET) is not only depending on the curriculum and language, but also on effective NSTECH teachers (Slavin, 2013 & Stronge, 2018). Thus, grade four teachers have the responsibility to make use of a range of teaching methods that support learning of NSTECH. **Mbally** indicated that, "*I repeat now and again to make learners understand and grasp scientific*

and technological terms". She further responded by stating that, "*in class I give learners topics to make presentations and debates and try to make it more fun"*. **Bussy** explained that EFAL grade four learners also confuse their NSTECH exercise books as they are still battling with the language of instruction. With regard to this, she said, "*I make sure that learners are using the relevant exercise books. And when teaching NSTECH I use examples touching their everyday life experience"*.

Teachers showed much control of the teaching NSTECH to EFAL grade four learners. Shulman in the PCK maintains that when teachers have gained the total understanding of all the required information regarding the subject they teach, they become effective. Using their experience of teaching EFAL grade four learners, teachers maintain discipline and sustain a conducive and caring NSTECH classroom environment. They attract an essential endeavour from learners even though their language of instruction has not fully developed. Overall, teachers were able to accomplish teaching NSTECH to EFAL grade four learners through acquiring knowledge of PCK (Kafyulilo, 2014).

Shulman (1987) put forward that there are different types of interactions that teachers experience in the classroom, which lead to develop lived artistic teaching experiences. Therefore, grade four NSTECH teachers' experiences gave them more understanding of what knowledge and skills they want their grade four learners to develop. This makes them engage in creating better teaching solutions. Dewey (2005) believes that teachers' real-life experiences are a significant part of an on-going teaching experience in class. Shulman (1987) attests to the point of teachers mastering the curriculum they teach. The section presented themes based on teachers' experiences in teaching NSTECH to EFAL grade four learners. Among the findings, professional knowledge to teachers' teaching the subject to grade four is paramount (Mehta & Doctor, 2013). These responses and teacher experiences indicate that in the primary schools, the teaching of NSTECH especially to grade four learners requires great attention from the education stakeholders. The next section will answer the research question two: what strategies do teachers employ when teaching NSTECH to EFAL grade four learners?

4.4 WHAT STRATEGIES DO TEACHERS EMPLOY WHEN TEACHING NSTECH TO EFAL GRADE FOUR LEARNERS?

Teaching strategies collaborate with PCK to provide adequate access to teachers' experiences. The preceding data gathered from participants in this research study indicate that teachers utilise

distinct teaching strategies to implement NSTECH curriculum to EFAL grade four learners in the classroom (Cohen et al., 2013). There were various strategies that teachers applied when teaching NSTECH in English as LoLT to grade four learners in the study. The key strategies are broken down as follows: frequently asking questions: a reinforcement to evaluate learners understanding, code-switching to facilitate teaching of NSTECH to EFAL grade four learners, lecture teaching for profound teaching and learning of NSTECH to EFAL grade four learners, active learning: strategy to build NSTECH skills and knowledge, group work for peer empowerment and attaining social skills and competences. To conceptualise grade four teachers' strategies in teaching NSTECH using EFAL, the researcher will theorise their ongoing experiences in class as they were narrated by teachers.

4.4.1 FREQUENT ASKING OF QUESTIONS: A REINFORCEMENT TO EVALUATE UNDERSTANDING

Most NSTECH teachers in this study seemed to frequently ask questions as a strategy to build their teaching capacity during teaching NSTECH content in EFAL. According to Tofade, Elsner, and Haines (2013), asking questions is the oldest teaching strategy for teachers to equip learners to recall information, think deeply and to talk. Grade four teachers seemed to capture this essence when they gave their responses. This is what the two teachers **Mbally** and **Cindy** indicated. From the beginning of the lesson until the end they frequently asked questions as an assessment strategy to evaluate whether learners understood what they were being taught. Abell, Appleton, and Hanuscin (2013) consider the question and answer strategy as an effort to exercise authority and reinforce what is being taught in the classroom. The response from **Sanele** might say a lot regarding this strategy. He said, "*I find asking questions working for me during teaching NSTECH because I am able to track their understanding of the content and the language. Learners try very well to answer"*. He then revealed that the strategy assisted him to correct and improve learners' challenges immediately.

Carlsen (1991) views asking questions differently, as he points out that sometimes several questions could be asked by teachers if they are not familiar with the subject content that they teach. Nevertheless, it proves to be positive as it guides teachers to be on track. **Bussy** revealed the following on this strategy:

> *I frequently ask my learners questions to make sure that we are still on track with the lesson. Also, to make sure at the end of the lesson that I have met the goals of the lesson and this assist me with the task that they will write.*

Through PCK teachers ask questions to facilitate learners' understanding and through feedback they are able to instil the culture of communication in the classroom. It is imperative to also understand that the questions are to be clear and understandable to learners. Even questions need to be planned by NSTECH grade four teachers to be valid and reliable.

4.4.2 CODE-SWITCHING TO ADDRESS ISSUES OF LANGUAGE BARRIER

One of the strategies addressed by NSTECH teachers in this study was the practice of code-switching during teaching between teachers and EFAL grade four learners. During the interview sessions, participants indicated that it was necessary to employ language code-switching techniques.

Teachers divert from English language as the language of instruction to learners' home language in order to facilitate good communication skills to teach NSTECH in the classroom (Cohen et al., 2011). **Mbally** mentioned the following on the code-switching strategy when she explained scientific and technological concepts in isiZulu. She further said, *"Learners' become clearer when I use their home language. The challenge is during assessments because they cannot use their home language".* This means that code-switching assists teachers during teaching while it fails learners during assessments. According to Gardner-Chloros and Weston (2015) Code-switching (CS) happen consciously where people interject with words from their home language between sentences when they are faced with using any foreign language. Horasan (2014) indicates that CS is the way of communication for most Africans if they are faced with more than one language.

The learners' transitional phase from mother tongue to EFAL as a language of instruction shapes and influences teachers to make interpretations and give meanings in learners' vernacular language. They believe this improves their teaching of NSTECH to grade four learners who still find EFAL somewhat unfamiliar and NSTECH terms abstract. Teachers gave positive feedback on this strategy and appeared to be code-switching in their NSTECH teaching. **Mbally** affirmed on this strategy in this way "I *code -switch in the classroom by explaining the scientific and technological concepts in isiZulu with an aim of making learners understand the lesson".* Code-switching allows the teacher to clarify the desired response, translate the subject content to learners and allow an opportunity to give and receive feedback on performance (Horasan, 2014). **Bussy** reported that she mixed language of instruction with learners' home language in teaching NSTECH to EFAL grade four learners. This is how she illustrated this, "*I teach NSTECH to grade four using both isiZulu and English, to engage learners in the lesson".* From the viewpoint of the

teachers' responses, their willingness to code-switch is entirely personal and it happens voluntarily.

Another option is that teacher's code-switching is subjective to the fact that teachers are teaching with the language which is their additional language too (Msimanga & Lelliott, 2014). This is noted from this illustration from **Sanele** " *I find myself using more words in Zulu trying to explain a science concept e.g. the concept photosynthesis when I explain it in isiZulu I say use more than usual words than there will be in English".* However, Modupeola (2013) insists that code-switching is relevant in the multilingual societies where every language is official.

PCK encourages grade four NSTECH teachers to recollect their teaching experiences to lead or guide them to for more significant strategies of teaching in the classroom (Shulman, 1987). Teachers need to limit their code-switching during teaching to the point of using it as a tool to only assist learning on critical situations without making it a habit, that is, only if all natural sciences and technology language has failed (Shulman, 1987). That way, it can be said that the function of code-switching has performed at the optimum level.

4.4.3 LECTURE STYLE TEACHING FOR PROFOUND TEACHING AND LEARNING

This section clarifies how teachers use a lecture style as the teaching strategy in the classroom. Teachers did not deny other important strategies, yet the significant similarities have been noted between NSTECH teachers teaching to EFAL grade four learners in the study. **Sanele** indicated that lecture method has proved to be extremely productive by saying: *"I use lecture method frequently depending on the topic I teach. As we have no libraries and good NSTECH resources in our school it is better to tell learners what exactly what the topic is all about and it's really working".* **Mbally** also spoke interrelated words about teaching in the class. This is what she said, *"I know they still have a language challenge; therefore, I teach while using non-verbal expressions simultaneously in order to explain the subject content effectively to all learners in the class.* Teachers teach with an aim to create and manage an optimal learning environment, which assists learners to execute their work with understanding.

When learners are taught collaboratively, facts are presented and teachers are able to control and unite all learners to do their activities (Kuusisaari, 2013). Teachers found it easy to teach all learners at the same time to facilitate unity and direction since learners still struggle to manage on their own due to EFAL. **Cindy** defined her lecturing strategy as follows:

I address all learners and make them to repeat statements' and concepts now and again to make sure that all learners understand scientific and technology terms, as they are still new to the subject and the terms are very abstract to them.

Teachers believed that teaching strategies served as a powerful tool to improve learners' knowledge and facilitate understanding of the subject to all learners (McKeachie & Svinicki, 2013). Teachers use lecture method to clarify concepts that have to be common to the whole class to make sure that all learners understand. Also, NSTECH concepts and language skills shared by all learners and the teacher brings about unity in the classroom especially as grade four learners are still new to the subject. Therefore, teachers can use the lecture method to develop language and reading skills. Tanner (2013) refers to the whole class teaching as equitable teaching strategy. He condones this strategy because he feels it fairly caters for all learners and encourages them to think and be verbally involved. The teacher can identify other alternative methods of addressing the problem as he can easily diagnose problems immediately in the class as all learners participate in the classroom. This strategy can even assist the NSTECH grade four teachers in curbing negative behaviour of learners.

As teaching in the classroom is in progress, the other hidden concept is the collaborative learning amongst learners. Learners become co-operative during collaborative learning which can result in a positive competition where they want to shine amongst their peers (Mercer, 1996). Therefore, the lecturing method used by teachers in the study also encouraged collaborative learning amongst leaners. This collaborative learning sometimes could also create a situation where learners could be afraid to reveal that they did not understand because other learners might laugh or judge them negatively. Although the participants did not reveal this information, it is commendable to explore this further.

Teachers' content knowledge of NSTECH encouraged teachers to vigorously explore their teaching experiences with an aim of engaging with beneficial teaching strategies (Fernandez, 2014). Teachers therefore used strategies, which would be relevant for assisting teachers in teaching NSTECH to grade four learners. Wieman (2014) argues that the lecture method is appropriate in presenting vast information to all members at the same moment. It could be the reason why all teachers seemed to enjoy this method. Therefore, it is hoped that the lecturing strategy with collaborated learning will be beneficial in dispensing the wealth of knowledge in NSTECH at EFAL grade four level. Teaching in the classroom should be exercised in a way that will make learners active.

4.4.4 ACTIVE LEARNING: STRATEGY TO BUILD NSTECH SKILLS AND KNOWLEDGE

In this study, NSTECH teachers indicated that they also used a strategy that made learners active. They used diverse approaches that required learners to exercise their brain power and become active (Bonwell & Eison, 1991). Some of these tasks required less communication, but needed learners' understanding and full co-operation for their projects to succeed (Roehl, Reddy & Shannon, 2013). In addition, the NSTECH curriculum allows teachers to assist learners to build their knowledge through discovery learning. This is what **Mbally** explained about this strategy "*I allow my grade four learners to do experiments and observe them depending on the theme I am teaching, e.g. I give them all the resources and they conducted their mini circuit*". I asked her what resources she supplied and why, as learners were expected to be active with the whole activity.

She responded by saying, "*I understand the kind of community that learners come from as many parents are unemployed, and the school lack funds. Therefore, I bought cells fortunately the electrical cables were present in the school.*"

Allowing learners to be active and make presentations in class will boost their egos and interest and will satisfy their natural curiosity (Taylor & von Fintel, 2016). **Cindy** also agreed that making learners' active in class and discover solutions to tasks on their own was indeed a good thing to do. She stated that "*Learners seem to enjoy discovering answers on their own more than when I teach them*".

To ensure that learners were active in class, **Sanele** also confirmed that he used the active learning strategy when teaching NSTECH to grade four EFAL classroom. He said he planned the type of activity that learners would perform and made them active depending on the lesson topic. According to **Sanele,** if he gave learners homework or an assignment, the following day learners took turns to give answers and others would have to agree or disagree with the answer. He further elaborated that, "*I also give them formal projects which they are to be performed in class and add to learners' marks*".

In Natural Sciences, teachers have to build learners' knowledge and concepts so that learners can make predictions. Therefore, practical tasks assist learners to discover facts to either accept or reject their predictions. Technology also equips learners with skills and concepts to solve problems. Bussy added to this theme by declaring that "*It is better when I make them perform practical tasks, but when they have to present their findings in English it is still a challenge even though they try very hard*". Learners who are still struggling with the language of instruction can be motivated

extrinsically when they view others perform well and try to communicate without fearing their teacher (Hennessey, 2000).

Grade four NSTECH teachers showed being flexible in class as they not only depended on one specific strategy or made their teaching teacher centred all the time. Veal (1999) acknowledged that teachers gain experience from teaching NSTECH that determines the merits of new strategies with different approaches in teaching. Indeed, teachers who embraced PCK seemed to cope with teaching NSTECH as they indicated a variety of strategies that they used for teaching NSTECH to EFAL grade four learners. Each NSTECH teacher in the study embraced active learning depending on the context of the curriculum they taught to EFAL grade four learners. Either they gave learners individual tasks to perform, or group tasks. The following strategy is about learners working in groups. It is thus another strategy, which was significant amongst teachers with an aim to influence learners to be active (Zayapragassarazan & Kumar, 2012).

4.4.5 GROUP WORK FOR PEER EMPOWERMENT AND ENRICHING SOCIAL SKILLS

Another strategy which appeared to be mostly identified by teachers was the grouping of learners to perform a shared task. Group work provides a context in which individuals help each other, it is a strategy of helping groups as well as helping individuals (Brown, 2017, p. 8). Teachers in the study undertook to teach learners to be self-disciplined by dividing them into small groups where they performed NSTECH tasks together. This means that teachers allowed learners to empower each other while they performed the task (Schreiber & Valle, 2013). This is how **Mbally** gave details of using groups in the class:

> *Even though my learners struggle with the language of instruction, I divide them into groups. Each group is given allocation of task to perform regarding the lesson taught. They work together. It boosts their social skills of communication to teach each other and they learn to be disciplined since the task must be finished before they make presentations. They seem to enjoy this.*

The peer group teaching strategy seems to be rewarding to both learners and teachers. Learners become active on their own in acquiring knowledge through communicative skills without a fear of their teacher (Geller, 2017). NSTECH grade four teachers made use of this opportunity of group work and the vital role it played in teaching. **Bussy** explained that "*I group learners and give them projects while I move around assessing them and that will add on their assessment marks*".

Teachers can use this opportunity to attend to those learners who are still behind if the other groups are successfully working well in the classroom. **Bussy** explained "*Sometimes I group*

learners and give them projects while I move around assessing whether there are groups which require assistance". She said that learners also taught each other in the groups, which involved learning the concepts. From listening to teachers' responses, I noticed when teachers had instructed learners to work in groups that they took instructional rounds, which was much appreciated. Instructional rounds are when teachers move around in the classroom checking if learners are doing what is expected to be done in their groups (City, Elmore & Fiarman, 2011). Learners achieve better in the classroom if they are actively involved and working collaboratively in small groups (Weissberg & Cascarino, 2013). This method will assist learners to communicate their ideas with their classmates during peer discussions. Teachers also got a chance to pick up any misconceptions that grade four learners may have acquired which could be corrected timeously.

Allocating learners in groups for peer teaching empowers them to acquire more knowledge and to develop leadership skills rather than teaching in other instructional manner (Kuusisaari, 2013). It took teachers' experience, planning and creativity to be able to mix all the teaching strategies in class, and be able to form groups amongst learners. It proved that teachers were able to understand learners' challenges and use their PCK to enhance NSTECH knowledge through strategies that would be beneficial to EFAL grade four learners. Crafting and analysing NSTECH teachers' experiences in teaching to EFAL grade four learners is related to Shulman's PCK theory. This is further in the following section.

4.5 CONSOLIDATING TEACHERS' EXPERIENCES OF TEACHING NSTECH TO EFAL GRADE FOUR LEARNERS TO SHULMAN'S PCK CONCEPTUAL FRAMEWORK

In this section, the researcher will draw attention to the potential impact of relating teachers' experiences in teaching NSTECH to EFAL grade four learners and PCK. PCK was potentially related to the study as it incorporated teachers' experiences in teaching NSTECH to EFAL grade four learners in trying to achieve quality teaching (Shulman, 1986 & Zepke, 2013). Teachers are the key to all educational change, according to Fullan (2014). PCK relates well with teachers' teaching transformative learners who are taught a new subject (NSTECH) in a new language of instruction. By understanding Shulman's (1986, 1987) PCK theory, the researcher was able to recognise the aspects of effective teaching and learning. Utilising PCK drawn from various teachers in the study made this kind of understanding possible. Grossman (1990) emphasised that the success of the teaching relies on the four domains. These four domains are related in detail with data gathered from teachers' experiences in the study.

PCK, according to Grossman (1990) explains that teachers must possess the special knowledge of the subject they teach. Therefore, teachers must qualify to understand both NS and TECH knowledge and concepts in order to assist grade four learners with concrete examples. The researcher is able to understand that some teachers teach the subject with just the experience of teaching even though they have a limited knowledge of the subject. The challenge is obviously that teachers were not allocated according to their specialisation of the subject. Hence, according to Ball et al., (2008) teachers' subject knowledge provide them with appropriate techniques to make teaching and learning easier. Another crucial domain of PCK is the ability for teachers to know and understand the learners they teach (Shing et al., 2018). When relating PCK with the recent study, teachers understand their learners especially their barrier in the LoLT. Their understanding of grade four learners in the transition phase from home language to English as a language of instruction leads them to create a quality classroom atmosphere to improve and assist learners with language barriers. Understanding learners assists teachers to use various strategies to support learners with the meaningful learning of NSTECH.

According to Shulman (1986) PCK serves as a useful process for the teachers to develop a deep insight in the totality of the curriculum. It assisted the researcher to develop more insight on the key elements of teachers' experiences as they constitute pedagogical content knowledge (Kola & Sunday, 2015). During the process of data gathering Cindy discussed "*cold-calling*" as one of the teaching strategies she uses in teaching NSTECH with English as a language of instruction. *Cold-calling* is a method where teachers encourage learners to be involved by also participating in the lesson (Dallimore, Hertenstein & Platt, 2012). Cindy indicated that learners are asked a question and the focus on those who did not raise their hands or who show that they do not know the answer. The teacher assists such learners who are called by their names to show them that the teacher is concerned about them and they are valued. This method seemed good to the teacher. Though Dallimore et al, (2012) argues that some learners may feel uneasy when they are exposed to other learners in class.

Cindy also discussed "*exit-ticket*" as a strategy she uses in class. She says in order for her to assess who has gained the correct insight in NSTECH, learners are given papers to write what they understood regarding the NSTECH lesson taught (Francis, 2012). Cindy believes this method assists her to also assess the English language development in learners' writings. Mbally's PCK of understanding learners was also revealed when she discussed how she checks whether learners had all their resources in order before she could teach them. Mbally says that she asks all learners to raise their NSTECH books and pens before the lesson starts. She then moves around and checks

whether learners have their learning resources including the right books. Learners also check with each other. She says she then counts from one to ten and learners will bang their pens down which really excites them.

Teachers' PCK taught them that grade four learners sometimes behaved like new learners when starting a new phase. They got confused with the language of instruction and confused their exercise books and sometimes chose to simply sit without writing. According to Shulman (1986, p. 9), PCK "goes beyond knowledge of subject matter to determine the subject matter for teaching". This means that teachers move beyond understanding NSTECH as a subject to understanding the nature of grade four learners who have transitioned from the foundation phase. Therefore, constant relating with PCK played a significant role to the researcher to explore each teachers' thinking regarding teaching NSTECH in English as a LoLT to grade four learners.

PCK was effective to reveal what teachers thought of the current NSTECH grade four CAPS policy regarding the instructional time, the choice of language usage in the classroom especially the EFAL grade four learners. It made the researcher able to deduce that grade four learners needed a teacher who had a specialised knowledge of NSTECH, a teacher who possessed knowledge to teach the subject. According to Ball et al (2008), PCK assists teachers to understand the significance of upgrading their knowledge. However, teachers in this study realised they needed to be competent with special NSTECH knowledge to teach effectively.

The researcher could understand teachers' dedication and preparedness in teaching as a whole. In the same way, it was not difficult to conclude about the possibilities that made teachers able to teach NSTECH to EFAL grade four learners. Gess-Newsome and Lederman (2001) indicated that PCK assists teachers with knowledge of the subject and increases as more experience is gained. Moreover, through teachers' PCK, it may be analysed that more developmental programmes are required for most grade four NSTECH teachers. There is little difficulty that is caused by deficiency of specific knowledge of NSTECH.

4.6 CONCLUSION

Teachers' experiences in teaching NSTECH to EFAL grade four learners in this study were presented. NSTECH subject knowledge and English as a language of instruction play a huge role and directly influence teaching and learning strategies, classroom environment and activities to cope with language barriers in the classroom. Data gathered from grade four NSTECH teachers in the study indicate an urgent need for an additional support to assist teachers cope with grade

four learners who are new in English as a language of instruction. The following chapter will present the discussion of findings and a summary of each theme formulated during data gathering, recommendations of this study and recommendations for further studies.

CHAPTER FIVE

SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

The previous chapter was based on analysing responses gathered from teachers' experiences of teaching NSTECH in EFAL grade four learners in the study. Hence, the objective of the current chapter is to reflect upon and to provide a summary of the findings that emerged during data gathering and analysis in the previous chapter. It will commence with the summary of the study to reflect teachers' real experiences as closely as possible. Also, the summary behind each finding will be carefully interpreted. This will allow the researcher to make suggestions based on the findings of this study as well as recommendations for the possibility of future research studies. The researcher drew insight in data gathered from chosen teachers' teaching NSTECH to EFAL grade four learners for the current study. Data was gathered using the two gathering techniques: questionnaires and semi-structured interviews. The main aim was to address the two following research questions:

- What are teachers' experiences of teaching NSTECH to EFAL grade four learners?
- What teaching strategies do teachers employ when teaching NSTECH to EFAL grade four learners?

5.2 SUMMARY OF THE STUDY

The aim of the study was to explore and gain insight regarding teachers' experiences in teaching NSTECH to EFAL grade four learners. The main focus was to understand both positive and negative teachers' experiences. The study was also to recognise the role teachers play in teaching grade four learners who had just transitioned from being taught in their home language to English as LoLT. Grade four teachers are faced with the task of introducing the new subject like NSTECH, which is an integrated subject in English as the LoLT for the first time in public schools.

The study generated quality data using purposive sampling where four teachers in the urban area teaching NSTECH to EFAL grade four learners were chosen. The qualitative research in the study concluded that grade four teachers' deal with various challenges while implementing NSTECH

curriculum in English as LoLT in the classroom. These challenges are unpacked as summary of findings in the following section. Due to learners limited English vocabulary and their lack of familiarity with English as the language of instruction, and with NSTECH being the new subject with many abstract concepts teachers find the quality of their teaching compromised. However, grade four teachers are empowered by their increased accountability and experience as they understand the learners' transitional phase and are able to meet their learners' needs. They are able to create classroom conditions for effective teaching and learning. The recurring theme is that starting English as LoLT at grade four needs revision by the department of basic education. Further insight on data gathered is narrated briefly on the themes.

5.3 SUMMARY OF EACH FINDING

This section will discuss themes gathered from teachers who participated in the study. Each theme contributed to a valuable and meaningful exploration of teachers' experiences in teaching of NSTECH to grade four EFAL learners. Themes were formulated in response to the two research questions.

RESEARCH QUESTION 1: WHAT ARE TEACHERS' EXPERIENCES OF TEACHING NSTECH TO EFAL GRADE FOUR LEARNERS?

5.3.1 CHALLENGES OF TEACHING NSTECH IN ENGLISH AS A LANGUAGE OF INSTRUCTION

Teachers are challenged when teaching NSTECH in English as a language of instruction as it is the learners' second language. It is difficult for teachers to make grade four learners relate to NSTECH with their prior knowledge because they are introduced to the subject content for the first time. The main contrast is that grade four learners find it difficult to understand NSTECH in English. Teachers find themselves having to translate many words in a language, which will be understandable by learners. There is a communication breakdown between teachers and learners during teaching and learning caused by a limited language proficiency in EFAL of learners. The issue of language is a major challenge in grade four learners because neither teachers nor learners have chosen the delay of English as a language of instruction in the public schools. The biggest concern is that English is still the official language for teaching any academic content subject including NSTECH in the intermediate phase. Even books for natural sciences and technology are written in the English language (Pennycook, 2017).

5.3.2 EFAL GRADE FOUR LEARNERS STRUGGLE TO GRASP NSTECH

Learners struggle to understand NSTECH content and remain passive in the classroom. This is because grade four learners struggle to understand the subject taught in a language they were not taught with in the foundation phase. Teachers claim that learners' ideas are blocked as it takes time for them to express themselves in English as LoLT. This does not empower grade four learners as much as they are expected as they are not keen to participate in classroom activities. Learners become confused and it results in various contradictions in the classroom. Teachers find themselves in a dilemma as they have to spend more time on each topic and at times, they have to attend to developing learners' language skills. Sometimes teachers have to force learners to talk while they are not comfortable to express themselves. This may contribute to learners losing interest in NSTECH studies and some learners may even resort to drop-out of school. From this perspective, teachers become the givers of knowledge (Trybus, 2013) and are challenged because learners cannot express themselves in English as a language of communication in teaching NSTECH.

5.3.3 LIMITED INSTRUCTIONAL TIME COMPROMISES QUALITY TEACHING

Instructional time provided by the department for teaching NSTECH to EFAL grade four learners does not allow teachers enough time to effectively engage learners. Teacher participants felt there is a limited time to develop NSTECH competence while using a range of communication skills due to language barrier. Hence, the limited instructional time results in teachers failing to meet with the objectives of NSTECH curriculum planning. Teachers' professional teaching energy is compromised as they are marginalised from keeping pace with classroom activities. One of the negative impacts with limited instructional time is that grade four teachers are challenged to cover all intended topics within each term.

5.3.4 LIMITED INSTRUCTIONAL TIME AFFECTS LEARNING

Learning of NSTECH to grade four learners is also affected by the limited instructional time. It is hard for learners to connect with NSTECH content while they cannot understand English as LoLT. As learners have a limited English vocabulary in grade four, they still require time to understand the meaning of NSTECH abstract concepts. They need time to first translate their findings to their mother tongue before they translate to English as a language of instruction. Learners cannot accommodate all their learning activities with the limited time. Limited instruction time doesn't allow learners to fully assimilate with both English as a new language of

instruction and NSTECH content. Thus, this encourages teachers to also limit important NSTECH activities and embark on mostly being talkative in class. Thus, learners are not actively engaged in acquiring new knowledge because teachers are pressured to preserve the limited time.

5.3.5 IMPOSITION OF NSTECH CAPS POLICY ON GRADE FOUR NSTECH TEACHERS

Teachers felt the CAPS policy compelled them to teach NSTECH as an integrated subject in English as the LoLT. NSTECH was imposed to grade four teachers as an integrated subject, although majority of the teachers had long taught in the primary school, CAPS gave teachers no option but to teach the subject as it was intended by the curriculum policy designers. The curriculum came with many challenges, and teachers feel are too much for grade four learners who transitioned from being taught in their home language in grade three. Teachers feel that the grade four NSTECH CAPS policy did not fully consider all important contextual factors of teaching and learning. Mostly these contexts have been highlighted as learners' prior knowledge, language of instruction and subject knowledge of teachers.

5.3.6 INADEQUATE NSTECH SUBJECT KNOWLEDGE COMPROMISES TEACHING AND LEARNING

The findings indicated that teachers teach NSTECH without the sound knowledge of the subject, which does not give them much confidence in the classroom to cater for learners needs (du Plessis, 2015). The participants were not subject specialists of NSTECH but they are teaching NCTECH. However, teachers have survived by being lifelong learners and gained much experience in the teaching field. Even though teachers are qualified in their profession of teaching and have sound teaching skills, what makes them sceptical is their lack of content knowledge of NSTECH as a subject. The research data clearly shows that grade four teachers would prefer to be subject specialist for NSTECH. They disclosed that they have acquired much PCK with their experience of teaching NSTECH to second language English speaking learners.

5.3.7 POSSIBILITIES FOR TEACHING OF NSTECH TO EFAL GRADE FOUR LEARNERS.

Teachers indicated that there were particular practices that assisted them to successfully teach NSTECH to EFAL grade four learners. The following were absolutely key to creating quality teaching and management of teaching and learning:

5.3.7.1 TEACHERS' EXPERIENCES LEADS TO IMPROVED TEACHING

The more teachers gain experience in teaching NSTECH in English as a second language to grade four learners, the more they improved their teaching skills. Gaining experience provides teachers with the means for understanding how best to teach NSTECH in English as the LoLT. According to Van Hoorn et al. (2014) the more teachers gain experience in teaching the subject content, the better they are able to implement the curriculum to learners.

5.3.7.2 CREATING A DISCIPLINED CLASSROOM ENVIRONMENT

Teachers keep learners disciplined in the classroom by motivating them to participate in classroom activities. Learners are taught to support each other by discouraging bad behaviour like mocking others during class activities.

5.3.7.3 SUSTAINING A CONDUCIVE AND CARING CLASSROOM ENVIRONMENT

Teachers' knowledge of learners, the value of English as LoLT and the understanding of subject knowledge encouraged teachers to sustain successful teaching of NSTECH. Teachers make sure that they link NSTECH activities with learners' everyday experiences and encourage them to extend their knowledge beyond the classroom. Charts and other concrete resources are displayed in NSTECH grade four classrooms. Learners are able to keep reminding themselves about NSTECH concepts and other activities. Teachers also prepare informal assessments to   assess how learners have mastered the subject before they write the formal assessments.

5.4 RESEARCH QUESTION 2: WHAT TEACHING STRATEGIES DO TEACHERS EMPLOY WHEN TEACHING NSTECH TO EFAL GRADE FOUR LEARNERS?

5.4.1 FREQUENTLY ASKING QUESTIONS: REINFORCEMENT TO EVALUATE UNDERSTANDING

Most teachers ask questions as a strategy to capture learners' attention and make learners recall knowledge they have gained. Some teachers ask questions to monitor whether their NSTECH implementation is successful or not. Questions keep a connection between teachers, learners, and the subject content. Teachers try to keep learners attentive by frequently asking questions during the teaching and learning process. Hence, teachers design their lesson in a way that allows for the continuous question and answer method. However, teachers do indicate that this strategy consumes time as they have to code-switch the question because of the language barrier.

However, when learners answer questions they increase and develop their oral skills. Therefore, questions fulfil one of the objectives of NSTECH curriculum for grade four learners to develop language skills. Questioning is a strategy that is motivated by teachers in making a warm and a caring atmosphere in the classroom and creating disciplined learners who are not scared to answer questions.

5.4. 2 CODE- SWITCHING TO ADDRESS ISSUES OF LANGUAGE BARRIER

Code-switching appeared a common strategy amongst teachers teaching NSTECH in English as a second language to grade four learners. Grade four teachers prefer to code-switch from English as the LoLT to learners' home language in addressing the challenges caused by transition in the language of instruction for both learners and teachers. Teachers use code-switching to develop interpersonal skills between learners and teachers regarding the lesson taught. Code-switching enables learners to participate in class activities. Teachers' code-switch from one NSTECH concept to sentences. All teachers indicated that this strategy also consumes time as both teachers and learners have to translate the content into learners' home language so that it makes sense.

5.4.3 LECTURE STYLE TEACHING FOR PROFOUND TEACHING AND LEARNING OF NSTECH TO EFAL GRADE FOUR LEARNERS

All teachers in the research study seemed excited to implement a lecturing method with an aim of creating interactive teaching and learning classroom situations. They believed lecturing in class assisted them to acquaint all learners with knowledge of NSTECH as a subject. Teachers preferred the lecturing method as they claimed they were able to attend to all learners while teaching them equal education (Tanner, 2013). Lecturing to all learners assisted teachers to clarify more precisely how the work was done. Teachers can also emphasise NSTECH concepts while developing English as a language of instruction and learning. This strategy assists teachers to observe built-in attitudes of learners and they can then use other varieties of methods to support teaching and learning of NSTECH to EFAL grade four learners.

5.4.4 ACTIVE LEARNING: STRATEGY TO BUILD NSTECH SKILLS AND KNOWLEDGE

Teachers allow learners to perform experiments and do practical projects in order to discover more of NSTECH facts and knowledge themselves. While learners are involved in these activities, teachers move around to check learners' strengths and weaknesses. Then, those learners that really need assistance are given attention though time is a limiting factor. Active learning strategies help to make more sense of NSTECH skills and knowledge and improves

EFAL skills while learners engage in different projects. According to Criticos et al. (2012) accentuates that learners can only gain 20% of the knowledge they have from listening, but if they were actively involved while learning they will demonstrate an understanding at 80%.

5.4.5 GROUP WORK FOR PEER EMPOWERMENT AND REINFORCING NSTECH KNOWLEDGE

Teachers divide learners into small groups to perform NSTECH tasks. The major aim is to reinforce NSTECH knowledge based on the lesson done during teaching and learning. In groups learners learn to solve problems, share the responsibilities as they have to discuss and listen to each other. They can even practice English language skill without fearing to be heard by the whole class. Teachers facilitate groups by instilling virtues of discipline so that learners can interact with each other and that improves their language skills. Through group work teachers can assess how significantly learners have mastered NSTECH knowledge and decide whether to teach again. It is also easy to identify learners with good oral presentations. Learners become fully active when they work in their groups.

5.4.6 CONSOLIDATING TEACHERS' EXPERIENCES IN TEACHING NSTECH TO EFAL GRADE FOUR LEARNERS TO SHULMAN'S PCK CONCEPTUAL FRAMEWORK

Teachers' experiences in teaching NSTECH to EFAL grade four learners was discussed in relation to Shulman's PCK theory. These included teachers' knowledge of the subject content, curriculum goals and objectives, learners' educational background and the teachers' choice of teaching strategies. As the study was progressing in conjunction with the PCK literature, it. Another useful feature for PCK was possible to identify gaps and measure teachers' success in teaching NSTECH to EFAL grade four learners, and to deduce suggestions from the study.

5.5 SUGGESTIONS BASED ON THE FINDINGS OF THE STUDY

In responding to the most essential exploring of teachers' experiences of teaching NSTECH to EFAL grade four learners, the researcher made the following suggestions:

- English as a language of instruction should begin in the foundation phase. This might decrease teachers' challenges in teaching NSTECH in English as a LoLT at grade four level as learners will be familiar with the language of instruction. This corresponds with the human factor that the brain is capable of co-ordinating more than one language from a very early stage (Roskos, 2017).

- Pre-service teacher programmes and in-service teacher workshops should focus on equipping teachers as subject specialists to implement integrated subjects like NSTECH successfully. More so, teachers should be prepared to teach in diverse South African contexts, such as teaching subjects to second language speaking learners in English as a LoLT.

- It might also be crucial to collaborate grade four NSTECH teachers with EFAL grade four teachers with an aim of sharing their teaching approaches. This will assist grade four NSTECH teachers with the deep understanding of teaching the subject content in English as a language of instruction (Ashley, 2016).

- Primary schools should also consider having teachers who are specialist in teaching NSTECH commencing from grade four. The special knowledge of the subject will boost teacher's self-esteem in teaching NSTECH (Ingvarson, Schwille, Tatto, Rowley, Peck & Senk, 2013). The most important factor for teaching learners is to impart worthwhile NSTECH knowledge to EFAL grade four learners. Good planning is required to make sure that teachers teach for a clear purpose to the learners.

- Each grade four NSTECH classroom should be fully equipped with upgraded teaching resources like the internet. This will assist teachers to involve learners with the use of technology in finding truths themselves and even the meaning of concepts. However, learners should be grouped according to their capabilities. It would be a brilliant idea for teachers to allow learners to name their groups using NSTECH words.

- The last suggestion would be for the DoE to increase the instructional time for NSTECH grade four learners. Adequate instructional time might ensure that teachers can attend to learners' needs especially their language so that they can better understand NSTECH content.

It is apparent that teaching and learning of NSTECH to EFAL grade four learners qualifies for further enrichment to accomplish its aims and objectives.

5.6 RECOMMENDATIONS FOR FUTHER RESEARCH

This chapter also concludes with a call for further research. This particular study is a fairly new area of study in the South African schooling context and therefore could contribute invaluable data on teachers experiences when teaching NSTECH to grade 4 EFAL learners. Further research recommendations are as follows:

- Since this study examines teachers' experiences of teaching NSTECH to grade 4 EFAL learners, it would also be interesting to note the findings of large-scale studies that delve into teaching NSTECH to grades 4, 5 and 6 learners with English as a medium of instruction.
- Exploring Teachers' perceptions of teaching in learners' home language in the foundation phase and changing the language of instruction from grade four.
- Since teachers experiences ultimately play a role in curriculum changes, it would be beneficial to undertake future studies on how these experiences affect the implementation and overall welfare of teachers and how it can be better suited to accommodate their experiences.
- A final recommendation advocates for the exploration into consistent communication between policy makers and teachers on how to best minimise the challenges experienced by teachers when planning and implementing a subject like NSTECH. Presumably, because teachers experience of teaching NSTECH affects the quality of education for all.

5.7 CONCLUDING REMARKS

Language should not deprive teaching and learning, for both teachers and learners (Seah, 2016). Teachers should not be discouraged by the language barrier. The study acknowledged the passion along with dedication from teachers to implement a newly integrated curriculum like NSTECH to grade four EFAL learners effectively. Teachers are faced with the challenge of familiarising learners with English as the LoLT whilst teaching them a combined subject, so that they can make sense of the content knowledge. Teachers require the necessary pre- and in-service training and knowledge, support and updated resources that relate to the current times to facilitate effective teaching. Especially in subjects like NSTECH, the context of this study is to develop both knowledge and improve English language skills.

REFERENCES

Abd-El-Khalick, F. (2013). Teaching with and about nature of science, and science teacher knowledge domains. *Science & Education,* 22 (9), 2087-2107.

Abdi, A. (2014). The Effect of Inquiry-Based Learning Method on Students' Academic Achievement in Science Course. *Universal journal of educational Research,* 2(1), 37-41.

Abell, S. K., Appleton, K., & Hanuscin, D. L. (2013). Science Education and Student Diversity: Race/Ethnicity, Language, Culture, and Socioeconomic Status *Handbook of Research on Science Education* (pp. 185-212). New York: Routledge.

Acharya, A. S., Prakash, A., Saxena, P., & Nigam, A. (2013). Sampling: Why and how of it. *Indian Journal of Medical Specialities,* 4(2), 330-333.

Alario-Hoyos, C., Perez-Sanagustin, M., Delgado-Kloos, C., & Munoz-Organero, M. (2014). Delving into participants' profiles and use of social tools in MOOCs. *IEEE Transactions on Learning Technologies,* 7(3), 260-266.

Algeo, J., & Butcher, C. A. (2013). *The origins and development of the English language*: Cengage Learning. Stanford, Ca: University Press.

Ali, N. L. (2013). A changing paradigm in language planning: English-medium instruction policy at the tertiary level in Malaysia. *Current Issues in Language Planning,* 14(1),73-92. Malaysia. Current Issues.

Alqahtani, M. (2015). The importance of vocabulary in language learning and how to be taught. *International journal of teaching and education,* 3(3), 21-34.

An, S., Kulm, G., & Wu, Z. (2004). The pedagogical content knowledge of middle school, mathematics teachers in China and the US. *Journal of mathematics teacher education*, 7 (2), 145-172.

Andersson, K., & Gullberg, A. (2014). What is science in preschool and what do teachers have to know to empower children? *Cultural studies of science education,* 9 (2), 275-296.

Angelle, P., & M. Teague, G. (2014). Teacher leadership and collective efficacy: Teacher perceptions in three US school districts. *Journal of Educational Administration,* 52(6)), 738-753.

Anohina, A. (2005). Analysis of the terminology used in the field of visualn learning. Journal of Educational Technology & Society, 8(3).

Appleton, K. (2003). How do beginning primary school teachers cope with science? Toward an understanding of science teaching practice. *Research in Science Education,* 33(1), 1-25.

Appleton, K. (2013). *Elementary science teacher education: International perspectives on contemporary issues and practice.* New York: Routledge.

Ashley, D. M. (2016). It's about Relationships: Creating Positive School Climates. *American Educator*, *39*(4), 13-16.

Auer, P. (2013). The'why'and'how'questions in the analysis of conversational code-switching *Code-switching in Conversation* (pp. 164-187). London / New York: **Routledge**.

Azian, A. A., Raof, A. H. A., Ismail, F., & Hamzah, M. (2013). Communication strategies of nonnative speaker novice science teachers in second language science classrooms. *System, 41*(2), 283-297.

Babson, A. (2014). Developing Possibilities for South African Youth: Beyond Limited Educational Choices? *The ANNALS of the American Academy of Political and Social Science, 652*(1), 149-165.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special?. *Journal of teacher education*, 59(5), 389-408.

Baines, E., Blatchford, P., & Kutnick, P. (2016). *Promoting effective group work in the primary classroom: A handbook for teachers and practitioners*. New York: Routledge.

Banda, F. (2018). Translanguaging and English-African language mother tongues as linguistic dispensation in teaching and learning in a black township school in Cape Town. *Current Issues in Language Planning, 19*(2), 198-217.

Bantwini, B. (2017). Analysis of teaching and learning of natural sciences and technology in selected Eastern Cape province primary schools, South Africa. *Journal of Education* (67), 39-64.

Baquedano-López, P., Alexander, R. A., & Hernández, S. J. (2013). Equity issues in parental and community involvement in schools: What teacher educators need to know. *Review of Research in Education, 37*(1), 149-182.

Barrow, L., & Markman-Pithers, L. (2016). Supporting young English learners in the United States. *The Future of Children*, 159-183.

Barrow, R. (2015). *Giving teaching back to teachers: A critical introduction to curriculum theory*. New York: Routledge.

Basturkmen, H. (2014). *Ideas and options in English for specific purposes*. New York: Routledge.

Batool, S. H., & Mahmood, K. (2016). Teachers' conceptions about information literacy skills of school children. *Pakistan Journal of Information Management & Libraries (PJIM&L), 13*.

Beane, J. A. (2016). *Curriculum integration: Designing the core of democratic education*. New York: Teachers College Press.

Behr, D., Braun, M., Kaczmirek, L., & Bandilla, W. (2013). Testing the validity of gender ideology items by implementing probing questions in web surveys. *Field Methods,* 25(2), 124-141.

Beni, S., Stears, M., & James, A. (2017). Foundation phase teachers' interpretation of the life skills programme with regard to the teaching of natural science. *South African Journal of Childhood Education,* 7(1), 1-14.

Benson, P. (2013). *Teaching and researching: Autonomy in language learning*. New York: Routledge.

Beres, A. M. (2015). An overview of translanguaging: 20 years of 'giving voice to those who do not speak'. *Translation and Translanguaging in Multilingual Contexts*, 1(1), 103-118.

Berger, R. (2015). Now I see it, now I don't: Researcher's position and reflexivity in qualitative research. *Qualitative Research,* 15(2), 219-234.

Berkowitz, S. (2013). Using qualitative and mixed-method approaches *Needs Assessment* (pp. 6986): Taylor & Francis.

Berry, A., & Van Driel, J. H. (2013). Teaching about teaching science: Aims, strategies, and backgrounds of science teacher educators. *Journal of teacher education,* 64(2), 117-128.

Berry, A., Friedrichsen, P., & Loughram., J. (Eds). (2015). Re-examining pedagogical content in science education. New York: Routledge.

Bills, P., Kulkarni, M., & Hart, R. S. (2017). Professional Development in Real Time. *Science and Children*, 55(1), 30.

Bianchini, J. A. (2013). Expanding underrepresented minority participation: America's science and technology talent at the crossroads. *Science Education,* 97(1), 163-166.

Bonwell, C. C., & Eison, J. A. (1991). Active Learning: Creating Excitement in the Classroom. Washington: ERIC Digest.

Botha, R. J. (2002). Outcomes-based education and educational reform in South Africa. *International journal of leadership in education*, 5(4), 361-371.

Botwe-Asamoah, K. (2013). *Kwame Nkrumah's Politico-Cultural Thought and Politics: An African-Centered Paradigm for the Second Phase of the African Revolution*. New York: Routledge.

Bradbury, L. U. (2014). Linking science and language arts: A review of the literature which compares integrated versus non-integrated approaches. *Journal of science teacher education,* 25(4), 465-488.

Braine, G. (2013). *Non-native educators in English language teaching*. New York: Routledge.

Braun, V., Clarke, V., & Terry, G. (2014). Thematic analysis. *Qual Res Clin Health Psychol,* 24, 95-114.

Brígido, M., Borrachero, A. B., Bermejo, M. L., & Mellado, V. (2013). Prospective primary teachers' self-efficacy and emotions in science teaching. *European Journal of Teacher Education, 36*(2), 200-217.

Brock-Utne, B. (2014). Language of instruction in Africa–the most important and least appreciated issue. *International Journal of Educational Development in Africa,* 1(1), 4-18.

Brock-Utne, B., & Qorro, M. (2015). Multilingualism and language in education in Tanzania. *Multilingualism and language in education: Current sociolinguistic and pedagogical perspectives from Commonwealth countries*, 19-30. Spring, Dordrecht.

Brookfield, S. D. (2017). *Becoming a critically reflective teacher*: John Wiley & Sons.

Brown, A. (2017). *Groupwork*. New York Routledge.

Bruna, K. R., Vann, R., & Escudero, M. P. (2007). What's language got to do with it?: A case study of academic language instruction in a high school "English Learner Science" class. *Journal of English for Academic Purposes,* 6(1), 36-54.

Bryman, A., & Bell, E. (2015). *Business research methods*. USA: Oxford University Press.

Bunch, G. C. (2013). Pedagogical language knowledge: Preparing mainstream teachers for English learners in the new standards era. *Review of Research in Education,* 37(1), 298341.

Byram, M., & Hu, A. (2013). *Routledge encyclopedia of language teaching and learning*.

London New York: Routledge.

Cammarata, L., & Tedick, D. J. (2012). Balancing content and language in instruction: The experience of immersion teachers. *The Modern Language Journal,* 96(2), 251-269.

Carlsen, W. S. (1991). Questioning in classrooms: A sociolinguistic perspective. *Review of Educational Research,* 61(2), 157-178.

Catling, S. (2014). Pre-Service Primary Teachers' Knowledge and Understanding of Geography and Its Teaching: A Review. *Review of International Geographical Education Online,* 4(3), 235-260.

Cavanagh, M., & McMaster, H. (2017). A Specialist Professional Experience Learning Community for Primary Pre-Service Teachers Focussed on Mathematical Problem Solving. *Mathematics Teacher Education and Development,* 19(1), 47-65.

Chen, A.h. (2013). An Evaluation on Primary English Education in Taiwan: From the Perspective of Language Policy. *English Language Teaching,* 6(10), 158-165.

Chiang, T. H.C., Yang, S. J., & Hwang, G.-J. (2014). An augmented reality-based mobile learning system to improve students' learning achievements and motivations in natural science inquiry activities. *Educational Technology & Society,* 17(4), 352-365.

Chicgona, A. (2010). ICTS for curriculum delivery: understanding educators' perceptions and experiences of the technology in disadvantaged high schools. *Journal for New Generation Sciences, (9(1)*, 1-13.

Childs, P. E., Markic, S., & Ryan, M. C. (2015). The role of language in the teaching and learning of chemistry. *Chemistry Education: Best Practices, Opportunities and Trends (eds J. García-Martínez and E. Serrano-Torregrosa), Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim: Germany.*

Chivhanga, E., & Chimhenga, S. (2013). Language planning in Zimbabwe: The use of indigenous languages (Shona) as a medium of instruction in primary schools. *Journal of Humanities and Social Science,* 12(5), 58-65.

Christiansen, I., Bertram, C., & Land, S. (2010). Understanding research. *Pietermaritzburg:*

UKZN Faculty of Education.

Christy, T. C. (2013). Vygotsky, Cognitive Development and Language. *Historiographia Linguistica, 40.*

City, E. A., Elmore, R. F., & Fiarman, S. E. (2011). What Are Instructional Rounds? *Learning,* 69(2).

Clarke, V., & Braun, V. (2014). Thematic analysis *Encyclopedia of quality of life and well-being research* (pp. 6626-6628): Springer.

Cleary, M., Horsfall, J., & Hayter, M. (2014). Data collection and sampling in qualitative research: does size matter? *Journal of advanced nursing,* 70(3), 473-475.

Clements, D. H., & Sarama, J. (2016). Math, science, and technology in the early grades. *The Future of Children*, 75-94.

Cobern, W. W. (1996). Worldview theory and conceptual change in science education. *Science Education,* 80(5), 579-610.

Cohen, A. D. (2014). *Strategies in learning and using a second language.* New York: Longman, Routledge.

Cohen, L., Manion, L., & Morrison, K. (2002). *Research methods in education.* London:

Routledge.

Cohen, L., Manion, L. & Morrison, K. (2007). *Research methods in education* (5th ed.). London and New York: Routledge Falmer.

Cohen, L., Manion, L., & Morrison, K. (2011). Coding and content analysis. *Research methods in education*, 559-573.

Cohen, L., Manion, L., & Morrison, K. (2013). Validity and reliability *Research methods in education* (pp. 203-240). London: Routledge.

Comas-Quinn, A. (2011). Learning to teach online or learning to become an online teacher: An exploration of teachers' experiences in a blended learning course. *ReCALL*, 23(3), 218-232. doi:10.1017/S0958344011000152

Cope, D. G. (2014). *Methods and meanings: credibility and trustworthiness of qualitative research.* Paper presented at the Oncology nursing forum.

Council, T. A., National Academies of Sciences, E., & Medicine. (2016). *Science teachers' learning: Enhancing opportunities, creating supportive contexts*: National Academies Press.

Creswell, J. W. (2009). Editorial: Mapping the field of mixed methods research. *Journal of Mixed Methods Research, 3*(2), 95-108.

Creswell, J. W. (2013). Steps in conducting a scholarly mixed methods study.

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research.* Thousand Oaks,CA:Sage Publications.

Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. *Handbook of mixed methods in social and behavioral research, 209*, 240. Thousand Oaks, CA: Sage Publications.

Cross, M., Mungadi, R., & Rouhani, S. (2002). From policy to practice: Curriculum reform in South African education, 38(2), 171-187.

Cummins, J., & Swain, M. (2014). *Bilingualism in education: Aspects of theory, research and practice*: Routledge.

Dallimore, E. J., Hertenstein, J. H., & Platt, M. B. (2013). Impact of cold-calling on student voluntary participation. *Journal of Management Education*, *37*(3), 305-341.

Dang, T. K. A., Nguyen, H. T. M., & Le, T. T. T. (2013). The impacts of globalisation on EFL teacher education through English as a medium of instruction: An example from Vietnam. *Current Issues in Language Planning,* 14(1), 52-72.

Danielewicz, J. (2014). *Teaching selves: Identity, pedagogy, and teacher education*. New York: Suny Press.

Davis, E. A. & Krajcik, J.S. (2005). Designing educative curriculum materials to promote teacher learning. Educational researcher, 34(3), 3-14.

Demm, L. M. (2016). *Creating a Third Space for Developing Language and Cultural Practices: Exploring Translanguaging in a Third Grade Dual Language Classroom*. Hofstra University.

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2011). *The Sage handbook of qualitative research*. Thousand Oaks: Sage Publications.

Department of Education. (2011). *Curriculum and Assessment Policy Statement: Natural Science and Technology (Intermediate Phase)*. Pretoria.

De Vos, A., Delport, C., Fouché, C., & Strydom, H. (2011). Research at grass roots: A primer for the social science and human professions. Pretoria: JL Van Schaik Publishers. Van Schaik Publishers.

Dearden, J. (2014). *English as a medium of instruction-a growing global phenomenon*. Oxford: University of Oxford British Council.

Dewey, J. (1963). *Liberalism and social action* (Vol. 74) New York: Capricon books.

Dewey, J. (2005). *Art as experience*: Penguin.

Dhillon, J. K., & Wanjiru, J. (2013). Challenges and strategies for teachers and learners of English as a second language: The case of an urban primary school in Kenya. *International Journal of English Linguistics,* 3(2), 14.

Dillon, J. (2016). 17 On Scientific Literacy and Curriculum Reform. *Towards a Convergence Between Science and Environmental Education: The Selected Works of Justin Dillon*. Taylor & Francis.

Dörnyei, Z. (2014). Researching complex dynamic systems:'Retrodictive qualitative modelling'in the language classroom. *Language Teaching,* 47(1), 80-91.

Dowden, T. (2014). Challenging, integrated, negotiated and exploratory curriculum in the middle years of schooling: Designing and implementing high quality curriculum integration. *Australian Journal of Middle Schooling*, *14*(1), 16-27.

Drew, H. (2014). Overcoming Barriers: Qualitative Interviews With German Elites. *Electronic Journal of Business Research Methods, 12*(2).

du Plessis, A. E. (2015). Effective education: Conceptualising the meaning of out-of-field teaching practices for teachers, teacher quality and school leaders. *International Journal of Educational Research, 72*, 89-102.

Eady, M., & Lockyer, L. (2013). Tools for learning: Technology and teaching. *Learning to teach in the primary school,* 71. Brisbane: Qeensland University of Technology, Astralia

Early, M., & Norton, B. (2014). Revisiting English as medium of instruction in rural African classrooms. *Journal of Multilingual and Multicultural Development,* 35(7), 674-691.

Eckert, S. A. (2013). What do teaching qualifications mean in urban schools? A mixed-methods study of teacher preparation and qualification. *Journal of teacher education,* 64(1), 75-89.

Edelson, D. C. (2001). Learning_for_use: A framework for the design of technology_supported inquiry activities. *Journal of Research in Science teaching,* 38(3), 355-385.

Eisner, E. W. (2017). *The enlightened eye: Qualitative inquiry and the enhancement of educational practice*. New York: Teachers College Press.

Ellington, H. (1993). *Handbook of educational technology*. Nichols Publishing, PO Box 6036, East Brunswick, NJ 08816. Paperback: Kogan Page India

EL-Deghaidy, H., Mansour, N., Aldahmash, A., & Alshamrani, S. (2015). A framework for designing effective professional development: Science teachers' perspectives in a context of reform. *Eurasia Journal of Mathematics, Science & Technology Education,* 11(6).

Elbaz, F. (2018). *Teacher thinking: A study of practical knowledge*. London and Boston: Routledge.

Erduran, S., & Msimanga, A. (2014). Science curriculum reform in South Africa: Lessons for professional development from research on argumentation in science education. *Education as Change,* 18(sup1), S33-S46.

Eriksson, P., & Kovalainen, A. (2015). *Qualitative methods in business research: A practical guide to social research*. London: Sage.

Erlingsson, C., & Brysiewicz, P. (2013). Orientation among multiple truths: An introduction to qualitative research. *African Journal of emergency medicine,* 3(2), 92-99.

Espinoza Jaramillo, S. G. (2015). Factors that influence teachers not to develop the strategies to improve the correct classroom management with an english language environment.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics,* 5(1), 1-4. Fernandez, C. (2014). Knowledge base forteachingand Pedagogical Content Knowledge (PCK):Some useful modelsand implications for teachers' training. Problems of Education in 21st century,60.

Feza, N. (2014). Inequities and lack of professionalisation of early childhood development practice hinder opportunities for mathematics stimulation and realisation of South African policy on quality education for all. *International Journal of Inclusive Education,* 18(9), 888-902.

Fitzgerald, A., Dawson, V., & Hackling, M. (2013). Examining the beliefs and practices of four effective Australian primary science teachers. *Research in Science Education, 43*(3), 9811003.

Flick, U. (2014). *An introduction to qualitative research*. London: Sage Publication Limited.

Flick, U. (2015). *Introducing research methodology: A beginner's guide to doing a research project*. Thousand Oaks, California: Sage.

Fomunyam, K. G. (2014). Curriculum theorizing and individualism: An exploration of the curriculum's relation to the social, personal and political dimensions of schooling. *Mevlana International Journal of Education (MIJE), 4*(2), 122-131.

Fomunyam, K. G. (2018). Deconstructing quality in South African higher education. *Quality Assurance in Education, 26*(1), 44-59.

Francis, R. W. F. (2012). Engaged: Making large classes feel small through blended learning instructional strategies that promote increased student performance. *Journal of College Teaching & Learning (Online)*, *9*(2), 147.

Friborg, O., & Rosenvinge, J. H. (2013). A comparison of open-ended and closed questions in the prediction of mental health. *Quality & Quantity, 47*(3), 1397-1411.

Fullan, M. (2014). *Teacher development and educational change*. London: Routledge.

García, O., & Wei, L. (2014). Translanguaging. *The Encyclopedia of Applied Linguistics*, 1-7.

Gardner-Chloros, P., & Weston, D. (2015). Code-switching and multilingualism in literature. *Language and Literature, 24*(3), 182-193.

Gecer, A., & Ozel, R. (2012). Elementary Science and Technology Teachers' Views on Problems Encountered in the Instructional Process. *Educational Sciences: Theory & Practice, 12*(3), 2256-2261.

Geddis, A. N. (1993). Transforming subject matter knowledge: the role of pedagogical content knowledge in learning to reflect on teaching. *International Journal of Science Education*, 15(6), 673-683.

Geller, E. S. (2017). *Actively caring for people in schools: How to cultivate a culture of compassion*. New York: Morgan James Publishing.

Gentles, S. J., Charles, C., Ploeg, J., & McKibbon, K. (2015). Sampling in qualitative research: Insights from an overview of the methods literature. *The qualitative report, 20*(11), 17721789.

Gess-Newsome, J., & Lederman, N. G. (2001). *Examining pedagogical content knowledge: The construct and its implications for science education* (Vol. 6): Springer Science & Business Media.

Gibbs, G. R. (2018). *Analyzing qualitative data* (Vol. 6). Beverly Hills: Sage.

Gibbs, G. R., & Jenkins, A. (2014). *Teaching large classes in higher education: How to maintain quality with reduced resources*. London: Routledge.

Gillies, R. M., & Nichols, K. (2015). How to support primary teachers' implementation of inquiry: Teachers' reflections on teaching cooperative inquiry-based science. *Research in Science Education, 45*(2), 171-191.

Giordano, T. (2014). Multi-level integrated planning and greening of public infrastructure in South Africa. *Planning Theory & Practice, 15*(4), 480-504.

Glynn, S. M. (1991). Explaining science concepts: A teaching-with-analogies model. *The psychology of learning science*, 219-240.

Goldenberg, C. (2013). Unlocking the Research on English Learners: What We Know--and Don't Yet Know--about Effective Instruction. *American Educator, 37*(2), 4.

Goldkuhl, G. (2012). Pragmatism vs interpretivism in qualitative information systems research. *European journal of information systems, 21*(2), 135-146.

Gopal, N., & Marimuthu, B. (2014). Gatekeeping: An obstacle to criminological research with Indian youth drug users in Chatsworth, KwaZulu-Natal. *Acta Criminologica: Southern African Journal of Criminology, 2014*(Special Edition 2), 27-35.

Gray, D. E. (2013). *Doing research in the real world*. London: Sage.

Green, D., De Jager, R., Bredenkamp, L., & Van den Heever, M. (2013). Natural Sciences and Technology*: Teachersguide. Grade 4*. Cambridge University Press.

Grossman, P., Loeb, S., Cohen, J., & Wyckoff, J. (2013). Measure for measure: The relationship between measures of instructional practice in middle school English language arts and teachers' value-added scores. *American Journal of Education, 119*(3), 445-470.

Grossman, P. L. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York:Teachers College Press, Teachers College, Columbia University.

Gudmundsdottir, S. (1990). Values in pedagogical content knowledge. *Journal of teacher education, 41*(3), 44-52.

Guthrie, G. (2010). *Basic research methods: An entry to social science research*. Thousand Oaks CA: SAGE Publications India.

Guzey, S. S., & Roehrig, G. H. (2009). Teaching science with technology: case studies of science teachers' development of technological pedagogical content knowledge (TPCK). *Contemporary Issues in Technology and Teacher Education,* 9(1), 25-45.

Hamid, M. H. S., Shahrill, M., Matzin, R., Mahalle, S., & Mundia, L. (2013). Barriers to mathematics achievement in Brunei secondary school students: Insights into the roles of mathematics anxiety, self-esteem, proactive coping, and test stress. *International Education Studies,* 6(11), 1.

Hannah, R. (2013). The effect of classroom environment on Student Learning.

Harlen, W. (2017). *The teaching of science in primary schools*. London: David Fulton Publishers.

Harper, C. (2015). *Organizations: Structures, processes and outcomes*. New York: Routledge.

Harrell, P. E. (2010). Teaching an integrated science curriculum: Linking teacher knowledge and teaching assignments. *Issues in Teacher Education, 19*(1), 145-165.

Harrell, P. E., & Subramaniam, K. (2014). Teachers need to be smarter than a 5th grader: What pre-service teachers know about density. *Electronic Journal of Science Education,* 18(6).

Harris, K.-L., Jensz, F., & Baldwin, G. (2014). Who's teaching Science: Meeting the demand for qualified science teachers in Australian secondary schools.

Hart, C. (2018). *Doing a Literature Review: Releasing the Research Imagination*: Sage.

Hassard, J., & Dias, M. (2013). *The art of teaching science: Inquiry and innovation in middle school and high school*. New York: Routledge.

Hedgcock, J., & Ferris, D. R. (2013). *Teaching ESL composition: Purpose, process, and practice*. New York: Routledge.

Hennessey, B. A. (2000). Self-determination theory and the social psychology of creativity. *Psychological Inquiry,* 11(4), 293-298.

Herrera, L. Y. (2017). Translanguaging Practices for Educational Equity: Moments in a Bilingual Middle School Classroom.

Heugh, K. (2013). Multilingual education policy in South Africa constrained by theoretical and historical disconnections. *Annual Review of Applied Linguistics*, 33, 215-237.

Hobbs, L. (2013). Teaching 'out-of-field'as a boundary-crossing event: Factors shaping teacher identity. *International journal of science and mathematics education,* 11(2), 271-297.

Hodson, D. (2014). Learning science, learning about science, doing science: Different goals demand different learning methods. *International Journal of Science Education*, 36(15), 2534-2553.

Holbrook, J., & Rannikmae, M. (2007). The nature of science education for enhancing scientific literacy. *International Journal of Science Education,* 29(11), 1347-1362.

Horasan, S. (2014). Code-switching in EFL classrooms and the perceptions of the students and teachers. *Journal of Language and Linguistic Studies,* 10(1), 31-45.

Hsu, C., & Ou Yang, F.-C. (2013). A vocabulary learning tool for L2 undergraduates reading science and technology textbooks. *International Journal of Science Education,* 35(7), 1110-1138.

Ingram, J. B. (2014). *Curriculum integration and lifelong education: A contribution to the improvement of school curricula* (Vol. 6): Elsevier.

Ingvarson, L., Schwille, J., Tatto, M. T., Rowley, G., Peck, R., & Senk, S. L. (2013). *An Analysis of Teacher Education Context, Structure, and Quality-Assurance Arrangements in TEDSM Countries: Findings from the IEA Teacher Education and Development Study in Mathematics (TEDS-M)*: ERIC.

Irvine, A., Drew, P., & Sainsbury, R. (2013). 'Am I not answering your questions properly?'Clarification, adequacy and responsiveness in semi-structured telephone and face-to-face interviews. *Qualitative Research, 13*(1), 87-106.

Israel, M. (2014). *Research ethics and integrity for social scientists: Beyond regulatory compliance*. London: Sage.

Izci, K. (2017). Nature of science as portrayed in the middle school science and technology curriculum: The case of Turkey. *Journal of Education in Science, Environment and Health (JESEH), 3*(1), 14-28.

James, A. (2012). Teaching natural science in the foundation phase: Teachers' understanding of the natural science curriculum. *South African Journal of Childhood Education, 2*(1), 19.

James, C., Garrett, P., & Candlin, C. N. (2014). *Language awareness in the classroom.* New York, NY: Routledge.

Jamshed, S. (2014). Qualitative research method-interviewing and observation. *Journal of basic and clinical pharmacy, 5*(4), 87.

Janesick, V. J. (2015). *Stretching exercises for qualitative researchers*. Thousand Oaks, CA: Sage Publications.

Januszewski, A., & Molenda, M. (2013). Definition Definition and Terminology Committee of the Association for Educational Communications and Technology. In *Educational Technology*(pp. 13-26). New York: Routledge.

Janks, H. (2014). *Globalisation, diversity, and education: A South African perspective.* Paper presented at the The Educational Forum, 78(1),8-25.

Janks, H., & Makalela, L. (2013). Engaging a visionary: Horizons of the (im) possible. *Education as Change*, *17*(2), 219-228.

Jayarajah, K., Saat, R. M., Rauf, A., & Amnah, R. (2014). A Review of Science, Technology, Engineering & Mathematics (STEM) Education Research from 1999-2013: Malaysian Perspective. *Eurasia Journal of Mathematics, Science & Technology Education, 10*(3).

Jiménez, R. T., David, S., Fagan, K., Risko, V. J., Pacheco, M., Pray, L., & Gonzales, M. (2015). Using translation to drive conceptual development for students becoming literate in English as an additional language. *Research in the Teaching of English*, 248-271.

Jita, L. C., & Mokhele, M. L. (2014). When teacher clusters work: selected experiences of South African teachers with the cluster approach to professional development. *South African Journal of Education*, *34*(2).

Johnson, G. (2014). *Research methods for public administrators*. New York, NY: Routledge.

Johnson, D. C. (2013). What is language policy? *Language policy* (pp. 3-25): Springer.

Kafata, F. (2015). An investigation into the impact of teaching in local languages on pupils and teachers (Advantages, Challenges, Opportunities, etc.) in selected primary schools in Kitwe District of the Copperbelt Province of Zambia. *International Journal of Scientific & Technology Research*, *4*(8), 10-16.

Kafyulilo, A. (2014). Access, use and perceptions of teachers and students towards mobile phones as a tool for teaching and learning in Tanzania. *Education and Information Technologies*, *19*(1), 115-127.

Kanjee, A., & Sayed, Y. (2013). Assessment policy in post-apartheid South Africa: Challenges for improving education quality and learning. *Assessment in Education: Principles, Policy & Practice, 20*(4), 442-469.

Karal, I. S., & Alev, N. (2016). Development of pre-service physics teachers' pedagogical content knowledge (PCK) throughout their initial training. *Teacher development, 20*(2), 162-180. Kaschula, R. (2013). *Multilingual teaching and learning models at South African Universities: opportunities and challenges.* Paper presented at the seminar on the implementation of the Charter for Humanities and Social Sciences. University of KwaZulu-Natal.

Katz, J. (2015). A theory of qualitative methodology: The social system of analytic fieldwork. *Méthod (e) s: African Review of Social Sciences Methodology, 1*(1-2), 131-146.

Kelly, A. V. (2004). *The Curriculum: Theory and Practice* (5th ed.). London: SAGE Publications.

Kharisov, F. F., & Kharisova, C. M. (2014). Bilingualism and multilingualism in a globalized society. *Life Science Journal, 11*(11s), 439-443.

Khoza, S. B. (2015). Student teachers' reflections on their practices of the curriculum and assessment policy statement. *South African Journal of Higher Education,* 29(4), 179-197.

Kim, C. M., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education,* 29, 76-85.

Kim, Y. (2013). Promoting attention to form through task repetition in. *Second language interaction in diverse educational contexts,* 34(3).

Kind, V. (2014). Science teachers' content knowledge *Exploring mathematics and science teachers' knowledge* (pp. 37-50). Abingdon: Routledge.

King, N. (2012). Doing template analysis. *Qualitative organizational research: Core methods and current challenges,* 426. London: Sage.

King, N., & Horrocks, C. (2010). *Interviews in qualitative research.* London: Sage.

Kini, T., & Podolsky, A. (2016). Does teaching experience increase teacher effectiveness. *A Review of the Research*.

Kleickmann, T., Richter, D., Kunter, M., Elsner, J., Besser, M., Krauss, S., & Baumert, J. (2013).

Teachers' content knowledge and pedagogical content knowledge: The role of structural differences in teacher education. *Journal of teacher education,* 64(1), 90-106.

Koh, J. H. L., Chai, C. S., & Tay, L. Y. (2014). TPACK-in-Action: Unpacking the contextual influences of teachers' construction of technological pedagogical content knowledge (TPACK). *Computers & Education,* 78, 20-29.

Kok, L., & van Schoor, R. (2014). A science-technology-society approach to teacher education for the foundation phase: Students' empiricist views. South African Journal of Childhood Education, 4(1), 95-110.

Kola, A. J., & Sunday, O. S. (2015). A review of teacher self-efficacy, pedagogical content knowledge (PCK) and out-of-field teaching: Focussing on Nigerian teachers. *International Journal of Elementary Education, 4*(3), 80-85.

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

Kothari, C. R. (2004). *Research methodology: Methods and techniques*. Daryaganj, New Delhi: New Age International.

Kraft, M. A., & Papay, J. P. (2014). Can professional environments in schools promote teacher development? Explaining heterogeneity in returns to teaching experience. *Educational evaluation and policy analysis, 36*(4), 476-500.

Kridel, C. (2013). *Writing educational biography: Explorations in qualitative research*. New York: Routledge.

Kriek, J., & Stols, G. (2010). Teachers 'belief and their intention to use interactive simulations in their classrooms. South African Journal of Education, 30(3).

Kümmerling-Meibauer, B. (2013). Code-Switching in Multilingual Picturebooks. *Bookbird: A Journal of International Children's Literature, 51*(3), 12-21.

Kunter, M., Klusmann, U., Baumert, J., Richter, D., Voss, T., & Hachfeld, A. (2013). Professional competence of teachers: Effects on instructional quality and student development. *Journal of Educational Psychology, 105*(3), 805.

Kuusisaari, H. (2013). Teachers' collaborative learning–development of teaching in group discussions. *Teachers and Teaching, 19*(1), 50-62.

Larsen-Freeman, D., & Long, M. H. (2014). *An introduction to second language acquisition research*. New York : Routledge.

Laurillard, D. (2013). *Teaching as a design science: Building pedagogical patterns for learning and technology*. London: Routledge.

Lederman, N. G. (2013). Nature of science: Past, present, and future *Handbook of research on science education* (pp. 845-894). New York: Routledge.

Lee, O., Llosa, L., Jiang, F., Haas, A., O'Connor, C., & Van Booven, C. D. (2016). Elementary teachers' science knowledge and instructional practices: Impact of an intervention focused on english language learners. *Journal of Research in Science teaching, 53*(4), 579-597.

Lee, O., Quinn, H., & Valdés, G. (2013). Science and language for English language learners: Language demands and opportunities in relation to Next Generation Science Standards. *Educational researcher, 42*(4), 423-433.

Leedy, P. D., & Ormrod, J. E. (2005). *Practical research*. Upper Saddle River, N.J.: Pearson Custom.

Leininger, M. M. (1985). Ethnography and ethnonursing: Models and modes of qualitative data analysis. *Qualitative research methods in nursing*, 33-72.

Leung, C., Davison, C., & Mohan, B. (2014). *English as a second language in the mainstream: Teaching, learning and identity*. New York, NY: Routledge.

Le Roux, C. J. B., & Evans, N. (2011). Can cloud computing bridge the digital divide in South African secondary education ?. Information development, 27(2), 109-116.

Levis, J. M., Sonsaat, S., Link, S., & Barriuso, T. A. (2016). Native and nonnative teachers of L2 pronunciation: Effects on learner performance. *Tesol Quarterly,* 50(4), 894-931.

Lichtman, M. (2013). *Qualitative research for the social sciences*. London, UK: SAGE publications.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry* (Vol. 75). Thousand Oaks, Califonia: Sage.

Linn, M. C. (2013). *Internet environments for science education*. New York: Routledge.

Linn, M. C., & Hsi, S. (2000). *Computers, teachers, peers: Science learning partners*. New York: Routledge.

Lo, Y. Y., & Lo, E. S. C. (2014). A meta-analysis of the effectiveness of English-medium education in Hong Kong. *Review of Educational Research,* 84(1), 47-73.

LoBiondo-Wood, G., & Haber, J. (2014). Reliability and validity. *Nursing research-ebook: Methods and critical appraisal for evidencebased practice. Missouri: Elsevier Mosby*, 289-309.

Loh, J. (2013). Inquiry into issues of trustworthiness and quality in narrative studies: A perspective. *The qualitative report, 18*(33), 1-15.

Loughran, J., Berry, A., & Mulhall, P. (2012). Portraying pck *Understanding and developing science teachers' Pedagogical Content Knowledge* (pp. 15-23): Springer.

Luce, M. R., & Hsi, S. (2015). Science relevant curiosity expression and interest in science: an exploratory study. *Science Education*, *99*(1), 70-97.

Ludger, W. (2015). *Universal Basic Skills What Countries Stand to Gain: What Countries Stand to Gain*: OECD Publishing.

Luna, M. J., Rye, J. A., Forinash, M., & Minor, A. (2015). Gardening for Homonyms: Integrating Science and Language Arts to Support Children's Creative Use of Multiple Meaning Words. *Science Activities: Classroom Projects and Curriculum Ideas, 52*(4), 92-105.

Mackenzie, N., & Knipe, S. (2006). Research dilemmas: Paradigms, methods and methodology. *Issues in educational research, 16*(2), 193-205.

Madiba, M. (2014). Promoting concept literacy through multilingual glossaries: A translanguaging approach. *Multilingual teaching and learning in higher education in South Africa*, 68-87.

Magno, C. (2010)." The role of metacognitive skills in developing critical thinking." Metacognition and learning, 5(2), 137-156.

Makalela, L. (2015). Breking African Language Boundaries: Student Teacher' Reflections on Translanguaging Practices. *Language Matters, 46*(2), 275-292.

Makoe, P., & McKinney, C. (2014). Linguistic ideologies in multilingual South African suburban schools. *Journal of Multilingual and Multicultural Development, 35*(7), 658-673.

Manyike, T. V., & Lemmer, E. M. (2014). Research in language education in South Africa: Problems & prospects. *Mediterranean Journal of Social Sciences, 5*(8), 251.

Marshall, B., Cardon, P., Poddar, A., & Fontenot, R. (2013). Does sample size matter in qualitative research?: A review of qualitative interviews in IS research. *Journal of Computer Information Systems, 54*(1), 11-22.

Marshall, J. C., Smart, J. B., & Alston, D. M. (2017). Inquiry-based instruction: a possible solution to improving student learning of both science concepts and scientific practices. *International journal of science and mathematics education, 15*(5), 777-796.

Martin, D. J. (2012). *Elementary science methods: A constructivist approach*. Belmont, CA:Wadsworth, Cengage Learning.

Maxwell, J. A. (2012). *A realist approach for qualitative research*. Los Angeles: Sage.

Mayer, I. (2015). Qualitative research with a focus on qualitative data analysis. *International Journal of Sales, Retailing & Marketing, 4*(9), 53-67.

McClellan III, J. E., & Dorn, H. (2015). *Science and technology in world history: an introduction*: JHU Press.

McGuirk, P. M., & O'Neill, P. (2016). Using questionnaires in qualitative human geography.

McKeachie, W., & Svinicki, M. (2013). *McKeachie's teaching tips*: Cengage Learning.

McLaughlin, B. (2013). *Second language acquisition in childhood: Volume 2: School-age Children*: Psychology Press.

Mecoli, S. (2013). The influence of the pedagogical content knowledge theoretical framework on research on preservice teacher education. *Journal of Education, 193*(3), 21-27.

Mehta, J., & Doctor, J. (2013). Raising the bar for teaching. *Phi Delta Kappan, 94*(7), 8-13.

Mercer, N. (1996). The quality of talk in children's collaborative activity in the classroom. *Learning and instruction, 6*(4), 359-377.

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation*. San Fransisco, CA: John Wiley & Sons.

Mertens, D. M. (2014). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods*. Thousand Oaks, CA: Sage publications.

Modupeola, O. R. (2013). Code-Switching as a teaching strategy: Implication for English Language teaching and learning in a multilingual society. *IOSR Journal of Humanities and Social Science,* 14(3), 92-94.

Montibeller, G., & Von Winterfeldt, D. (2015). Cognitive and motivational biases in decision and risk analysis. *Risk Analysis,* 35(7), 1230-1251.

Montiel-Overall, P., & Grimes, K. (2013). Teachers and librarians collaborating on inquiry-based science instruction: A longitudinal study. *Library & Information Science Research,* 35(1), 41-53.

Morrissey, M. S. (2000). Professional learning communities. New York: An ongoing exploration.

Morrow, S. L. (2007). Qualitative research in counseling psychology: Conceptual foundations. *The Counseling Psychologist,* 35(2), 209-235.

Morse, J. M. (1997). *Completing a qualitative project*. Thousand Oaks, CA: **Sage**.

Motshegwa,T., Wright, C., Sithole, H., Ngolwe, C., & Morgan, A., (2018, May). Developing a Cyber - infrastructure for Enhancing Regional Collaboration on Education, Research, Science, Technology and Innovation. In 2018 IST - Africa Week Conference (IST - Africa) (pp.Page - 1).

Motshekga, A. (2011). Statement by the Minister of Basic Education, Mrs Angie Motshekga, MP, on the progress of the review of National Curriculum Statement. *Retrieved on, 17*.

Msimanga, A., & Lelliott, A. (2014). Talking science in multilingual contexts in South Africa: Possibilities and challenges for engagement in learners home languages in high school classrooms. *International Journal of Science Education, 36*(7), 1159-1183.

Mueller, P. A., & Oppenheimer, D. M. (2014). The pen is mightier than the keyboard: Advantages of longhand over laptop note taking. *Psychological science, 25*(6), 1159-1168.

Munje, P. N. (2018). The impact of teacher professional conduct on learner experiences and performance in poor school communities in South Africa. *Compare: A Journal of Comparative and International Education*, 1-18.

Narmadha, U., & Chamundeswari, S. (2013). Attitude towards learning of science and academic achievement in science among students at the secondary level. *Journal of Sociological Research, 4*(2), 114-124.

Ngcobo, S. S. (2015). *Negotiating the Introduction of Subjects Whilst Simultaneously Changing the Language of Instruction in Grade 4: A Case Study of Natural and Social Sciences in a Rural KwaZulu-Natal.* University of KwaZulu-Natal, Pietermaritzburg.

Nielsen, W., & Hoban, G. (2015). Designing a digital teaching resource to explain phases of the moon: a case study of preservice elementary teachers making a slowmation. *Journal of Research in Science teaching, 52*(9), 1207-1233.

Nieuwenhuis, J. (2007). Introducing qualitative research. *First steps in research*, 5. Pretoria: Van Schaik. p. 224-254).

Nilsson, P. (2014). When teaching makes a difference: Developing science teachers' pedagogical content knowledge through learning study. *International Journal of Science Education,* 36(11), 1794-1814.

Noom-Ura, S. (2013). English-teaching problems in Thailand and Thai teachers' professional development needs. *English Language Teaching, 6*(11), 139.

Nowicki, B. L., Sullivan-Watts, B., Shim, M. K., Young, B., & Pockalny, R. (2013). Factors influencing science content accuracy in elementary inquiry science lessons. *Research in Science Education,* 43(3), 1135-1154.

Nyika, N., & Van Zyl, S. (2013). From attitudes and practices to policy: Reflections on the results of a large-scale study at the University of the Witwatersrand. *South African Journal of Higher Education, 27*(3), 713-734.

Oh, P. S., & Kim, K. S. (2013). Pedagogical transformations of science content knowledge in Korean elementary classrooms. *International Journal of Science Education, 35*(9), 15901624.

Okebukola, P. A., Owolabi, O., & Okebukola, F. O. (2013). Mother tongue as default language of instruction in lower primary science classes: Tension between policy prescription and practice in Nigeria. *Journal of Research in Science teaching,* 50(1), 62-81.

Ollerenshaw, C., & Ritchie, R. (2013). *Primary Science-making it work*. Abingdon: **Routledge**.

Oloruntegbe, K. O. (2013). Effective science learning through restructuring and reconstruction from the knowledge soup. *American Journal of Humanities and Social Sciences*, *1*(2), 63-66.

Olsen, B. (2016). *Teaching for success: Developing your teacher identity in today's classroom*. New York: Routledge.

Oppong, S. H. (2013). The problem of sampling in qualitative research. *Asian journal of management sciences and education, 2*(2), 202-210.

Orcher, L. T. (2016). *Conducting research: Social and behavioral science methods*. New York, NY : **Routledge**.

Osborne. J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. International journal of science education, 25(9). 1049-1079.

Ovando, C. J., & Combs, M. C. (2018). *Bilingual and ESL classrooms: Teaching in multicultural contexts*. Lanham, Maryland : **Rowman & Littlefield.**

Oyoo, S. O. (2017). Learner Outcomes in Science in South Africa: Role of the Nature of Learner Difficulties with the Language for Learning and Teaching Science. *Research in Science Education,* 47(4), 783-804.

Özgün-Koca, S. A., & Şen, A. İ. (2006). The beliefs and perceptions of pre-service teachers enrolled in a subject-area dominant teacher education program about "effective education". *Teaching and Teacher Education,* 22(7), 946-960.

Pachler, N., Evans, M., Redondo, A., & Fisher, L. (2013). *Learning to teach foreign languages in the secondary school: A companion to school experience*. London: **Routledge**.

Padilla-Díaz, M. (2015). Phenomenology in educational qualitative research: Philosophy as science or philosophical science. *International Journal of Educational Excellence,* 1(2), 101-110.

Pareti, S., O'Keefe, T., Konstas, I., Curran, J. R., & Koprinska, I. (2013). *Automatically detecting and attributing indirect quotations.* Paper presented at the Proceedings of the 2013 Conference on Empirical Methods in Natural Language Processing.

Park, M. (2008). Implementing curriculum integration: The experiences of Korean elementary teachers. *Asia Pacific Education Review, 9*(3), 308-319. Beverly Hills, CA: Sage.

Park, S., & Chen, Y. C. (2012). Mapping out the integration of the components of pedagogical content knowledge (PCK): Examples from high school biology classrooms. *Journal of Research in Science teaching,* 49(7), 922-941.

Park, M. S. (2013). Code-switching and translanguaging: Potential functions in multilingual classrooms. *Teachers College, Columbia University Working Papers in TESOL & Applied Linguistics, 13*(2), 50-52.

Pawley, A. L. (2014). From the mouths of students: two illustrations of narrative analysis to understand engineering education's ruling relations as gendered and raced. *age,* 24, 1.

Pennycook, A. (2017). *The cultural politics of English as an international language*. New York: Routledge.

Pinter, A. (2017). *Teaching young language learners*: Oxford University Press. USA.

Plüddemann, P. (2015). Unlocking the grid: language-in-education policy realisation in postapartheid South Africa. *Language and Education, 29*(3), 186-199.

Probyn, M. (2015). Pedagogical translanguaging: Bridging discourses in South African science classrooms. *Language and Education, 29*(3), 218-234.

Punch, K. F. (2013). *Introduction to social research: Quantitative and qualitative approaches*. London: **Sage**.

Qablan, A., Mansour, N., Alshamrani, S., Aldahmash, A., & Sabbah, S. (2015). Ensuring Effective Impact of Continuing Professional Development: Saudi Science Teachers' Perspective. *Eurasia Journal of Mathematics, Science & Technology Education,* 11(3).

Ramnarain, U. U. (2013). *The achievement goal orientation of disadvantaged black physical sciences students from South Africa*.

Ramrathan, L., & Mzimela, J. (2016). Teaching reading in a multi-grade class: Teachers' adaptive skills and teacher agency in teaching across grade R and grade 1. *South African Journal of Childhood Education*, 6(2), 1-8.

Reddy, V., Visser, M., Winnaar, L., Arends, F., Juan, A., Prinsloo, C., & Isdale, K. (2016). TIMSS 2015: Highlights of mathematics and science achievement of grade 9 South African learners.

Rehmat, A. P., & Bailey, J. M. (2014). Technology integration in a science classroom: Preservice teachers' perceptions. *Journal of Science Education and Technology, 23*(6), 744-755.

Rezat, S., & Rezat, S. (2017). Subject-specific genres and genre awareness in integrated mathematics and language teaching. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(7b), 4189-4210.

Rezai-Rashti, G. M. (2013). Conducting field research on gender relations in a gender repressive state: a case study of gender research in Iran. *International Journal of Qualitative Studies in Education, 26*(4), 489-502.

Richards, J. C., & Rodgers, T. S. (2014). *Approaches and methods in language teaching*: Cambridge university press.

Richards, J. C. (2017). Teaching English through English: Proficiency, pedagogy and performance. *RELC Journal*, 48(1), 7-30.

Ritchie, R. (2013). *Primary Design and Technology: A Prpcess for Learning*: David Fulton Publishers (London).

Ritchie, J., Lewis, J., & Elam, R. G. (2013). Selecting samples. *Qualitative research practice: A guide for social science students and researchers,* 111.

Rivkin, S. G., & Schiman, J. C. (2015). Instruction time, classroom quality, and academic achievement. *The Economic Journal, 125*(588), F425-F448.

Roberts, L. D. (2015). Ethical issues in conducting qualitative research in online communities. *Qualitative Research in Psychology,* 12(3), 314-325.

Roehl, A., Reddy, S. L., & Shannon, G. J. (2013). The flipped classroom: An opportunity to engage millennial students through active learning strategies. *Journal of Family & Consumer Sciences,* 105(2), 44-49.

Rohaan, E. J., Taconis, R., & Jochems, W. M. (2012). Analysing teacher knowledge for technology education in primary schools. *International Journal of Technology and Design Education,* 22(3), 271-280.

Rohaan, E. J., & van Keulen, H. (2011). What everyone should know about science and technology: a study on the applicability of The Canon of Science in primary education. In M. J. Vries, de, H. Keulen, van, S. Peters, & J. Walma van der Molen (Eds.), Professional development for primary teachers in science and technology: The Dutch VTB-Pro project in an international perspective (pp. 35-47). (International Technology Education Studies; Vol. 9). Rotterdam: Sense Publishers. DOI: 10.1007/978-94-6091-713-4_4

Rollnick, M., & Mavhunga, E. (2017). Pedagogical content knowledge *Science Education* (pp. 507-522): Springer.

Romaine, S. (2017). The impact of language policy on endangered languages. In *Democracy and human rights in multicultural societies* (pp. 217-236). London: **Routledge**.

Romm, N. R. (2013). Employing questionnaires in terms of a constructivist epistemological stance: reconsidering researchers' involvement in the unfolding of social life. *International Journal of Qualitative Methods,* 12(1), 652-669.

Roskos, K. A. (2017). *Play and literacy in early childhood: Research from multiple perspectives.* New York, NY: **Routledge**.

Roulston, K., & Shelton, S. A. (2015). Reconceptualizing bias in teaching qualitative research methods. *Qualitative Inquiry,* 21(4), 332-342.

Rowley, J. (2012). Conducting research interviews. *Management Research Review,* 35(3/4), 260271.

Sadler, P. M., Sonnert, G., Coyle, H. P., Cook-Smith, N., & Miller, J. L. (2013). The influence of teachers' knowledge on student learning in middle school physical science classrooms. *American Educational Research Journal, 50*(5), 1020-1049.

Şahin, Ç. (2014). *What do the prospective science teachers know about human eye?* Paper presented at the Asia-Pacific Forum on Science Learning and Teaching.

Scholtz, S., Watson, R., & Amosun, O. (2004). Investigating science teachers' response to curriculum innovation. *African Journal of Research in Mathematics, Science and Technology Education, 8*(1), 41–52.

Saka, Y., Southerland, S. A., Kittleson, J., & Hutner, T. (2013). Understanding the induction of a science teacher: The interaction of identity and context. *Research in Science Education, 43*(3), 1221-1244.

Saldaña, J. (2015). *The coding manual for qualitative researchers*. Thousand Oaks: Sage.

Savery, J. R. (2015). Overview of problem-based learning: Definitions and distinctions. *Essential readings in problem-based learning: Exploring and extending the legacy of Howard S. Barrows, 9*, 5-15.

Saville-Troike, M., & Barto, K. (2016). *Introducing second language acquisition*: Cambridge University Press.

Schurink, E. (2009). Qualitative research design as tool for trustworthy research. *Journal of Public Administration*, *44*(Special issue 2), 803-823.

Schreiber, L. M., & Valle, B. E. (2013). Social constructivist teaching strategies in the small group classroom. *Small Group Research, 44*(4), 395-411.

Seabi, J., Seedat, J., Khoza-Shangase, K., & Sullivan, L. (2014). Experiences of university students regarding transformation in South Africa. *International Journal of Educational Management, 28*(1), 66-81.

Seah, L. H. (2016). Elementary teachers' perception of language issues in science classrooms. *International Journal of Science and Mathematics Education*, 14(6), 10591078.

Sefotho, M. P., & Makalela, L. (2017). Translanguaging and orthographic harmonisation: A crosslingual reading literacy in a Johannesburg school. *Southern African Linguistics and Applied Language Studies, 35*(1), 41-51.

Seidman, I. (2013). *Interviewing as qualitative research: A guide for researchers in education and the social sciences*: Teachers college press.

Setati, M., Adler, J., Reed, Y., & Bapoo, A. (2002). Incomplete journeys: Code-switching and other language practices in mathematics, science and English language classrooms in South Africa. *Language and Education,* 16(2), 128-149.

Sharp, J., Peacock, G., Johnsey, R., Simon, S., Smith, R., Cross, A., & Harris, D. (2017). *Primary science: teaching theory and practice*: Learning Matters.

Shrum, J. L., & Glisan, E. W. (2015). *Teacher's handbook, contextualized language instruction*: Cengage Learning.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard educational review,* 57(1), 1-23.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational researcher,* 15(2), 4-14.

Sibanda, J. (2017). Language at the Grade Three and Four interface: The theory-policy-practice nexus. *South African Journal of Education,* 37(2).

Silverman, D. (2013). *Doing qualitative research: A practical handbook*: SAGE Publications Limited.

Silverman, D. (2016). *Qualitative research*. Thousand Oaks: Sage.

Singh, R.J., and Rapetsoa, J.M. (2012). Challenges experienced by history learners during assessment using the medium of English. South African Journal of Higher Education, 26(1), 10-23.

Slavin, R. E. (2013). *School and classroom organization*. New York: **Routledge**.

Smith, J. A. (2015). *Qualitative psychology: A practical guide to research methods*. Thousand Oaks: Sage.

Spaull, N. (2013a). Poverty & privilege: Primary school inequality in South Africa. *International Journal of Educational Development,* 33(5), 436-447.

Spaull, N. (2013b). South Africa's education crisis: The quality of education in South Africa 1994-2011. *Johannesburg: Centre for Development and Enterprise*, 1-65.

Spradley, J. P. (2016). *The ethnographic interview*, Waveland Press. New York: Oxford University.

Spreen, C. A. (2004). Appropriating borrowed policies: Outcomes-based education in South Africa. *The global politics of educational borrowing and lending*, 101-113.

Stanley, G. (2013). *Language learning with technology: Ideas for integrating technology in the classroom*. Cambridge, UK: **Cambridge University Press**.

Stears, M., & Mpanza, N. (2015). Using a theory of implementation to determine teachers' ability to implement an innovative science curriculum. *Teachin for Tomorrow Today*, 439.

Stürmer, K., Könings, K. D., & Seidel, T. (2013). Declarative knowledge and professional vision in teacher education: Effect of courses in teaching and learning. *British Journal of Educational Psychology*, 83(3), 467-483.

Stuckey, M., Hofstein, A., Mamlok-Naaman, R., & Eilks, I. (2013). The meaning of 'relevance' in science education and its implications for the science curriculum. *Studies in Science Education*, 49(1), 1-34.

Strand, S., Malmberg, L., & Hall, J. (2015). English as an Additional Language (EAL) and educational achievement in England: An analysis of the National Pupil Database.

Stronge, J. H. (2018). *Qualities of effective teachers*. Alexandria, VA: Association for Supervision and Curriculum Development (**ASCD**).

Sun, M. H., bin Sallahuddin, M. A., & Kaur, M. (2016). To what extent do the benefits of multilingualism outweigh its disadvantages?

Tandogan, R. O., & Orhan, A. (2007). The Effects of Problem-Based Active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning. *Online Submission*, 3(1), 71-81.

Tang, K. s., Delgado, C., & Moje, E. B. (2014). An integrative framework for the analysis of multiple and multimodal representations for meaning-making in science education. *Science Education,* 98(2), 305-326.

Tanner, K. D. (2013). Structure matters: twenty-one teaching strategies to promote student engagement and cultivate classroom equity. *CBE—Life Sciences Education,* 12(3), 322331.

Tarone, E. E., Gass, S. M., & Cohen, A. D. (2013). *Research methodology in second-language acquisition*. London and New York: **Routledge.**

Taylor, S., & von Fintel, M. (2016). Estimating the impact of language of instruction in South African primary schools: A fixed effects approach. *Economics of Education Review,* 50, 75-89.

Taylor, S. J., Bogdan, R., & DeVault, M. (2015). *Introduction to qualitative research methods: A guidebook and resource*. New York: **John Wiley** & **Sons**.

Thanh, N. C., & Thanh, T. (2015). The interconnection between interpretivist paradigm and qualitative methods in education. *American Journal of Educational Science,* 1(2), 24-27.

Tharp, R. G., & Gallimore, R. (1991). *Rousing minds to life: Teaching, learning, and schooling in social context*. Cambridge: **Cambridge University Press**.

Tofade, T., Elsner, J., & Haines, S. T. (2013). Best practice strategies for effective use of questions as a teaching tool. *American journal of pharmaceutical education, 77*(7), 155.

Tomlinson, C. A. (2014). *The differentiated classroom: Responding to the needs of all learners.* Alexandria : **ASCD.**

Torrey, L. (2012). *Teaching problem-solving in algorithms and AI.* Paper presented at the 3rd Symposium on Educational Advances in Artificial Intelligence.

Trybus, M. (2013). Preparing for the future of education-equipping students with 21st century skills: An interview with Dr. Robin Fogarty. *Delta Kappa Gamma Bulletin, 80*(1), 10.

Turner, P., & Thompson, E. (2014). College retention initiatives meeting the needs of millennial freshman students. *College student journal, 48*(1), 94-104.

Tyler, R. W. (2013). Basic principles of curriculum and instruction *Curriculum Studies Reader E2* (pp. 60-68). New York: Routledge.

Vainio, A. (2013). Beyond research ethics: Anonymity as 'ontology','analysis' and 'independence'. *Qualitative Research, 13*(6), 685-698.

van Aalderen‗Smeets, S. I., & Walma van der Molen, J. H. (2015). Improving primary teachers' attitudes toward science by attitude‗focused professional development. *Journal of Research in Science teaching, 52*(5), 710-734.

van der Berg, S., Burger, C., Burger, R., de Vos, M., du Rand, G., Gustafsson, M., & van Broekhuizen, H. (2011). Low quality education as a poverty trap. Stellenbosch: Stellenbosch University.

Van Driel, J. H., & Berry, A. (2012). Teacher professional development focusing on pedagogical content knowledge. *Educational researcher, 41*(1), 26-28.

Van Driel, J. H., Verloop, N., & De Vos, W. (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 35*(6), 673-695.

Van Hoorn, J. L., Monighan-Nourot, P., Scales, B., & Alward, K. R. (2014). *Play at the center of the curriculum.* New Jersey: Pearson.

Van Laere, E., Aesaert, K., & van Braak, J. (2014). The role of students' home language in science achievement: A multilevel approach. *International Journal of Science Education, 36*(16), 2772-2794.

Van Teijlingen, E. (2014). Semi-structured interviews. *Retrieved from.* http://hdl.handle.net/2299/11561

van Wyk, A. (2014). English-medium education in a multilingual setting: A case in South Africa.

International Review of Applied Linguistics in Language Teaching, 52(2), 205-220.

Veal, W. R. (1999). The TTF Model To Explain PCK in Teacher Development.

Velasco, P., & García, O. (2014). Translanguaging and the writing of bilingual learners. *Bilingual Research Journal*, 37(1), 6-23.

Velthuis, C., Fisser, P., & Pieters, J. (2014). Teacher training and pre-service primary teachers' self-efficacy for science teaching. *Journal of science teacher education,* 25(4), 445-464.

Vithal, R., & Jansen, J. (2012). *Designing your first research proposal: a manual for researchers in education and the social sciences*. Cape Town: Juta and Company Ltd.

Vogl, S. (2013). Telephone versus face-to-face interviews: Mode effect on semistructured interviews with children. *Sociological Methodology,* 43(1), 133-177.

Voogt, J., Tilya, F., & van den Akker, J. (2009). Science teacher learning of MBL-supported student-centered science education in the context of secondary education in Tanzania. *Journal of Science Education and Technology,* 18(5), 429-438.

Vygotsky, L. S. (1978). Mind in society: The development of higher mental process: Cambridge, MA: Harvard University Press.

Wang, X. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal,* 50(5), 10811121.

Ward, H., & Roden, J. (2016). *Teaching science in the primary classroom*. London: **Sage**.   Watson, D., & Tinsley, D. (2013). *Integrating information technology into education*. London, UK: Springer.

Wei, B. (2009). In Search of Meaningful Integration: The experiences of developing integrated science curricula in junior secondary schools in China. *International Journal of Science Education, 31*(2), 259-277.

Weissberg, R. P., & Cascarino, J. (2013). Academic learning+ social-emotional learning= national priority. *Phi Delta Kappan,* 95(2), 8-13.

Weninger, C., & Kiss, T. (2013). Culture in English as a foreign language (EFL) textbooks: A semiotic approach. *Tesol Quarterly,* 47(4), 694-716.

Westbury, I. (2013). Reading Schwab's the 'Practical'as an invitation to a curriculum enquiry. *Journal of Curriculum Studies,* 45(5), 640-651.

Whitaker, T. (2013). *What great teachers do differently: 17 things that matter most*. New York: Routledge.

Wieman, C. E. (2014). Large-scale comparison of science teaching methods sends clear message.

Proceedings of the National Academy of Sciences, 111(23), 8319-8320.

Wilcox, R. R., & Keselman, H. (2012). Modern regression methods that can substantially increase power and provide a more accurate understanding of associations. *European journal of personality,* 26(3), 165-174.

Wilkinson, S. (2011). Analysing focus group data. *Qualitative Research,* 3, 168-184. London: Sage.

Williams, E. (2014). *Bridges and barriers: Language in African education and development*. London: Routledge.

Wilson, S. M. (2013). Professional development for science teachers. *Science,* 340(6130), 310313.

Wilson, E. (2017). *School-based research: A guide for education students*: Thousand Oak: Sage.

Yanez, M., Khalil, T. M., & Walsh, S. T. (2010). IAMOT and education: defining a technology and innovation management (TIM) body-of-knowledge (BoK) for graduate education (TIM BoK). *Technovation*, 30(7-8), 389-400.

Yeong, Y.L., & Tan, T.-P. (2014). *Language identification of code-switching sentences and multilingual sentences of under-resourced languages by using multi structural word information.* Paper presented at the Fifteenth Annual Conference of the International Speech Communication Association.

Yildiz-Duban, N. (2013). Science and technology teachers' views of primary school science and technology curriculum. *International Journal of Education in Mathematics, Science and Technology, 1*(1), 64-74.

Yin, R. K. (2013). Validity and generalization in future case study evaluations. Evaluation, 19(3), 321–332. https://doi.org/10.1177/1356389013497081

Zayapragassarazan, Z., & Kumar, S. (2012). Active learning methods. *Online Submission,* 19(1), 3-5.

Zeidler, D. L. (2002). Dancing with maggots and saints: Visions for subject matter knowledge, pedagogical knowledge, and pedagogical content knowledge in science teacher education reform. *Journal of science teacher education,* 13(1), 27-42.

Zepke, N. (2013). Threshold concepts and student engagement: Revisiting pedagogical content knowledge. *Active Learning in Higher Education, 14*(2), 97-107.

Zhang, Y., & Wildemuth, B. M. (2016). Qualitative analysis of content. *Applications of social research methods to questions in information and library science,* 318.

Zhou, G., & Kim, J. (2010). Impact of an integrated methods course on preservice teachers'

perspectives of curriculum integration and faculty instructors' professional growth. *Canadian Journal of Science, Mathematics and Technology Education, 10*(2), 123-138. doi:10.1080/14926151003778266

Zhou, G., Kim, J., & Kerekes, J. (2017). Collaborative teaching of an integrated methods course. *International Electronic Journal of Elementary Education*, 3(2), 123-138.

Zohrabi, M. (2013). Mixed Method Research: Instruments, Validity, Reliability and Reporting Findings. *Theory & practice in language studies, 3*(2).

Zohrabi, M., Torabi, M. A., & Baybourdiani, P. (2012). Teacher-centered and/or student-centered learning: English language in Iran. *English Language and Literature Studies, 2*(3), 18. URL: http://dx.doi.org/10.5539/ells.

Zwiers, J. (2013). *Building academic language: Essential practices for content classrooms, grade* 5-12. Edison, NJ: John Wiley & Sons.