AN EXPLORATION OF HOW GRADE 3 FOUNDATION PHASE TEACHERS DEVELOP BASIC SCIENTIFIC PROCESS SKILLS USING AN INQUIRY-BASED APPROACH IN THEIR CLASSROOMS

A thesis submitted in fulfillment of the requirements for the degree

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DOCTOR OF PHILOSOPHY

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By

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November 2019

DECLARATION

I declare that this thesis work which strives to show How Foundation Phase Teachers use an Inquiry-Based Approach to develop Scientific Process Skills in their Grade 3 learners, is a product of my own determination and effort. All the other sources used or cited have been fully acknowledged and referenced. It is being submitted for the Degree of Doctor of Philosophy at Rhodes University. It has not been submitted elsewhere in any format for a degree or examination at any other university.

Signature **Date: 9 November 2019**

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DEDICATION

This thesis is dedicated to my late Grandmother Nonandi Jobela (MamNgwevu). Being under her arm as a child has made me who I am today. Through her guidance and support, as a child she made sure that I understood what it meant to stand tall through all life's situations. She never handed anything to me on a silver platter or any of her grandchildren, she taught us to work hard for everything in the house and at school. As our Grandmother, after school she would make sure we all individually explained what we did at school that day. She would look at our books as if she understood what was expected of us to do. Whenever there was an "X" next to your answer, you were in trouble! Growing up with ten grandchildren groomed me to know and to understand what it means to have 'Ubuntu'. Never will I regret being part of such a warm loving person.

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ABSTRACT

Some studies have looked at Foundation Phase teachers' perspectives on the teaching of science in this phase. Such studies have highlighted various challenges on the teaching of science in the Foundation Phase. They pointed out issues such as large class numbers, lack of resources and lack of science knowledge from Foundation Phase teachers. However, none of these studies have looked at how Foundation Phase teachers are using an Inquiry-Based Approach in their classrooms instead few studies have looked at the Foundation Phase teachers' perspectives about scientific inquiry in this phase. Even though many scholars have presented several challenges to the teaching of science both at secondary and primary level, the argument is strongly made that Foundation Phase learners should be exposed to the learning of science.

Generally, children at the Foundation Phase level naturally enjoy observing and thinking about nature; exposing learners to science develops positive attitudes towards science; the use of scientifically informed language at an early age influences the eventual development of scientific concepts; children can understand scientific concepts and reason scientifically; and science is an efficient means for developing scientific thinking. It is within these arguments and discussions that this interpretive case study research sought to explore the Pedagogical Content Knowledge of four Foundation Phase teachers in developing the Scientific Process Skills using an Inquiry-Based Approach in their classrooms and subsequently, the significance of this research study.

The socio-cultural theory, Topic Specific Pedagogical Content Knowledge, Zaretskii's six conditions for development during mediation and the principles of an Inquiry-Based Approach were used as analytical lenses in this research. To use an Inquiry-Based Approach, generally teachers have to understand its principles and know how to develop basic Scientific Process Skills while teaching the science content. In the Foundation Phase, the Natural Sciences component or content is embedded in the Beginning Knowledge study area of the Life Skills subject and this can create difficulties for teachers to even recognise the scientific concepts in the Life Skills. The four IsiXhosa female teachers used the home language of learners as the language of instruction to implement an Inquiry-Based Approach in their classrooms. Data were generated in four phases. Phase one was baseline data through document analysis. Three of the phases were directed by the research question asked. Data were generated using questionnaires, interviews (semi-structured & stimulated recall), lesson observations (videotaped) and group reflections and discussions. From the work of Vygotsky, Zaretskii formulated six conditions that can be used to develop learners' zone of proximal development in learning and these were used as analytical lenses to analyse data to understand how teachers mediated learning and development of Scientific Inquiry in their Grade 3 classrooms. In addition, the principles of an Inquiry-Based Approach were used as analytical lenses as to how teachers implemented the scientific inquiry approach. The categories or components of Topic Specific Pedagogical Content Knowledge were used as analytical lenses as to how these teachers dealt with science concepts or content when using an inquiry-based Approach in their classrooms.

Using the home language of learners as an instructional tool, data showed that learners were afforded the opportunity to freely engage in activities and as a result, the context of learning was non-threatening for both teachers and learners. Although learning activities could be improved, teachers created social spaces for learners to take part in learning. In addition, the use of learners' environments in the observed lessons made it comfortable for learners to act as young scientists. The new knowledge in this research was presented by the use of the adapted analytical tool, which combined diverse components of theory and literature that aligned with each other. The reflection space for the participants did not only afford the participants to discuss about each other's lessons or experiences in this research, it allowed the participants to engage with the research objectives. The reflection space strengthened the research ethics if this study. Hence, the concept that says, 'Absenting the absences'. In conclusion, the study thus recommends further professional development spaces that promote community of practice in using an Inquiry-Based Approach in the Foundation Phase.

Key words: Foundation Phase teachers, scientific Inquiry-Based Approach; basic Scientific Process Skills, socio-cultural theory, mediation, social interactions, culture, Zone of Proximal Development, Pedagogical Content Knowledge and Topic Specific Content Knowledge

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LIST OF ABBREVIATIONS

C2005:	Curriculum 2005
CAPS:	Curriculum Assessment Policy Statement
DBE:	Department of Basic Education
DoE:	Department of Education
PCK:	Pedagogical Content Knowledge
TIMSS:	Trends in International Mathematics and Science Study
TSPCK:	Topic Specific Pedagogical Content Knowledge
ZPD:	Zone of Proximal Development

CHAPTER ONE: CONTEXTUALISATION OF THE STUDY

> *Early childhood practitioners are viewed as having a specialised body of knowledge and this includes knowledge about children, teaching, learning and the curriculum that can be translated into meaningful practice*. (Garbett, 2003, p. 469)

1.1 Introduction

In this study, the Socio-Cultural Theory and Pedagogical Content Knowledge (PCK) focusing specifically on Topic Specific Pedagogical Content Knowledge (TSPCK)[1] framework were used as my theoretical frameworks. Additionally, an interpretive methodological approach to study the mediation of an Inquiry-Based Approach in developing Scientific Process Skills in Grade 3 Foundation Phase[2] classrooms was employed. “Foundation Phase (Grade R-3) is part of Early Childhood Development, which refers to the process by which children from birth to at least 9 years grow and thrive physically, mentally, emotionally, spiritually, morally and socially” (South Africa [SA]. Department of Education [DoE], 2001, p. 3).

Concerning the implementation or the use of an Inquiry-Based Approach, I took into account the principles of inquiry-based science education (Pollen, 2009; Tunnicliffe, 2013; Worth, 2010). With regards to how the participants engaged their learners during their teaching, Zaretskii’s (2016) six conditions of developing learners’ Zone of Proximal Development (ZPD) during mediation of learning were adapted.

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[1] **Topic Specific Pedagogical Content Knowledge** (TSPCK) as a theoretical construct is defined as the capacity to transform a specific topic through the five content specific components (Mavhunga, 2015).

[2] **Foundation Phase (Grade R-3)** is part of Early Childhood Development, which refers to the process by which children from birth to at least 9 years grow and thrive physically, mentally, emotionally, spiritually, morally and socially” (DoE, 2001, p. 3).

Essentially, I used the six conditions of developing the learners' ZPD in conjunction with the inquiry-based science education principles as lenses in each lesson observed in this study. With reference to the transformative work of Vygotsky (1978), Zaretskii suggests six conditions that could be used to develop learners' ZPD during mediation of learning. To supplement the principles of inquiry-based scientific education and the six conditions, the TSPCK analytical framework was used to understand teachers' knowledge of using an inquiry approach in developing inquiry skills in their classrooms. The study comprised of four female IsiXhosa speaking Grade 3 Foundation Phase teachers from four different schools in terms of quintiles[3] in the Eastern Cape[4] of South Africa (see Figure 1.1).

This chapter thus introduces the reader to the contextual background of the study, the significance of the study, research aim and objectives. The statement of the problem and the research questions are also outlined. Deliberation of main concepts in this study is explained and discussed. Following from this, an Inquiry-Based Approach and Scientific Process Skills are briefly explained with regards to the study. An overview of the theoretical framework underpinning this study is introduced together with the theoretical concepts focused on. The introduction to methodology, data analysis and ethical issues in this study are briefly explained as well. Lastly, the chapter concludes by giving the thesis outline, followed with a chapter summary.

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[3] **Quintiles:** The National poverty ranking of schools (quintiles) for public schools and learners: One of five groups into which all public ordinary schools and their learners are placed. Quintile 1 is the "poorest" quintile, while Quintile 5 is the "least poor".

[4] **Eastern Cape Province:** IsiXhosa is the most spoken language in the Eastern Cape (78,8% population).

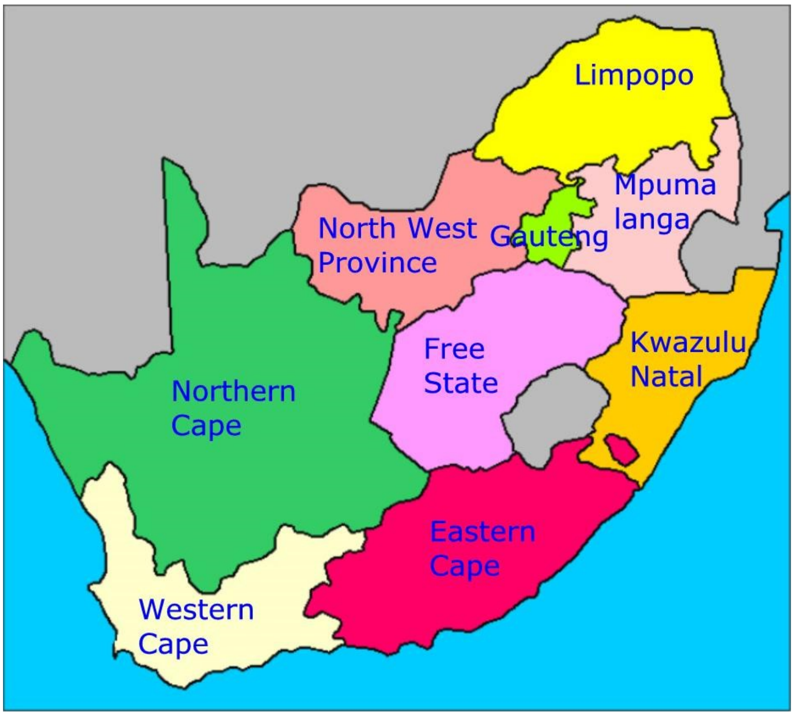

Figure 1.1: South African Provinces

(https://www.google.com/search?q=Provinces+of+SA+MAP&tbm)

Figure 1.2: Regions of the Eastern Cape

(https://images.search.yahoo.com/yhs/search?p=Regions+of+the+Eastern+Cape+Map&fr)

1.2 Contextual Background

The Constitution of the Republic of South Africa (Act 108 of 1996) provides the foundation for the curriculum transformation and improvement in South Africa (DoE, 2002). One of the aims of the South African Constitution is to place the fundamentals for a democratic and open society in which the government is based on the will of the people and to improve the quality of life of all citizens and free the potential of each person (SA. DoE, 2002). Following from this, it is evident that education, in particular the curriculum, has an important role to play in realising the aims of the South African Constitution. It is for the above-mentioned reason that the general aims of the South African Curriculum reflect the purposes, the principles, and describes the types of learners to be produced and inclusivity for classroom practice. In alignment with this study, I highlight one of each of the stated general aims:

- Equipping learners, irrespective of their socio-economic background (Mavuru & Ramnarain, 2017), race, gender, physical ability or intellectual ability, with the knowledge, skills and values necessary for self-fulfilment, and meaningful participation in society as citizens of a free country;
- Active and critical planning: encouraging an active and a critical approach to learning, rather than rote and uncritical learning;
- Learners need to be able to:
    - Identify and solve problems and make decisions using critical thinking;
    - Work effectively as individuals and with others as members of a team;
    - Organise and manage themselves and their activities responsibly and effectively;
    - Collect, analyse, organise and critically evaluate information; and
    - Communicate effectively using visual, symbolic, and/or language skills in various modes.
    - Use science and technology effectively and critically showing responsibility towards the environment and health of others. (Life Skills, Curriculum and Assessment Policy Statement (CAPS) (SA. Department of Basic Education[DBE], 2011, pp. 4-5)

With regards the above aims, likewise the specific aims of the Life Skills curriculum are in line with the general aims of the South African curriculum. In line with the general aims of the curriculum, the Life Skills curriculum aims at guiding learners for life and its possibilities. This includes equipping learners for meaningful and successful living in a rapidly changing and a transforming society (Life Skills CAPS, 2011). Through the subject of Life Skills, Grades R-3 learners are afforded an opportunity to develop a range of knowledge, skills and values that strengthen their:

- Physical, social, personal, emotional and cognitive development;
- Creative and aesthetic skills and knowledge through engaging in dance, music (Liveve, 2017), drama and visual art activities;
- Knowledge of personal health and safety;
- Understanding of the relationship between people and the environment; and
- Awareness of social relationships, technological processes and elementary science.

As a result, the Life Skills curriculum has been shifted from the traditional approach in which the curriculum was content-based and teacher-centred to one which focuses on knowledge, skills values and attitude and is learner-centred (Hobden, 2005; Nyambe, 2008; Nyambe & Wilmot, 2012; SA. DoE, 2002). Through teaching and learning processes, the learner-centred approach emphasises that learners ought to be active participants rather than being inactive recipients (Moll, 2004; Sedlacek & Sedova, 2017). As already stated above, this change in approach to teaching and learning has been also propagated in all the learning areas across the curriculum. However, Nyambe and Wilmot (2012) highlight that many teachers are still grappling enacting learner-centred approaches in their classrooms.

As a result, since the introduction of Curriculum 2005 there have been many arguments on how to approach teaching and learning activities in schools. For example, the Natural Sciences Learning Area is one of the learning areas in which these arguments have raised concerns on how teachers should approach it since the new curriculum involves the development of a range of basic Scientific Process Skills that are beneficial in everyday life (SA. DoE, 2002). This is largely evident in the way in which the Natural Sciences Curriculum is structured. For instance, the three learning outcomes, which are scientific investigations, constructing science knowledge and science society and the environment, demand that both teachers and learners interact with the world in which they live during the process of teaching and learning. In addition, the general aims of the South African curriculum together with the specific aims of the Life Skills subject are promoting critical learning, active learning, solving problems and critical thinking, which talk to the aims of teaching Natural Sciences, and how knowledge should be developed in the Natural Sciences learning area.

Miller (2004) argues further by saying that scientific knowledge is something that provides material explanations for the behaviour of the material world and their properties. Seemingly, Miller's view about science resonates with the South African Curriculum since it also refers to science as making sense of the world in which we live. However, Hodson and Hodson (1998) argue that learning science is not simply a matter of making sense of the world in whatever terms and for whatever reasons satisfy the learner. Rather, learning science involves introduction into the world of concepts, ideas, understandings and theories that scientists have developed and accumulated. From this school of thought, it is suggested that although learners have some knowledge from their experiences, they also need guidance and scaffolding from teachers in order to develop scientific knowledge.

Furthermore, Hodson and Hodson (1998) state that in any scientific inquiry, learners achieve three kinds of learning. Primarily, conceptual understanding of whatever is being studied or investigated is enhanced. Secondly, they will enhance procedural knowledge, learning more about experiments, acquiring a more sophisticated understanding of observation, experiment and theory. Lastly, they will enhance investigative expertise. Hence, this brings me to the importance and focus of this study. Young children are unexpectedly capable scientists that demonstrate surprisingly abstract abilities (Duschl, Schweingruber, & Shouse, 2007). Concurring, Metz (2011) continues by stating that anyone who has spent time with young children will agree that science and children are a natural fit. Additionally, all young children have the potential to observe, explore, and discover the world around them and like real scientists, they seek out new experiences (Gelman, Brenneman, Macdonald, & Roman, 2010).

It is against this background that this study explored how Grade 3 Foundation Phase teachers used an Inquiry-Based Approach pedagogy to develop basic Scientific Process Skills in their classrooms. The National Curriculum Statement of the Department of Education[5] (2003) and the Department of Basic Education's[6] Curriculum and Assessment Policy Statement (CAPS) (2011), promote an Inquiry-Based Approach in teaching of Life Skills curriculum. This approach in pedagogy is expected to transform classroom practices of teachers and to enhance learning abilities of their learners.

The above Section stated the expectation of the CAPS for the Life Skills curriculum. Admittedly, this expectation has posed a critical issue for both teachers in the field and the higher institutions of learning that are training teachers for Foundation Phase teaching. The scientific Inquiry-based Approach, as a teaching approach or pedagogy has its principles and it is through understanding these principles that teachers can use a scientific approach in their classrooms.

With this in mind, my interest for this study was triggered by my 10 years teaching experience as a Senior Phase (Grades 7-9) Natural Sciences teacher. I developed an interest in observing and understanding how Foundation Phase teachers engage and work with their learners when teaching Natural Sciences in their classrooms. It should be remembered that the Foundation Phase is when children have their first encounter with inquiry into the natural world which they are naturally always curious to know about. I have also taught Intermediate Phase (Grades 4-6) Natural Sciences, and it was evident from learners' discussions and conversations during my Natural Sciences classes that there was a gap in their understanding of scientific concepts. Based on these observations, I realised that it was difficult and challenging for learners to explain some scientific concepts that should have been taught during the Foundation Phase.

When I became the Head of Department (HoD) in my school and the Natural Sciences lead teacher in my district, I had access to learners' portfolios from other schools from which I became aware of some of the challenges faced by teachers when teaching Natural Sciences,

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[5] DoE: D**epartment** of the federal executive branch responsible for providing federal aid to **educational** institutions and financial aid to students, keeping national **educational** records, and conducting some **educational** research.

[6] DBE: The **Department of Basic Education** (DBE) is one of the **departments** of the South African government. It oversees **primary** and secondary **education** in South Africa.

especially in the Foundation Phase. In conducting workshops for Foundation Phase teachers, it was clear that most teachers felt intimidated hearing the concept of '*science*'.

Bosman (2006), in her study conducted in the Gauteng Province (Tshwane-North & South), found out that Foundation Phase teachers tend to avoid teaching science because they lack the basic science background knowledge. Her study aimed at establishing whether Foundation Phase schooling provides a proper foundation for the promotion of scientific literacy. Additionally, she reported that teachers in her study did not feel confident with the subject matter knowledge (Shulman, 1986), especially on the topics of Planet Earth and Beyond; Matter and Materials; and Energy and Change. Instead, they focused more on the strand Life and Living. This was further evident in the two-day workshop I conducted for 56 Foundation Phase teachers from the Sarah Baartman District in the Eastern Cape.

The workshop was a revelation for me, and it was on ways of '*Developing Creative Thinkers'* in the classroom practice. This was through a practical demonstration where I used Grade 3 learners as my participants to model creative teaching in science. I exposed the 56 Foundation Phase (FP) teachers to the use of simple techniques such as questioning, learner group discussions and giving learners' space to explore and investigate while learning. In addition, the use of easily accessible resources was another aspect that I focussed on since many teachers highlighted the shortage of resources and materials in their schools (Asheela, 2017; Kuhlane, 2011; Shinana, 2019). Subsequently, teachers had the opportunity to evaluate the workshop and it emerged that they found it difficult to plan creative science lessons for their teaching. This too adds to the challenges FP teachers have in teaching of science in the Foundation Phase (Beni, Stears, & James, 2012; Bosman, 2006).

Coincidentally, I am currently teaching both Life Skills and the Natural Sciences component in the Bachelor's degree course in the Foundation Phase. In the Foundation Phase, science knowledge is embedded in the Life Skills subject and is called Beginning Knowledge. Hence, the Natural Sciences component in the Bachelor's degree course is named '*Understanding the Social and Physical world'*, a course designed to build pre-service students' content and experiential knowledge in the Natural Sciences. Although in this study my focus is on Grade 3 classrooms, this experience of teaching in these courses presented me with an opportunity to explore the use of an Inquiry-Based Approach in developing basic Scientific Process Skills when teaching science related concepts at Foundation Phase level. It was anticipated that the strategies and the methods used by Foundation Phase teachers when implementing an Inquiry-Based Approach in their classrooms might assist in identifying the challenges, the opportunities and the strengths they faced when using this approach in their classroom. It could be argued, therefore, that the findings from the study might assist higher institutions of learning on how to strengthen their approaches on training Foundation Phase teachers to teach science through an inquiry approach in this phase, an area which seems to be under-researched in South Africa.

Moreover, this study might further assist the Department of Education in strengthening teachers' ways of using an inquiry-based approach in their Foundation Phase classrooms. Besides, the research in the South African Foundation Phase context, the focus on mediation of an inquiry-based approach, development of basic Scientific Process Skills and teaching of science in Foundation Phase is limited. In the South African context, for instance, Scientific Inquiry-Based Learning and learner performance in science has been mostly explored in the secondary school set-up. Scholars have raised various challenges and implications of science teaching and learning through this approach (DBE, 2011; Howie, 2003; Seroto, 2012; TIMSS[7], 2011; TIMSS, 2015).

Yet, both the South African Constitution and the South African Curriculum continue to encourage Foundation Phase teachers to develop basic Scientific Process Skills through scientific investigations and to produce learners that are critical thinkers (SA. DBE, 2011). My assumption is that if more research could be conducted on Foundation Phase science teaching, it could assist in identifying challenges and opportunities and this could subsequently strengthen the teaching of science and ultimately minimise the challenges faced in higher grades, especially Grades 10-12. It is against this caveat that my research aim and the research questions of this study were formulated based on the curriculum requirements, descriptions, pedagogy of science in the Foundation Phase and my research interests as given above.

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[7] **TIMSS**: Test, Measurement, and Diagnostic Equipment) Integrated Maintenance Management System.

1.3 Statement of the Problem and Significance of the Study

The inclusion of the Beginning Knowledge study area (Natural Sciences, Social Sciences, Technology) and basic Scientific Process Skills in the Life Skills subject in the Foundation Phase (Grades R-3), represents the need for Foundation Phase teachers to be able to have adequate content knowledge and pedagogies to teach these components through the process of inquiry (Beni et al., 2012). Although the curriculum expectations are clearly stated, researchers identified several challenges (Beni et al., 2012; Bosman, 2006; Koen & Ebrahim, 2013; Plaatjies 2015). Findings from the research conducted in South Africa established that for many years in South African schools, Life Skills in the Foundation Phase was not regarded as a focus subject or an important subject (Koen & Ebrahim, 2013; Plaatjies 2015). Moreover, from my experience, Numeracy and Languages in the Foundation Phase are externally examined but not the Life Skills subject. This suggests that the Department of Education at provincial level sets the examination papers for Numeracy and Languages for this phase but not for the Life Skills subject[8]. Even if a learner does not do well in Life Skills s/he will be allowed to progress into the next grade and yet this subject comprises very important foundational knowledge.

Essentially, important foundational knowledge which has various content subjects like Natural Sciences, Social Sciences and Technology that are embedded in the Beginning Knowledge study area in Life Skills are neglected (Koen & Ebrahim, 2013). Beni et al. (2012) and Bosman (2006) in their studies, also highlight that Foundation Phase teachers lack confidence in teaching science and have not been equipped to do so. Additionally, limited scheduled time to focus on all Life Skills content, lack of resources and large class numbers have been other contributing factors in teaching science successfully in the Foundation Phase. Yet, as reiterated by Asheela (2017), the scientific inquiry approach provides teachers with the opportunity to use easily accessible resources and to plan practical experiences for their learners. Furthermore, it allows teachers and learners to explore field experiences and learning outside the physical

[8]ANA Exams: The Annual National Assessments (ANA) are standardised national assessments for languages and mathematics in the senior phase (grades 7 - 9), intermediate phase (grades 4 - 6) and in literacy and numeracy for the foundation phase (grades 1 - 3). The question papers and marking memoranda (exemplars) are supplied by the national Department of Basic Education and the schools manage the conduct of the tests as well as the marking and internal moderation.

classroom while developing scientific concepts and skill in their learners (Bosman et al., 2016; Kidman & Casinader, 2017; Kuhlane, 2011; Worth, 2010).

As already stated in Section 1.2 above, in the South African education context, there is limited research on science teaching and learning in the Foundation Phase. It is against this background that the aim of this study was to explore how Foundation Phase teachers used an Inquiry-Based Approach in developing the basic Scientific Process Skills in their classrooms.

As already explained earlier, the significance of this study is that it might provide information about the opportunities and challenges facing Foundation Phase teachers in the development of basic Scientific Process Skills and the use of an Inquiry-Based Approach. Additionally, it might assist teacher-training institutions on to how to improve the teaching and learning of science in the Foundation Phase. Lastly, this study might inform the Department of Basic Education and the teachers themselves on the need to strengthen the teaching of Life Skills, in particular, the science component in Foundation Phase classrooms.

1.4 Research Goal and Objectives

1.4.1 The Research Aim

The main goal of this study was to explore how Grade 3 Foundation Phase (FP) teachers mediate the development of basic Scientific Process Skills using an Inquiry-Based Approach in their classrooms.

1.4.2 Research Objectives

1. To understand Grade 3 Foundation Phase teachers' perceptions about basic Scientific Process Skills and an Inquiry-Based Approach;
2. To understand how Grade 3 Foundation Phase teachers, mediate the development of basic Scientific Process Skills through an Inquiry-Based Approach in their classrooms; and
3. To understand how the research process has influenced (or not) Grade 3 Foundation Phase teachers' teaching practice of Science as a subject in their classrooms.

1.5 Research Questions

1. What is the understanding of basic Scientific Process Skills and an Inquiry-Based Approach by Grade 3 Foundation Phase teachers?
2. How do Grade 3 Foundation Phase teachers mediate the development of basic Scientific Process Skills through an Inquiry-Based Approach in their classrooms?
3. How do discussions and group reflections influence (or not) Grade 3 Foundation Phase teachers' understanding of basic Scientific Process Skills and Inquiry-Based Approach?

Data were generated through various methodological research instruments. For research question 1, for instance, data were generated using questionnaires and semi-structured interviews. Both questionnaires and the semi-structured interviews assisted me to understand the participants' schooling contexts and their views about the research topic. For research question 2, data were generated using lesson observations (videotaped lessons) and stimulated recall-interviews. The observations and stimulated recall-interviews helped in understanding the mediation process that took place during teaching and learning of the observed and videotaped lessons. For research question 3, data were generated through group reflections and discussions. The group reflections aided in understanding the Foundation Phase teachers' perspectives about the process of this research and their understanding of the research aim. In Chapter Four, I will further explain in detail the data methodological processes involved in this study.

1.6 Definitions and Descriptions of Concepts in This Study

This section seeks to provide brief explanations and descriptions of the key concepts that are deemed important and have been used this study. I use literature to give a theoretical standpoint of each concept in this research.

1.6.1 Foundation Phase in the South African context

As alluded to in Section 1.1, Early Childhood Development (ECD) is a critical stage in the life of children. In this regard, Koen and Ebrahim (2013) refer to the Foundation Phase as the time of greatest risk and greatest opportunity. Richter and Strupp (2007) state that studies conducted in Gautemala, South Africa, the Phillipines, Jamaica, and Brazil emphasised the importance of early cognitive and social-emotional stimulation for later educational progress. Concurring, Ige (2011) states that the quality of education during the Foundation Phase is crucial; it plays an important role in learners' physical and cognitive development in the future. At the Foundation Phase level, the curriculum consists of three learning programmes, namely, *literacy*, *numeracy* and *Life Skills* (Beni et al., 2012). Hence, the next Section defines the understanding of what Life Skills curriculum is about in the South African context.

1.6.2 Life Skills curriculum or education in South African context

As specified in Section 1.2, Life Skills education is central to the holistic development of learners. It is concerned with the *social*, *personal*, *intellectual*, *emotional* and *physical* growth of learners, and with the way in which these are integrated. Bosman et al. (2016) also state that Life Skills education is recognised as a distinct methodology that can be beneficially applied to address a variety of issues of child and youth development. These scholars further aver that the expected learning outcomes of Life Skills education include the combination of knowledge, values, attitudes and skills, especially those falling under the categories of critical thinking, problem solving, self-management, communication and interpersonal skills (see Section 1. 2).

In the CAPS document, the Life Skills in Foundation Phase (Grade R-3) has been organised into four study areas (see Figure 1.1); Personal and Social Well-being, Creative Arts, Physical Education and Beginning Knowledge. It has been organised in this way, I believe, in order to ensure that the foundational skills, values and concepts of early childhood and the subjects offered in Grade 4-12 are taught and developed in Grade R-3 (SA. DBE, 2011). The Beginning Knowledge study area within the Life Skills curriculum has been drawn from Social Sciences (History and Geography), Natural Sciences and Technology (see Figure 1.1). As already stated, the Natural Sciences as a learning area is included as a component of the Beginning Knowledge study area of the Life Skills curriculum and this requires teachers to carefully plan effectively and creatively to promote and develop basic Scientific Process Skills and concepts within the stipulated time (Beni et al., 2012).

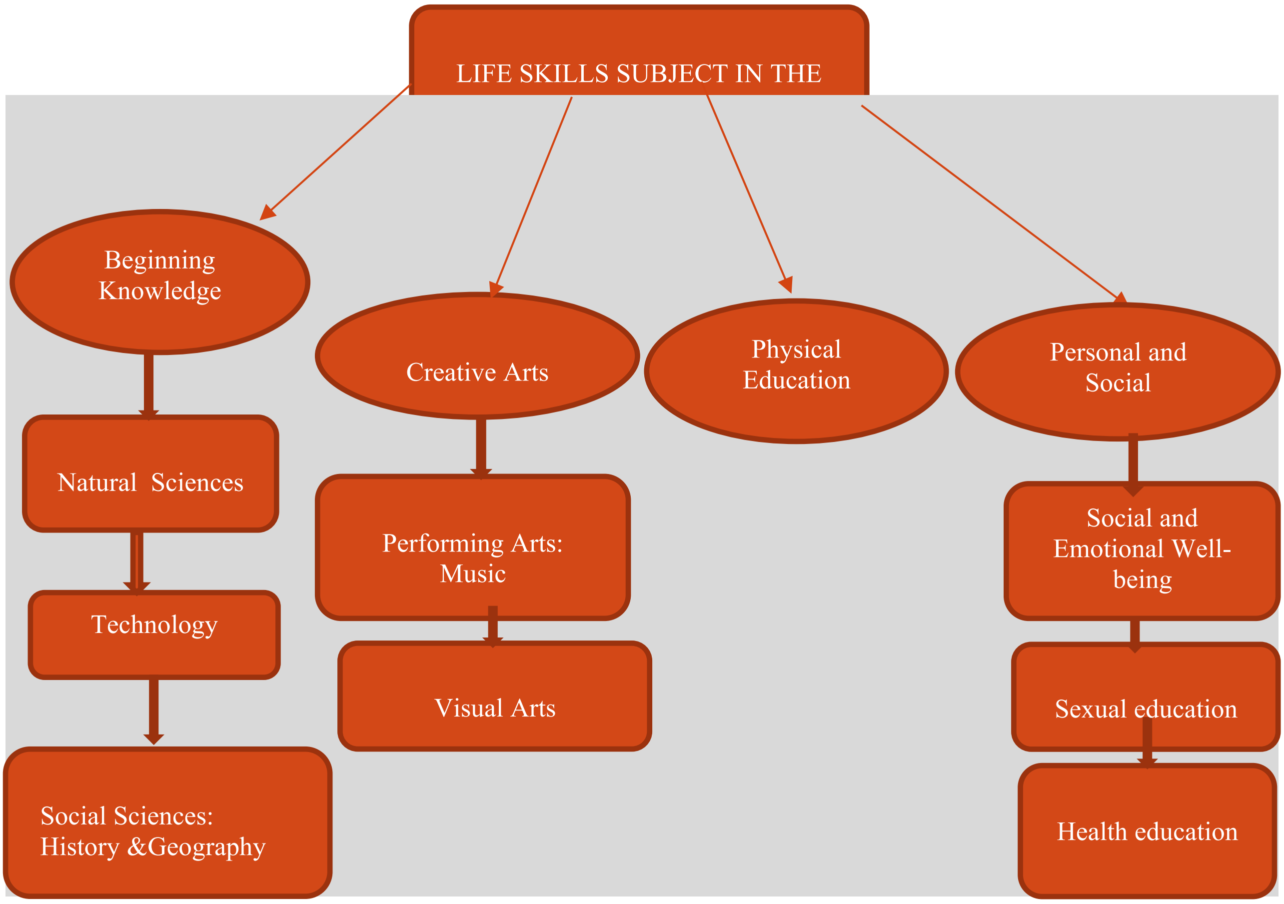

Figure 1.3: Life Skills Subject and its Study Areas in Foundation Phase (CAPS, 2011)

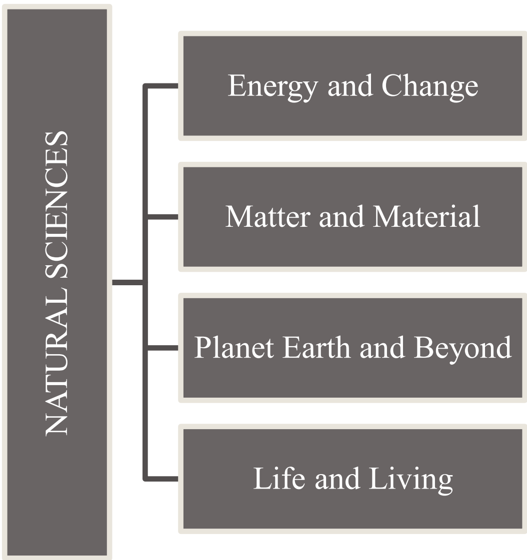

Figure 1.4: The Natural Science components in the beginning study area in Foundation Phase (CAPS, 2011)

1.6.3 Science teaching in the Foundation Phase

Zimmerman (2000) describes science as both the body of knowledge and the activities that give rise to that knowledge. He further argues that science may be thought of comprising two types of knowledges: domain-specific knowledge, and domain-general knowledge or domain-general strategies. Eshach and Fried (2005), in their research of science teaching in Early Childhood define the two domains as follows:

> Domain specific knowledge is the knowledge of a variety of concepts in the different domains of science. On the other hand, domain-general knowledge refers to general skills involved in experimental design and evidence evaluation (p. 316).

Additionally, they further explain that the domain-general skills which is the second domain of knowledge include observing, asking questions, hypothesising, designing controlled experiments, using appropriate apparatus, measuring, recording of data, representing data by means of tables, graphs, choosing data, choosing and applying appropriate statistical tools to analyse data, and formulating theories or models. Duschl et al. (2007) define science as first, the body of knowledge that represents current understanding of natural systems and second the process whereby that body of knowledge has been established and continuously extended, refined and revised.

According to Bosman et al. (2016), both elements of knowledge are important and one cannot make progress in science without understanding these aspects of science. Regarding the body of knowledge, teachers need to have pedagogical content knowledge (PCK) in order to transform it (Shulman, 1987). Hence, the importance of PCK of participants in this study. With regards to young learners, science is often seen as a vast subject and too complex for them to learn. It is mostly perceived as involving laboratories, using scientific equipment and doing experiments in class (Bosman et al., 2016). According to these scholars, at Foundation Phase level, science is concerned with children's everyday lives and their understanding of the world around them (Bosman et al., 2016; Kuhlane, 2011).

Even though scholars have presented several challenges on teaching science both at secondary and primary level, the argument is strongly made that elementary or Foundation Phase learners should be exposed in learning of science (Beni et al., 2011; Bosman, 2006; Koen & Ebrahim

2013; Worth, 2010). Seemingly, the use of learners' everyday lives and their surroundings is important in developing their scientific knowledge and skills (Mavhunga & Kibirige, 2018; Mavuru & Ramnarain, 2017). Therefore, at Foundation Phase level, teachers should not think of laboratory equipment or even formal experiments but see their learners as real scientists in action using easily accessible resources to solve problems in their everyday life (Asheela, 2017; Johnstone, 2005). To Johnstone (2005), when teaching science to young learners it is important to allow them to explore the materials familiar to them and in the higher grades, they can be introduced to scientific investigations. This statement highlights the importance of young learners to manipulate resources and explore them.

The South African curriculum and literature justifies the importance of introducing young children to science. When teaching science in Foundation Phase, the Life Skills curriculum encourages teachers to develop basic Scientific Process Skills in learners and to develop learners holistically (SA. DBE, 2011). Research adds that young learners should learn science because through it they learn about their own world and about things around them (Koen & Ebrahim, 2013). Eshach and Fried (2005) and Worth (2010) add to reasons why young learners should be taught science in their early years of schooling. They highlight the following about children:

- Children naturally enjoy observing and thinking about nature;
- Exposing learners to science develops positive attitudes towards science;
- Early exposure to scientific phenomena leads to better understanding of scientific concepts studied later in a formal way;
- The use of scientifically informed language at an early age influences the eventual development of scientific concepts;
- Children can understand scientific concepts and reason scientifically; and
- In children, science is an efficient means for developing scientific thinking.

Earlier on, I noted the challenges that Foundation Phase teachers encounter when teaching science in Foundation Phase (see Section 1.2). In addition, in Section 1.6.3 I explained that literature suggests two domains of science knowledge, namely, domain-specific knowledge, and domain-general knowledge or domain-general strategies. This study focused on the second domain which is the domain-general knowledge referred to as general skills that involve the experimental design and evidence evaluation. This domain is effectively taught through inquiry approach (Kidman & Casinader, 2017) which explains the main aim for this study. Therefore, how Foundation Phase teachers develop the basic Scientific Process Skills through inquiry-based learning or pedagogy in their Grade 3 classes was the focus of this study. Consequently, below the concept of inquiry-based learning is discussed.

1.6.4 Inquiry-based learning or approach

Hsin-Kai Wu and Chou-En Hsieh (2006) define inquiry-based learning as an approach to learning that involves a process of exploring the natural or the material world. Inquiry-based learning is a question-driven learning approach involving conducting investigations, documenting and interpreting narrative or numerical data, summarising and communicating findings (Halverson, 2007). While mostly used in science, Levy, Lameras, Mckinney and Ford (2011) posit that inquiry learning should preferably be used in other subjects such as mathematics and geography as well. According to Levy et al., an inquiry approach has some essential core components. The National Research Council (NRC, 2000, p. 25) highlights these components as follows:

- Learners must be engaged by scientifically oriented questions;
- Learners give priority to evidence, which allows them to develop and evaluate;
- Learners must give explanations that address scientifically oriented questions;
- Learners formulate explanations from evidence to address scientifically oriented questions; and
- Learners communicate and justify their proposed explanations.

Despite the challenges that research has highlighted about the effective implementation or use of an inquiry approach in the classroom, there has definitely been a consensus about the roles of both learners and teachers (Anderson, 2007). With regards to using this approach to teach science concepts, the teacher’s role is critical in this learning approach and it is a complex process informed by her/his knowledge of children and of pedagogical understanding of science knowledge (Halverson, 2007). Levy et al. (2011), Louca, Tzialli, Skoulia and

Costantinou (2013) and Worth (2010) point out that teachers play an important role in successfully implementing an inquiry approach and these are listed below;

- Teachers need to provide experiences, materials and sources of information that engage learners directly and actively (hands-on and minds-on);
- Demonstrate the use of instruments or materials that learners will need in their inquiry (for example to show learners how to use tools intended for the lesson activity);
- Be responsive to learners' inquiry by asking questions, making comments, encouraging learners to notice and reflect on important aspects of the phenomenon they are exploring;
- Ask open-ended and learner-centred questions to elicit learners' understandings and prompt explanations of their findings;
- Listen to learners' ideas and take them seriously;
- Ask questions to encourage learners to think about how to explain their findings; and
- Gather information about learners' developing skills and ideas through observation, questioning and interaction.

The above learners' and teachers' roles clearly stipulate what should take place with regards to the use of Inquiry-Based Approach in the classroom. Adding on, Lederman (2009) explains that an Inquiry-Based Approach has been the perennial focus of science education for the past century. Worth (2010) suggests that scientific inquiry provides learners with the opportunity to develop a range of scientific skills either explicitly or implicitly and Minner, Levy and Century (2010) describe the term scientific inquiry as involving three distinct categories of activities: what scientists do, how students learn and a pedagogical approach that teachers employ.

As claimed in Section 1.1, to broaden the understanding of an inquiry approach and its effective use, this study used the principles of an inquiry approach in conjunction with the six conditions of developing learners' ZPDs during mediation of activities (Vygotsky, 1978). This explains that this study used the above-mentioned conditions and principles to understand the roles played by both teachers and learners and to understand the teachers' PCK of an Inquiry-Based Approach. As underlined in Section 1.1, the principles of inquiry education by (Pollen, 2009; Tunnicliffe, 2013; Worth, 2010) are listed below:

- Direct (hands-on) experience with the phenomena under study is at the core of learning science;
- Learners must fully own and understand the question or problem they need to solve;
- Find out what learners already know and understand;
- Learners should be taught science inquiry skills;
- Learners should be involved in hands-on and minds-on activities;
- Secondary sources like books etc. should complement the direct experience;
- Science is a cooperative endeavour; and
- Develop language and argumentation in the context of science.

The use of an Inquiry-Based Approach and the development of basic Scientific Process Skills that are developed or are taught while using this kind of approach are the core of this study. Hence, basic Scientific Process Skills are briefly discussed below.

1.6.5 Basic Scientific Process Skills

Monhardt and Monhardt (2006) define process skills as a set of skills that are reflective of the behaviour of scientists, are appropriate to many science disciplines, and abilities that are broadly transferable to other situations. In addition, (Chabalengula, Mumba, & Mbewe, 2012; Yager & Akiay, 2010) see inquiry process skills as transferable skills that are applicable to many sciences and reflect behaviours of scientists. They additionally state that these skills are building blocks for critical thinking and inquiry science. Learners get to behave like scientists and assume responsibilities in their own learning and increase performance of learning. In agreement, research around the world suggests that the process skills may be one of the most important tools for producing and arranging information about the world around us (Lederman et al., 2014).

The National Science Education Standards (2000) categorise Scientific Process Skills into basic and integrated skills. In the science classroom, the basic process skills are developmentally appropriate for young learners and provide a foundation for more complex skills (Meador, 2003). In support of this, the DoE (SA. DBE, 2011) encourages Foundation Phase teachers to teach science using an inquiry approach and teaching the basic Scientific

Process Skills in their learners. Charlesworth and Lindt (2013) state that teachers need to plan science experiences where children can develop and use the basic Scientific Process Skills with the guidance of teachers. In alignment with theory, an Inquiry-Based Approach and basic Scientific Process Skills are the focus of this research, hence a brief discussion on socio-cultural theory and PCK theory that inform this study is given below.

1.7 Theoretical Overview

Yalmiz (2008) describes learning theories as indispensable for effective and pedagogical meaningful instructional practices. He (ibid.) further states that learning theories provide clarity, direction and focus throughout the instructional design process. Additionally, McLeod, Steinert, Meagher and McLeod (2003) state that an effective instructional framework takes into account the theoretical bases in which it is grounded. Amongst many different labels, learning theories can be categorised into three main areas; behaviourism, cognitivism and constructivism. Socio-cultural theory (Vygotsky, 1978) is a constructivist theory that underpins this study. PCK (Shulman, 1986), focusing in particular on the five components of TSPCK (Mavhunga & Rollnick, 2013) is used to complement socio-cultural theory, together with the principles of Inquiry-Based Approach as an analytical framework for this study. This section briefly introduces the two theories.

1.7.1 Socio-cultural theory

Vygotsky (1978) states that humans do not act directly on the physical world but rely instead on tools and labour activity, which allows humans to change the world. He further argued that symbolic tools or signs mediate and regulate the human relationships with each other and within themselves and thus change the nature of these relationships. Vygotsky, building on Piaget's idea that individual children grow cognitively in their developmental stages of growth (Verenikina, 2003). For Piaget, as children grow older their abilities to conceptualise knowledge grow. This suggests that Piaget viewed learning as an individual endeavour. On the other hand, Vygotsky (1978) recognised learning as both the cognitive and a social origin of mental development and learning. His socio-cultural theory was based on the principles that mediation of learning through language and cultural tools, symbols and artefacts, social activity and cultural practice as a source of thinking (Moll, 1990). Thus, the concept of 'mediation' is one of the key concepts and is explained in this study. Rubtsov (2016) states that the most fundamental concept of socio-cultural theory is that a human mind is mediated.

1.7.1.1 Mediation

Vygotsky (1978) states that the source of mediation is either a material tool, a system of symbols, notably language, or a behaviour of another human being in social interaction. Signs are an "auxiliary means of solving a given psychological problem" (Vygotsky, 1978, p. 52). According to Vygotsky (1978), the most important sign system is speech, as it enables social interaction and facilitates thinking. For example, words can be used to assist someone in remembering something and thus the "sign acts as an instrument of psychological activity" (p. 52). It is an internal (to whom or what?) activity. In their study, Donato and MacCormick (1994) define mediation as the instrument of cognitive change and this can take form of textbook, visual materials, classroom discourse patterns, opportunities for second language interactions, types of direct instruction or various kinds of teacher assistance.

Tools, on the other hand, are auxiliaries through which problems are resolved and focused outwards, on the object of the activity. Their use is a "means by which human external activity is aimed at mastering, or triumphing over nature" (Vygotsky, 1978, p. 55). Daniels (2005), in his *Introduction to Vygotsky*, takes care to point out that Vygotsky (1978) did not imply that external forces control human behaviour. The symbolic systems that come to form psychological signs, as well as the physical tools used in activity, are only useful because of the meaning the individual has come to ascribe to them. In other words, external operations have been "internally reconstructed" (Vygotsky, 1978, p. 56).

Mediation in this study was very important and considered how teachers use inquiry approach to develop the foundational basic Scientific Process Skills. The instructional approaches, the use of materials, the use of language by teachers used to mediate learning and to promote interactions with their learners to achieve the intended objectives of their lessons was important to the mediation process. As with physical tools, humans (teachers) use symbolic artefacts to establish an indirect, or mediated, relationship between what is taught in class and the learners.

Vygotsky views the human mind as a functional system in which the properties of the natural, or biologically specified brain is organised into higher, or culturally shaped mind through the integration of symbolic artefacts into thinking. This explanation also highlights the importance of culture in learning and during the mediation process.

1.7.1.2 Culture

Vygotsky (1986) defines culture as a social environment, a system of social standards rather than a mediator of human freedom. He sees culture as a way of self-perception of a person, which helps to reveal a creative potential. In this study, the concept of culture was taken into account with regards to the context of the four research schools, the instructional language used by the participants in their classrooms and how the four participants related to their learners and how they created space for learning. Kudryavstev (2016) in his article of celebrated work of Vygotsky, discussed culture as a concept of 'Self–Perception'. He explains that, the concept of culture in both historically and ontogenically forms and in at least current historical settings, it is initially created in personal form and enables it to acquire social significance.

Culture does not only bring people together based on some formal characteristics but also with it, people become significant to each other. Vygotsky (1986) further defines the concept of culture as something that people create together for each other and therefore it unites them in space and time. Thus, the influence and the importance of this to the individuals makes them not to be indifferent to each other. Moreover, culture as a concept is a creative and a unifying force amongst individuals. The concept of culture in this study refers to the participants' relationships with their learners. Also, with how participants created space for their learners to relate and work with each other during lessons. This has directed this research to the concept of 'Social Interactions' during teaching and learning.

1.7.1.3 Social interactions

According to Vygotsky, learning is a socially mediated process which starts at a social level as a social relationship the learner interacts with his/her peers and the knowledgeable others (a teacher, a parent or a care giver) before internalizing the knowledge on his/her own (Bodrova, 1997). Rubtsov (2016) defines social interactions as the mechanism of distribution of functions and a means or a method of mastering those functions. From this view, I take into account that when learners work together with the guidance of the knowledgeable ‘other’ there should be some distribution of tasks and this should be done to achieve an intended objective or goal. This reveals that when working in a group or in a social set-up, there should be a means to master a certain function together as a group with each individual participating or contributing to the learning experience.

Rubtsov adds that Vygotsky formulated two ideas, which became the cornerstones of the approach to the issues of learning activities. According to Rubtsov (2016), the scientific community realised that social interactions and cognitive development are neither mixed nor independent processes; they are neither reversible processes nor equivalent processes. With this view of educational situation and learning Vygotsky divided teachers and learners as being involved in a process of co-action and co-operation in a joint activity. This leads to development in learning and hence this study views the concept of Zone of Proximal Development (ZPD) in learning situations. Hence, I discuss the concept of ‘ZPD’ regarding this study.

1.7.1.4 Zone of Proximal Development (ZPD)

ZPD is the distance between the actual developmental level as determined by independent problem solving of an individual and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978). The ZPD is the instructional level, “where the instruction is targeting a specific point to achieve the greatest learning gains for each learner” (p. 86). Steele (2001) explains the ZPD as the place where learning is located, somewhere between the child’s actual understanding and his/her potential understanding. In addition, Lui (2012) defines the zone of proximal development as the difference between what a child can do independently and what he or she is capable of doing with targeted assistance.

Vygotsky (1978) in his theory of the ZPD observed that when learners were assessed on tasks in which they worked independently they did not do as well as they would do when they worked in collaboration with peers or adults. Zaretskii (2016) in his study used a multidimensional model of Vygotsky's ZPD as one of the conceptual tools in helping children to overcome learning difficulties and promoting their development. He used the method of "*reflection and activity approach*", a system of principles and techniques facilitating the child's development in the course of his or her collaboration with the adult or peers. The approach relies on supporting the child's sense of agency in terms of his or her activity, reflection, awareness, reforming and constructing modes of action (Zaretskii, 2016). In this research, the participants' pedagogical content knowledge of using an Inquiry-Based Approach when teaching various content knowledge in the observed lessons was also important.

1.7.2 Pedagogical content knowledge

Shulman's (1986) interest in how teachers transfer knowledge to learners led him to highlight the following questions: What are the sources of teacher knowledge? What does a teacher know and when did he or she come to know it? How is new knowledge acquired, how is the old knowledge retrieved, and how are they both combined to form new knowledge? Based on these questions, his assumption was that most teachers begin with some expertise in the content they teach. Shulman describes PCK as that special amalgam of content and pedagogy that is uniquely the area of teachers, this continues to talk to teachers' own special form of professional understanding. According to Goodnough and Hung (2009), PCK illustrates how the subject matter of a particular discipline is transformed for communication with learners.

Park and Oliver (2008) also viewed PCK as a mixture of interacting elements, including views of learning, views of teaching, understanding of content, understanding of students, knowledge and practice of children's conceptions, time, context, views of scientific knowledge, pedagogical, practice, decision-making, reflection, and explicit versus tacit knowledge of practice, beliefs, and ideas. According to Park and Oliver, all these result in Pedagogical Content Knowledge. The techniques and styles a teacher employ to teach her/his learners are the pedagogy in the classroom. The point of teaching is not simply the teaching of a particular subject or topic. It also includes how the teacher transfers the content knowledge or the skills that will enable children to learn both in and out of the classroom. The pedagogy the teacher uses to achieve this objective is critical to the success of the teaching objective. In this study, the teachers' knowledge of basic Scientific Process Skills and of an Inquiry-Based Approach was vital. In addition to this, teachers' knowledge of learners, their understanding of context in which they teach and the instructional strategies the participants used in the process of this study was also crucial (Park & Oliver, 2008). In Chapter Three where theory that underpins this study is discussed, PCK as an analytical framework is described and further deliberated upon.

1.8 Data Generation Methods in This Study

To collect data in this study, I used questionnaires, semi-structured interviews, lesson observations (videotaped lessons), stimulated-recall interviews and group reflections. Additionally, I used document analysis to understand the Life Skills Curriculum, its components and its expectations for teaching and learning. With regard to the Life Skills curriculum in this study, I drew my discussions from the documents that I analysed. Semi-structured interviews and questionnaires helped me to understand the participants' thoughts and views about the research topic. Questionnaires also documented the participants' profiles that assisted in understanding their background contexts. Videotaped lessons, the main data collection tool for this study, assisted in understanding the mediation processes and the strategies or pedagogies used by teachers in using an Inquiry-Based Approach in their classrooms. In addition, the data from the stimulated-recall interviews and group reflections highlighted the participants' views and ideas about their own teaching practice during the research process and their ideas about the research study. Next, I introduce the data analysis process in this study.

1.9 Data Analysis in This Study

Cohen, Manion and Morrison (2018) perceive data analysis as a method to move from the data to understand, explain and interpret the phenomena in question. They make it clear that, qualitative data analysis includes among other matters; organising, describing, accounting for, and explaining data, making sense of data in terms of the participants' definitions of the situation. Additionally, qualitative analysis includes noting patterns, themes, categories and regularities. For this study, I presented, analysed and discussed data and findings according to each research question. For research question 1, I used data from questionnaires and semi-structured interviews. These I catagorised according to the questions from both the questionnaires the semi-structured interviews. For research question 2, I interrogated the observed (videotaped) lessons. For this data analysis, I used two participants one from each quintile school (one participant from quintile 3 and the other from quintile 4). Additionally, I decided to choose these two teachers because of their teaching experience in the Foundation Phase; one participant is the least experienced teacher and the other participant is the most experienced teacher.

For research question 3, data is from the group reflections and stimulated-recall interviews. All data from the research tools were catagorised to formulate patterns and themes from the participants, theories and literature in this study was used for discussions and findings. Raw data were used to present the ‘voices’ of the participants and to give analytical statements from the participants. In the literature chapter, the theory chapter and the methodology chapter I further present data analysis in this study.

1.10 Dealing with Ethical Issues in This Study

Cohen et al. (2018) describe ethical research concerns as what researchers ought and ought not to do in their research and research behaviour. They add that ethical decisions are contextually situated – socially, politically, institutionally, culturally and personally. Moreover, they articulate that “ethical issues are not a once-for matter which can be decided before the research commences or when the proposal is put to an ethics committee, and then forgotten” (p. 111). Ethics should run throughout the entire research process. For this research, the objectives of this study through the proposal presentation were clearly articulated to the research Higher Degrees Committee of the faculty of education (Rhodes University). The clearance certificate was granted for undertaking the study (Appendix A). The letter of consent and explanation about the research process was discussed together with the participants (Appendix B). Permission for undertaking this study was discussed with the school principals (Appendix C). The permission was also requested from the district director of the Sarah Baartman district (Appendix D). Last, since lessons were video recorded to explain the process of this research the participants invited me to be part of their parent meetings. This helped me to clarify any issues with this research. In chapter four, I further explain the ethics processes I undertook during this research study.

1.11 Thesis Outline

Chapter One positioned the panorama for the study. This chapter introduced the reader to the contextual background of the study, the statement of the problem, significance of the study, research aim and objectives. The research questions were presented to highlight the research objectives and aims of this study. Explanation and description of concepts in this study were discussed. Introduction to an Inquiry-Based Approach and the basic Scientific Process Skills was briefly explained pertaining to the study. The theoretical overview underpinning this study was introduced together with the theoretical concepts. Next, I introduced data analysis and ethical issues in this study. Last, the chapter concluded by giving a thesis outline and a chapter summary.

Chapter Two engages with the literature relevant to my research topic. Literature related to an Inquiry-Based Approach and the development of basic Scientific Process Skills in relation to this study is explored. Literature on challenges and benefits of using an inquiry approach is deliberated upon in this chapter as well. Relative to this study, I also discuss literature on practical activities in relation to the development of inquiry skills.

Chapter Three provides the theoretical underpinnings of this study, namely, socio-cultural theory in particular, focusing on socio-cultural theory in relation to the concept of mediation, ZPD, culture and social interactions. I also discuss the analytical framework of PCK, focusing on TSPCK in relation to the participants' understanding and implementation of an Inquiry-Based Approach in this study. Finally, I discuss the process of data analysis relating to the above-mentioned theories and framework.

Chapter Four discusses the research design, methodology and the research techniques employed in this study. For this study, questionnaires, semi-structured interviews, observations, stimulated-recall interviews and group reflections are discussed with reference to how each data technique was used to gather data and which turn this study took. Additionally, to understand the curriculum expectations and content in the Foundation Phase Life Skills subject I used document analysis. I engage with data analysis as well as issues pertaining to ethics and validity in this chapter.

Chapter Five situates the participants' understanding and views from research question one. Using theory and literature, I present, analyse and discuss data and findings in this chapter. The participants' understanding of an Inquiry-Based Approach, basic Scientific Process Skills and their views on science teaching in the Foundation Phase are key in this chapter. With the aim to present the truthfulness of the participants' voices, I used analytical statements to keep the data alive.

Chapter Six deals with how the participants used an Inquiry-Based Approach to develop the basic Scientific Process Skills in their classrooms and this is the focus for research question two and the focus of this study. Again, as explained, I present the data from the question and the analysis of data using theory and literature is deliberated upon in this chapter. Therefore, the focus of this chapter is the mediation process in the participants' classrooms.

Chapter Seven concludes the process of research by presenting the data for question three. Essentially, this research question considered the participants' reflections and stimulated recall-interviews with regards to this research. Their thoughts and views of this whole process are the core of this chapter. How the research process impacted or did not in their practice, is what this chapter is about.

Chapter Eight pulls the threads of this research process together**.** My journey, my reflections throughout this process and the experiences gained from this research are also presented in this chapter. Additionally, the chapter presents an evaluation, limitations, as well as some recommendations for further research. This chapter concludes with a conclusion based on this study.

I will now discuss the literature that relates to the subject under study, highlighting the benefits and challenges of using an Inquiry-Based Approach.

CHAPTER TWO: SITUATING THE STUDY IN THE LITERATURE

> *The use of the term inquiry-based learning (IBL) to describe particular form of curriculum and pedagogical approach tends to have the effect of de-emphasising the fact and reality that IBL has its corollary in "inquiry-based teaching". This impression is reinforced in the research literature, which highlights the plethora of research evidence relating to positive impacts of inquiry learning by students, but a relative lack of similar studies on the role of the teacher in inquiry education.* (Kidman & Casinader, 2017, p. 31-32)

2.1 Introduction

The purpose of this chapter is to discuss and explore the various studies and the literature on the use of an Inquiry-Based Approach in teaching of science related topics. The literature on the learning and development of basic Scientific Process Skills during science teaching is also discussed. The discussion on this chapter leads to the understanding of how Foundation Phase teachers in the South African context understand the importance of teaching science and development of basic Scientific Process Skills in the Foundation Phase classroom.

Concerning my research, I also identified the gaps on the use of an Inquiry-Based Approach in the Foundation Phase. The limitations and the strengths of an Inquiry-Based Approach in relation to this study are discussed especially in the South African context, a gap that the study sought to address. In the South African context, specifically, there is limited research about Foundation Phase teaching and the use of an Inquiry-Based Approach in developing basic Scientific Process Skills in learners. As a result, most literature is from and on international studies. Lastly, according to this chapter, because my focus is on young learners in the early years of schooling, especially Grade 3 learners (9-10 years of age), I use the terms Foundation Phase or Early Childhood, also elementary schooling or primary schooling are used interchangeably in this chapter.

2.2 Foundation Phase Teaching in the South African Context

In Sections 1.1 and 1.6.1, I defined the Foundation Phase as part of Early Childhood Development, which refers to "the process by which children from birth to at least nine years grow and thrive physically, mentally, emotionally, spiritually, morally, and socially" (SA. DoE, 2001, p. 3). Koen and Ebrahim (2013) describe early childhood as time of greatest risk and greatest opportunity. This implies that, when it comes to Foundation Phase (FP), teachers can have an opportunity to explore a variety of teaching strategies that may assist in strengthening and developing knowledge in their learners. To add, teachers in this phase can develop a strong foundational learning or can weaken their learners' development in learning. Koen and Ebrahim (2013) argue that the quality of education during this stage "plays an important role in learners' physical and cognitive development in the future" (p. 1).

Foundation Phase, therefore, is a foundational stepping-stone for any South African child that aspires to become a valuable and an educated citizen. This is evident on the curriculum specific aims and objectives (SA. DBE, 2011). Pertaining to this phase, Beni et al. (2012) highlight that "the developments in South Africa are echoing the worldwide transformation trends in science education" (p. 65). They further explain that, in United Kingdom Target 1 for science in the National Curriculum has apportioned precedence to scientific investigation. Moreover, the Revised National Curriculum Statement for Natural Sciences learning area deals with the promotion of scientific literacy and this is achieved by developing and using Scientific Process Skills, critical thinking skills and problem-solving skills, which are invariably taught and promoted through an Inquiry-Based Approach.

In addition, it has been argued that the "focus of Foundation Phase is on primary skills, knowledge and values, and the laying of a solid foundation for further learning" (SA. DoE, 2003, p. 4). Koen and Ebrahim (2013) similarly argue that in this phase, Foundation Phase teachers play an important role in supporting young learners to reach their developmental potential. Additionally, this suggests that learning is most significant in this phase, its learning opportunities impact meaningfully on further learning and development of young children (Green, Parker & Hall, 2011). Bosman et al. (2016) highlight the importance of Foundation Phase teachers being aware of and understanding the domains of development of the Foundation Phase learner, which are (physical development, cognitive development and socioemotional development). Gordon and Brown (2014) elegantly summarised the developmental domains as follows:

- Physical or biological development is described as the physical changes in the body;
- The cognitive development relates to intellectual and language changes; and
- The socioemotional development reflects changes in an individual's relationships with other people, as well as in their emotions and personality.

The National Association for Education of Young Children discussed the above developmental domains because of the published research, which pronounced standards for high-quality care and education for young children. These, according to Bosman et al. (2016), are referred to as guidelines for a Developmentally Appropriate Practice. Gordon and Brown (2014) also refer to these domains as developmentally and culturally appropriate practice, and this concept was influenced by the diversity of learners or children in communities, which then impacts on the teaching and learning in the classroom.

Similarly, this in my view, speaks to how Foundation Phase teachers should consider planning and teaching of lessons for their learners. Their planning and teaching therefore needs to accommodate all learners as culturally diverse as they are (Mavuru & Ramnarain, 2017). Moreover, teachers in this phase have to integrate and promote literacy and numeracy throughout their teaching. Hence, the importance of critical planning across all subjects in this phase. In the Foundation Phase, there are four subjects that are taught and these have various amounts or degrees of instructional times as outlined and summarised in the Table 2.1 (SA. DBE, 2011).

Table 2.1: Instructional times per week in the Foundation Phase (Grades R-3)

Subject	**Grade R (Hours)**	**Grades 1-2 (Hours)**	**Grades 2-3 (Hours)**
Home Language	10	8/7	8/7
First Additional Language		2/3	3/4
Mathematics	7	7	7
Life Skills: Beginning Knowledge Creative Arts Physical Education Personal and Social Well-being	6 (1) (2) (2) (1)	6 (1) (2) (2) (1)	7 (2) (2) (2) (1)
Total	**23**	**23**	**25**

In Table 2.1, the Life Skills subject is allocated six hours of instructional time per week in Grades R to 2 and seven hours in Grade 3. In the seven hours in Grade 3, teachers are expected to accommodate all the study Life Skills areas, which are the Beginning Knowledge (Natural Sciences, Social Sciences and Technology), Creative Arts, Physical Education and Personal and Social Well-being. These are "all foundational components with their main being fundamental requirements and specific knowledge that assist learners to have foundational knowledge for the upper grades" (SA. DBE, 2011, p. 5). Essentially, Life Skills education learning outcomes highlight a combination of thinking, problem solving, self-management, communication and interpersonal skills. Through an Inquiry-Based Approach, the combination of the underlined skills can be taught and developed. Gordon and Brown (2014) highlight the importance for Foundation Phase teachers to teach developmentally and culturally appropriate skills to prepare learners for school extending from reception to beyond school leaving.

2.3 Life Skills Curriculum in the Foundation Phase

Life Skills is central to the holistic development of learners. That is, it is concerned with the social, personal, intellectual, emotional and physical growth of learners, and with the way in which these are integrated. I explained above that in the Life Skills CAPS document, Foundation Phase (Grade R-3) has been organised into four study areas: Beginning Knowledge, Personal and Social Well-being, Creative Arts and Physical Education (see Section 2.2 & Table 2.1). It has been organised in this way in order to ensure that the Foundational skills, values and concepts of early childhood and the subjects offered in Grade 4-12 are taught and developed in Grade R-3 (SA. DBE, 2011). Bosman et al. (2016) explain that Life Skills education is now recognised as a distinct methodology that can be beneficially applied to address a variety of issues of child and youth development.

Beni et al. (2012) highlight several challenges with the Life Skills curriculum. Amongst others, they point out that Life Skills, especially the science component, has not been traditionally the focus of instruction in this phase, hence in their research they noted a lack of confidence in teaching of science by Foundation Phase teachers. However, with the recent developments in the South African Curriculum, teachers are required to teach science and develop scientific literacy in the Foundation Phase using an Inquiry-Based Approach. The other challenge of teaching science in this phase, is that Natural Sciences in the Life Skills Curriculum is embedded under Beginning Knowledge and this makes more difficult for teachers to recognise it.

As explained previously, the Beginning Knowledge study area within Life Skills is the focus of this study. In the Foundation Phase, the Life Skills curriculum, the key concepts and skills relating to these disciplines have been detailed as follows:

- Social Science concepts: conservation, cause and effect, place, adaptation, relationships and interdependence, diversity and individuality, and change;

- Natural Science concepts: life and living, energy and change, matter and materials, planet earth and beyond;
- Scientific Process Skills: the process of inquiry which involves observing, comparing, classifying, measuring, experimenting, and communicating; and
- Technological process skills: investigate, design, make, evaluate, and communicate (SA. DBE, 2011).

Life Skills as a subject is designed to equip learners and prepare them for Intermediate Phase (IP) schooling or learning. This subject with its limited instructional time in FP prepares Foundation Phase learners for subjects such as, Life Orientation, Home Economics, Geography, History, Natural Sciences and Technology in the Intermediate Phase. This implies that Foundation Phase teachers have to be specialists in teaching Life Skills effectively and successfully. Notwithstanding the fact that in the Foundation Phase, teachers have to be Foundation Phase specialists, and this implies that they have to understand the developmental processes for each learner in the classroom (Bosman et al., 2016). In addition, the various components embedded in Life Skills have different literacies and knowledge. The recognition, the teaching and the development of scientific inquiry skills to promote the above literacies is important, hence the position of this study.

Beginning Knowledge:

- Natural Sciences
- Technological process skills (investigate, design, make, evaluate & communicate)
- Social Sciences
- Scientific Process Skills – process of inquiry (observe, compare, classify experiment & communicate)

SA. DBE (2011)

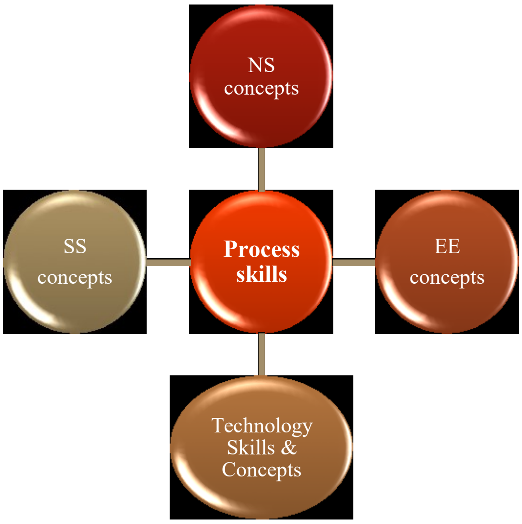

Figure 2.1: Scientific Process Skills at the centre of scientific concepts in the Foundation Phase

2.4 Science in Early Childhood

Worth (2010, p. 1) states that,

> In a world filled with products of scientific inquiry, scientific literacy has become a necessity for everyone. Everyone needs to use scientific information to make choices that arise every day. Everyone needs to be able to engage intelligently in public discourse and debate about important issues that involve science and technology. Moreover, everyone deserves to share in the excitement and personal fulfilment that come from understanding and learning about the natural world.

This requirement or expectation above has led globally to the development of the science curriculum in early childhood education. Worth (2010) in her research in Newtown, Massachusetts also highlights the need to focus on science in early childhood classrooms. She cites the following reasons: the growing understanding and recognition of the power of children's early thinking and learning and the recognition that children have much greater potential to learn than previously thought. Early childhood settings should therefore provide rich and challenging environments for learning. Research suggests that science may be a particularly important domain in early childhood, serving not only to build a basis for future scientific understanding, but also to build important skills and attitudes for learning (Halverson, 2007; Sackes, Trundle, Bell, & Connell, 2010).

Halverson (2007) and Sackes et al. (2010) point out some reasons as to why it is fundamental to teach science in early childhood. According to Halverson, from the classroom experience children can develop a greater appreciation and understanding of the natural world; young children are *naturally curious* and constantly exploring the world around them and classroom science provides the opportunity for children to extend this natural curiosity and build theories. Earlier, French (2004) in a new curriculum implementation for Early Childhood in New York, highlighted that engaging children's attention and participation is a critical first step in establishing a classroom environment that supports children's development and learning. She further explains that children's fascination with science activities supports their intellectual and linguistic development by providing a context for hands-on, personal experience during which they form mental representations of complex phenomena, process complex language, and attempt to communicate their understanding of experience to others.

Koen and Ebrahim (2013) also highlight that in the context of transformation in education in South Africa, Foundation Phase education is undergoing rapid change. This phase became more regulated through education reforms in guiding young learners' learning. Through literature and practice, it is evident that the teacher's role in this curriculum space and in creating learners' experiences in science is crucial. Similarly to the South African study by Beni et al. (2012), Appleton (2008) argued that primary teachers are normally hesitant to teach science. He cited two reasons for his argument, the first being a limited knowledge of science content, as well as a limited science pedagogical content knowledge (PCK) (Appleton, 2003; Shulman, 1986). Several studies consistently revealed challenges with science knowledge held by primary school teachers (Scholtz, Watson, & Amosun, 2004; Sherman & MacDonald, 2007).

Appleton (2008, p. 525) in his study of professional development programmes argues that "elementary or primary school teachers work with PCK in different ways when compared to secondary school teachers". According to him, primary school science teachers usually start with the view that science teaching should be activity-based and work from specific activity ideas. It is recognised, however, that most primary school teachers tend to have limited science content knowledge, as they are not science specialists. Similarly, the Foundation Phase teachers are primary school teachers too (Appleton, 2008). In Section 2.3, the Beginning Knowledge area in Life Skills is discussed highlighting the content strands of Natural Sciences (SA. DBE, 2011).

Discussing the four content strands, Bosman et al. (2016) explain that Life and Living is the study of living things and forms part of Life Science in the higher grades. Matter and Materials involves the study of non-living materials (natural and synthetic) to understand their structure, reactions and change and this forms part of Physical Science and Chemistry in the higher grades. Energy and Change forms part of Physical Science in higher grades and involves the study of how energy is transferred in physical and biological systems; and lastly Planet Earth and Beyond which forms part of Geography in the higher grades, involves the study of the structure of the earth (water, rocks and soil). As discussed above, with this understanding of content, Foundation Phase teachers now need not only to impart SMK but also to work with learners from diverse socio-cultural backgrounds (Mavuru & Ramnarain, 2017).

In the same vein, Kok and van Schoor (2014) present the need for Foundation Phase teachers to be specialists in each subject. Then again, it is suggested that Foundation Phase teachers are not required to specifically focus or teach science content to learners, but instead they need adequate content knowledge to facilitate scientific inquiry learning in their classrooms (Beni et al., 2012). In order to facilitate inquiry learning to a greater extent, Foundation Phase teachers are required to teach the Natural Sciences content and it is essential for these teachers to understand how science is taught and to understand its content. Hence, "the importance of Foundation Phase teachers having sufficient PCK for science teaching" (Plaatjies, 2014, p. 26).

In arguments about Foundation Phase teachers' knowledge of science teaching, it has been suggested that their knowledge is determined largely by how they respond to educational innovation (Henze, van Driel, & Verloop, 2007a). Henze, van Driel and Verloop (2007b) in their study on how teachers' pedagogic practices changed in response to a curriculum innovation and what factors affected the ways in which teachers changed, concluded that teachers' knowledge might eventually change and transform steadily over time. According to them, this might be due to new experiences. In addition to this, they highlight that to improve successful implementation, high quality of teaching materials needs to be applied. From this view, with all the contextual and social challenges that are presented by the research on teaching science in South African schools, what research has not mentioned is the advantages that Foundation Phase teachers have in making the teaching of science successful (Eshach & Fried, 2005; Worth, 2010). Teachers in the Foundation Phase have the opportunity of building a strong *foundational knowledge* for science teaching and learning and their role as teachers in the teaching of science is critical.

2.5 The Teacher's Role in The Teaching of Science

The teacher's role is critical to children's science learning, and it is a complex one that is informed by her/his knowledge of children, and of pedagogical science knowledge (Halverson, 2007). Adding to this, Worth (2010) argues that children's scientific inquiry is guided by the teacher's explicit understanding of the important underlying science concepts related to the focus she/he has chosen. De Kock (2005) highlights that children's domain-specific knowledge (see Section 1.6.3) is unlikely to be acknowledged and extended if teachers are not confident in the knowledge themselves. She further argues that it is doubtful that teachers would be able to identify, analyse, and extend children's scientific interests, if they are not comfortable with imparting the scientific knowledge themselves. Some challenges are also pointed out by Harlen (2001), who contends that teachers may not know when to introduce the scientific view of things or be able to do so in a way that children will understand.

Lending support to this view, Garbett (2003) stresses the importance of subject matter knowledge of science, as well as pedagogical content knowledge of how children may learn and develop scientific concepts and phenomena; the one is dependent on the other. This implies that the teacher may know how to interact with young children in gaining an understanding of science concepts, but a limitation of the understanding of the science concepts at hand will restrict the teacher from asking meaningful questions and extending the children's thoughts (de Kock, 2005).

Again supporting this view of science knowledge that Foundation Phase teachers should have, Johnson (2005) explains various domains that teachers should take into account. According to Johnson teachers should focus on cognitive ability (knowledge and understanding), developmental skills, as well as values (virtues and attitudes). Bosman et al. (2016) explains these domains constitute heads, hands, and hearts of science education. This explanation by Bosman et al. (2016) refers to the concept of holistic development of a learner in science, hence this study is important. According to them, there are areas that Foundation Phase teachers need to consider when planning science activities for their learners and to illustrate these I adapted Figure 2.2 below from Bosman et al. (2016).

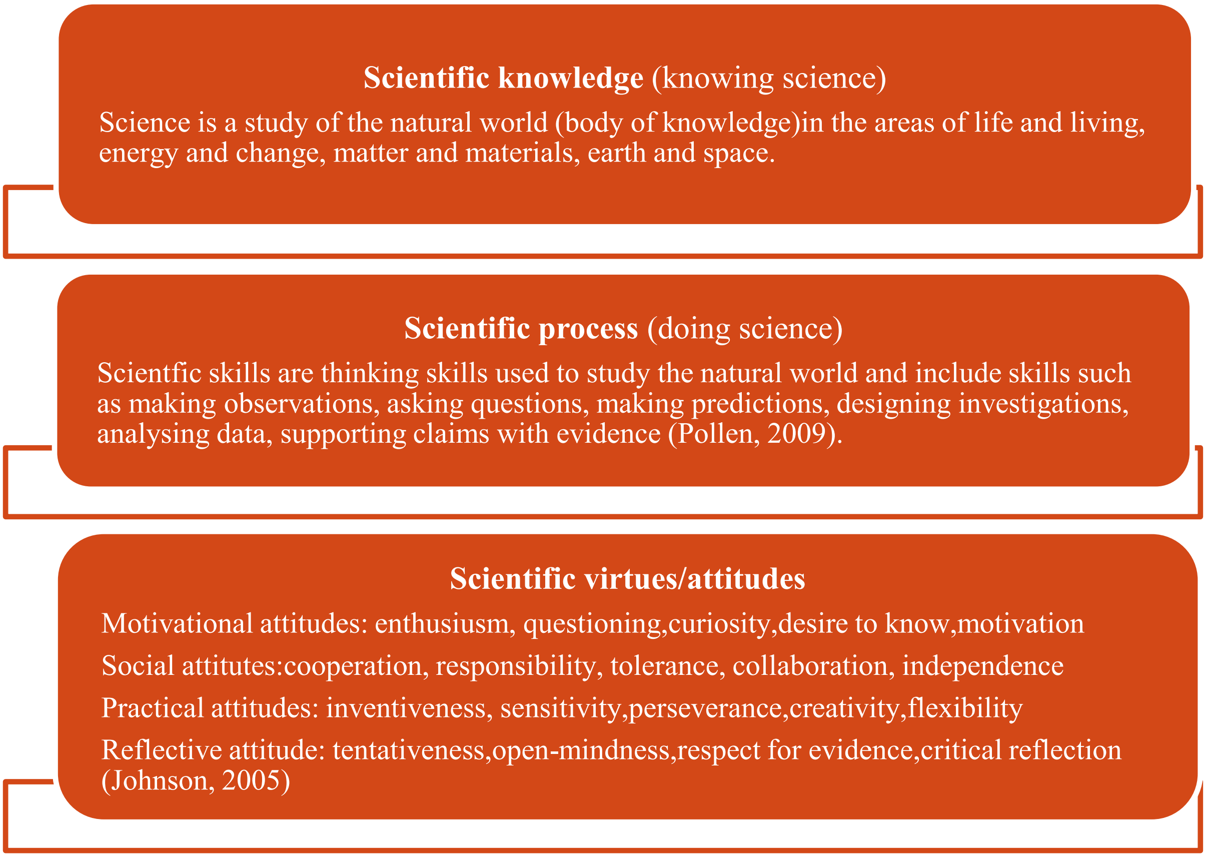

Figure 2.2: The domains of science education (adapted from Bosman et al., 2016)

In recognition of these domains, teachers in the Foundation Phase should be teaching and developing scientific inquiry skills and therefore implementing an Inquiry-Based Approach.

2.5.1 Inquiry-based learning and science teaching

Kidman and Casinader (2017) view inquiry-based education as a method that requires an intensive knowledge of pedagogy. They further argue that it requires knowledge creation within and across disciplines, development of learners' abilities, concepts and motivation towards autonomy. The domain inquiry has been considered in terms of classroom goals, instructional approach and the degree of teacher direction. The alignment of these three concepts is considered as important "for development of inquiry literacy in both teachers and learners, as well as differentiation of discipline-specific inquiry" (p. 4). In the same vein, Mkimbili, Tiplic and Ødegaard (2017) understand inquiry-based learning as a process of involving learners in developing questions for investigation, designing investigation procedures, collecting and interpreting, drawing conclusions from the data and communicating findings. According to these scholars, inquiry-based learning needs to adapt to the context of learners (Mavuru & Ramnarain, 2017), and hence the teacher needs to understand their schooling contexts (Mkimbili et al., 2017).

In addition, Alfieri, Brooks, Aldrich and Tenenbaum (2011) identify that learners require support to undertake inquiry and without this support they generally experience difficulties regulating their own learning processes (Harrison & Muthivhi, 2013; Vygotsky, 1978). Zimmerman (2007) points out that to draw conclusions and conduct investigations, learners do need their teacher's support when conducting inquiry activities. In this study, I focused on an Inquiry-Based Approach as my subject focus of the study was the Beginning Knowledge Study area (specifically the Natural Sciences). Zimmerman (2007) and Tenenbaum (2011) show how they "conceptualise the intertwining of Inquiry-Based Instruction in a way that it develops inquiry literacy and, in particular, differentiates the disciplined nature of inquiry literacy" (p. 7).

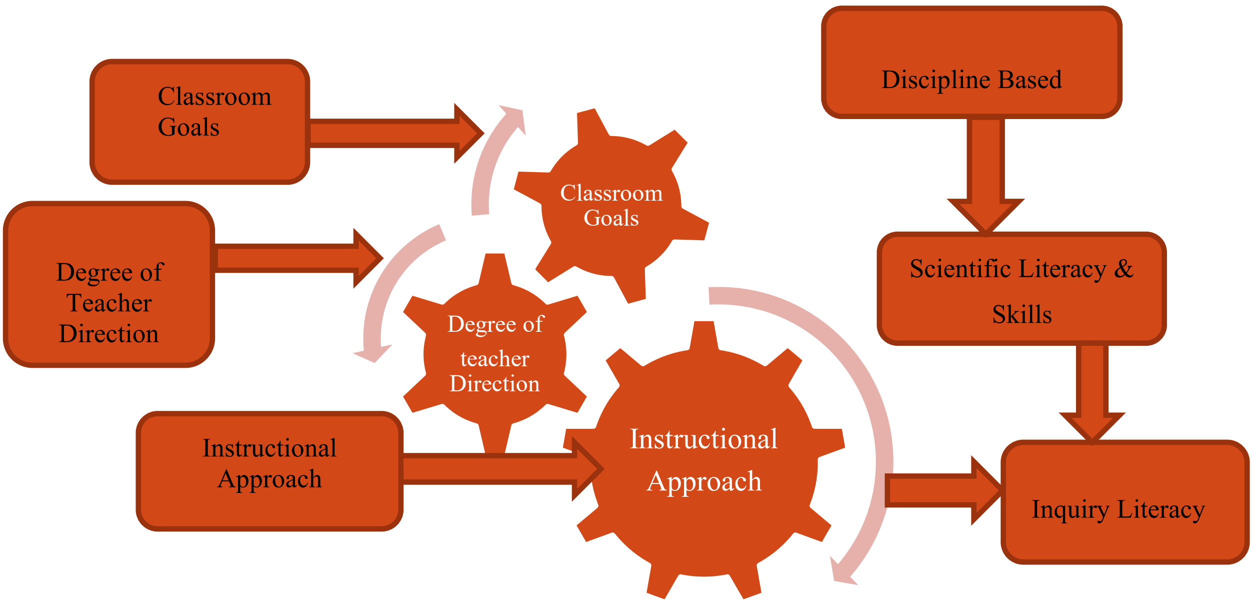

Figure 2.3: The intertwined nature of inquiry-based instruction or learning and inquiry literacy (Kidman & Casinader, 2017)

Figure 2.3 by Kidman and Casinader (2017) adds to the expectations of how an Inquiry-Based approach should be implemented or planned by teachers. They recognise the three intertwined categories of an Inquiry Approach: the classroom goals, the degree of teacher direction and the instructional approach. Regarding their explanations and discussions, these three categories speak to each discipline or subject taught in the classroom and hence the component of the instructional approach. Essentially, an Inquiry-Based Approach has its role and purpose in the classroom, which is to promote Scientific Process Skills and scientific literacy.

To Pedaste, Maeots, Leijen and Sarapuu (2015), inquiry-based learning is an educational strategy in which learners follow methods and practices similar to those of professional scientists in order to construct knowledge. They further see inquiry-based learning as a process of discovering new causal relations with a learner formulating hypotheses and testing them by conducting experiments and/or making observations. A number of researchers (Bosman et al., 2016; Kidman & Casinader, 2017; Pedaste et al. (2015) share the same sentiment about the definition of inquiry-based learning. Adding to this explanation, Pedaste et al. (2015) emphasise that this type of instructional approach promotes active participation (Sedlacek & Sedova, 2017) and learner responsibility for discovering knowledge that is new to the learner.

In addition, inquiry-based learning is also seen as a question-driven learning approach involving conducting scientific investigations, documenting and interpreting narrative or numerical data, and summarising and communicating findings (Gillies & Nichols, 2015; Minner et al., 2010). According to Gillies and Nichols (2015), scientific inquiry recognises the diverse ways in which scientists study the natural world and proposes explanations based on evidence derived from their work. From a pedagogical perspective, the complex scientific process (inquiry-based learning) is divided into smaller, logically connected units that guide learners and draw attention to important features of scientific thinking and these individual units are called inquiry phases.

The set of these inquiry phases form an inquiry cycle (Pedaste et al., 2015). Pedaste et al. (2015) in their research on the analysis of the descriptions and the definitions of inquiry phases presented in several articles they reviewed, led them to develop a new inquiry-based learning framework that includes five inquiry phases. These are "orientation, conceptualisation, investigation, conclusion and discussion" (Pedaste et al., 2015, p. 55). According to these scholars, this framework covers most of the inquiry phases that they have reviewed and the main core terms were extracted from the articles found in their review. Table 2.2 below shows the definitions of the five components of the synthesised inquiry-based learning framework.

Table 2.2: Definitions of the five phases for the synthesised inquiry-based learning framework

General phases	Definitions
Orientation	The process of stimulating curiosity about a topic and addressing a learning challenge through a problem statement.
Conceptualisation	The process of stating theory-based questions and/or hypotheses.
Investigation	The process of planning exploration or experimentation, collecting and analysing data based on the experimental design or exploration.
Conclusion	The process of drawing conclusions from the data. Comparing inferences made based on data with hypotheses or research questions.
Discussion	The process of presenting findings of particular phases or the whole inquiry cycle by communicating with others and/or controlling the whole learning process or its phases by engaging in reflective activities.

In Section 1.6.1, I noted that the teacher's role is critical in this learning approach and it is a complex process informed by the teacher's knowledge of children, and of pedagogical understanding of science knowledge (Halverson, 2007). Similarly, Worth (2010) posits that children's scientific inquiry is guided by the teacher's explicit understanding of the important underlying science concepts related to the focus she/he has chosen. De Kock (2005) cautions that children's domain-specific knowledge is unlikely to be acknowledged and extended if teachers are not confident in the knowledge themselves. Likewise, as mentioned in Section 2.5, research argues that it is doubtful that teachers will be able to identify, analyse, and extend children's scientific interests, if they themselves are not comfortable with imparting the scientific knowledge themselves (De Kock, 2005).

Notwithstanding, some challenges are pointed out by Harlen (2001), who contends that teachers may not know when to introduce the scientific view of things or be able to do so in a way that children will understand. Shulman (1986) and Garbett (2003) stress the importance of SCK of science as well as PCK of how children may learn and develop scientific concepts and phenomena, where the one is dependent on the other.

2.5.2 Scientific Process Skills

In Section 1.6.5, I highlighted the need for Foundation Phase teachers to teach science through the process of an Inquiry-Based Approach that promotes skills of observation, comparing, classifying, measuring, experimenting, and communicating (SA. DBE, 2011). These skills assist when studying the natural world and scientists learn about the world through these Scientific Process Skills. Scientists observe, investigate, analyse data, and support data with evidence (Ogu & Schmidt, 2009). Worth (2010) also highlights that teachers need to plan science experiences where children can develop and use these Scientific Process Skills. In a study conducted by Chabalengula, Mumba and Mbewe (2012) in USA, pre-service teachers' conceptual understanding and performance on Scientific Process Skills showed that these teachers had limited conceptual understanding of them. Conversely, these pre-service teachers had higher performance on Scientific Process Skills although the majority of them were unable to give definitions of these skills.

This study revealed the importance of teachers' Pedagogical Content Knowledge of their teaching subjects, topics and skills. This research study thus emphasises the need for teachers to have a better understanding of Scientific Process Skills to strengthen their teaching abilities and productivity. Beni et al. (2012) state that what early childhood teachers need is not the content knowledge *per se*, but rather on practical approaches that correspond to young children's characteristics. They also argue that teachers need adequate knowledge to facilitate inquiry learning that promotes the development of these Scientific Process Skills. Similarly, this means that teachers' content knowledge can influence what they teach, as well as how they teach it (Yilmaz-Tuzun, 2008).

Charlesworth and Lindt (2013) foreground that teachers need to plan science experiences where children can develop and use Scientific Process Skills with the guidance of teachers. Chabalengula et al. (2012) add that teachers must be proficient in Scientific Process Skills on a multitude of levels, and must have knowledge and understanding to teach these process skills, especially science teachers. However, Mbewe, Chabalengula and Mumba (2010) highlight that research studies in the domain of process skills rarely discuss elementary education pre-service teachers' conceptual understanding of and performance on Scientific Process Skills. Yet, conceptual understanding correlates highly to performance in specific topic areas of science and such conceptual understanding is widely acknowledged as one of the central goals of science education (Barbosa & Alexander, 2004; Mbewe et al., 2010).

Teaching with an eye toward Scientific Process Skills is an appropriate entry point for beginning elementary and middle school teachers (Chabalengula et al., 2012). The research further argues that Scientific Process Skills foster significant increase in subject matter understanding and science content knowledge. Therefore, science content and Scientific Process Skills should be taught together as they complement each other and both are mutually valuable and complementary. It is also argued that Scientific Process Skills provide a foundation for science inquiry hence they form an integral part of inquiry teaching (Chabalengula et al., 2012).

Settlage and Southerland (2007) view Scientific Process Skills as an integral feature of the actions of a scientific culture, although not as all there is to science. Monhardt and Monhardt (2006) define Scientific Process Skills as a set of skills that are reflective of the behaviour of scientists and are appropriate to many science disciplines. They argue that Scientific Process Skills are broadly transferable to other situations. Moreover, research suggests that Scientific Process Skills may be one of the most important tools for producing and arranging information about the world around us (Monhardt & Monhardt, 2006). Researchers categorise process skills at various levels and these are Basic Scientific Process Skills, Intermediate Scientific Process Skills and Advanced Scientific Process Skills (Chabalengula et al., 2012; Charlesworth & Lindt, 2013). Basic Scientific Process Skills provide a foundation for more complex skills and they are developmentally appropriate for young learners in elementary science classrooms (Meador, 2003; SA. DBE, 2011). Bosman et al. (2016) define and suggest how these basic Scientific Process Skills work:

- *Scientific observation* is the most important of the science skills. It is the first step of the inquiry process; it activates learners' senses and is the main route to gathering information from the environment;
- *Comparing* is the process skill that deals with the concept of similarities and differences, and builds upon the process of observation; it also sharpens learners' observation skills;
- *Classification* involves identifying, matching, sorting, naming, comparing, contrasting, grouping and distinguishing similarities and differences;
- *Measuring* is the skill of quantifying observations in terms of numbers, distances, time, volume and temperature using non-standard or standard units; it also involves placing objects or events in chronological or numerical sequence;
- *Predicting* is a statement about what you expect to happen in the future and it involves the ability to state a future occurrence based on the pattern that you have formed from previous observations;
- *Inferring* is described as an educated guess or speculation from immediate observation. It is not a mere observation, but an interpretation or explanation of an observation or a number of observations. It can also be inaccurate at times; and
- *Communication* is a fundamental human process, which involves conveying information in different verbal or written formats (for example; pictures, graphs, maps demonstrations, written descriptions, etc.).

Table 2.3 below, illustrates how teachers can develop or teach the above Scientific Process Skills. It identifies the indicators of proficiency in developing basic Scientific Process Skills and the teacher's role when developing these skills. To develop the basic Scientific Process Skills presented in this table and the discussions above, it is evident that teachers need to consider the use of practical activities or practical tasks.

Table 2.3: Indicators for proficiency in developing BSPS & teacher's role in developing BSPS

Learners ***observe*** when they: (Indicators of Proficiency)	How teachers should stimulate the BSPS in their learners. This should be through pointing out and asking questions to the learners.
• Use more than one sense, • Notice and identify the observable properties of objects, • Notice and state changes in objects or events, • Notice and state similarities and/or differences in objects or events, and • Interpret, describe and draw details of their observations.	• Why, how and what questions, • Ask open-ended questions and provide time for learners to describe their observations, • Differences and similarities, • Explain and describe.
Learners ***compare*** when they: (Indicators of Proficiency)	
• Use appropriate senses to observe similarities and differences in objects or events, • Can tell about the characteristics of objects, and • Compare objects and discuss how and why the objects are alike or different.	• Which… • Similarities and differences • How… • Describe
Learners ***classify*** when they: (Indicators of Proficiency)	
• Group objects or events by their properties or functions, • Identify properties that are common to all objects in a collection, • Give sound rationale for classification, • Can create their own criteria, and • Can form groups or subgroups using accurate properties.	• In what ways… • Can you explain … • Can you group … • How can you … • Why do you …
Learners ***measure*** when they:(Indicators of Proficiency)	
• Arrange objects in sequence by length, weight and volume, • Arrange objects in a chronological order, • Use measurements to draw conclusions, • Use tools to determine quantity, and • Select and use measuring instruments appropriately.	• What is the length … • The distance … • Time … • Temperature … etc • How can you … • Can you put things in sequence?
Learners ***predict*** when they: (Indicators of Proficiency)	
• Think systematically and logically about what might happen next, • Make simple predictions, • Extend patterns, • Extend and form patterns, • Provide sound logic for the reasons of their predictions, and • Suggest ways to check the accuracy of their predictions.	• What will happen … • Why do you say so … • What do you think ….

Learners make an ***inference*** when they: (Indicators of Proficiency)	
• Describe the relationship among the objects and events they observed, • Use all appropriate information in making an inference, • Give reasonable explanations of their observations but may not be correct, • Need to understand that they make inferences through evidence.	• How can you find out … • What do think is happening? • How can you find out … • What evidence supports your inference?
Learners ***communicate*** when they: (Indicators of Proficiency)	
• Describe objects or events in verbal or written format, • Verbalise thinking, • Describe objects or events accurately, • Record data, • Transmit understanding accurately to an audience in verbal or written format, and • Justify explanations through formulating reasonable and logical arguments.	• How can you describe what you have found so that others can understand what you mean? • How can you show your findings? • How can you keep track of findings or observations? • What can you draw to show…?

2.5.3 Practical activities in developing Scientific Process Skills

Mkimbili et al. (2017) argue that practical activities provide learners with insight into the natural world, but that this depends on how teachers and learners perceive these practical activities and how they conduct them in the learning situation (Crawford, 2014; Jiang & McComas, 2015). Miller (2004) too argues that the effectiveness of practical work or activities should have a purpose attached to them. The following question could be asked in order to verify the purpose of the practical task: Did learners learn what was intended for them to learn? Again, the task itself should be designed effectively so that learners could be able to develop various skills as science is characterised as the product, a process and an enterprise (Kidman & Casinader, 2017; Miller, 2004).

Maselwa and Ngcoza (2003) identified that most learners do enjoy practical activities in their classrooms especially if these are carefully planned with a focus on identification and development of key scientific concepts and Scientific Process Skills. They also suggested that practical activities can promote learners' conceptual understanding through discussions and conceptual maps. Following from this, hands-on practical activities should also allow opportunities for learners to use everyday materials and local materials especially in school contexts where there is a lack of resources (Asheela, 2017; Kuhlane & Ngcoza, 2015; Mkimbili et al., 2017; Ndevahoma, 2019). Implementing practical activities in science classes can result in knowledge and skills improvement of learners. Hodson (1990) also argues that practical work can be an enjoyable form of learning if properly planned. His criticism of practical work, however, is that in most cases it is of a recipe or cookbook approach. Hence, he cautions that practical activities should not only be about enjoyment, but they should promote learners' scientific understanding and skills.

2.5.4 Practical activities in science classrooms

The purpose of hands-on practical activities in science teaching is to develop cognitive knowledge, effectiveness of learning and skills (Bosman et al., 2016). From this, the question is: What is meant by cognitive knowledge? What is meant by effective practical activities? And what type of skills should be developed through practical activities? Cognitive knowledge is when practical activities improve learners' understanding of science and help confirm theory (Peers, Diezmann, & Watters, 2003). Effectiveness and skills development is based on 'hands-on', 'minds-on' and 'words-on' practical activities[9] as proposed by Maselwa and Ngcoza (2003). However, when it comes to skills development, learners can develop various skills such as *observation*, *measuring*, *predicting*, *inferring* and *evaluation* (processing). This complements the view alluded to earlier that science is characterised as a product, a process and an enterprise (Kidman & Casinader, 2015; Miller, 2004; Pedaste et al., 2015).

According to Pollen (2009), practical work helps learners to find facts and arrive at new principles. It helps to develop creative thinking and verify facts and principles that are already taught. Hence, Miller (2004) and Bosman et al. (2016) define practical work as any teaching and learning activity which involves the learners at some point observing or manipulating real objects and materials. However, the above scholars clarify that learners' involvement is crucial during practical activities. It is for this reason that practical tasks should allow learners to take

[9] '**Hands-on', 'minds-on' and 'words-on' practical activities**: During these activities learning occurs at multiple levels, including visual, auditory, tactile, kinesthetic, and social. Each learner might learn better in certain ways than others.

an active role in taking on the new knowledge and in making sense of the experiences and discourses in their science classrooms (Chabengula et al., 2012; Kuhlane, 2011).

There is an assumption that learners come to class with some knowledge and if so, I believe that learners should be given opportunities to explore that knowledge. In my view, this could improve their understanding of scientific concepts while learners relate, connect to and grasp new knowledge, and ultimately develop Scientific Process Skills (Kuhlane, 2011; Woodley, 2009). Therefore, the way teachers conduct practical activities in their classes is crucial. It is thus proposed that science teachers should not focus on the results of the activity but should also focus on the learning processes as well. Woodley (2009, p. 50) elegantly summarises the importance of practical activities (see Figure 2.4).

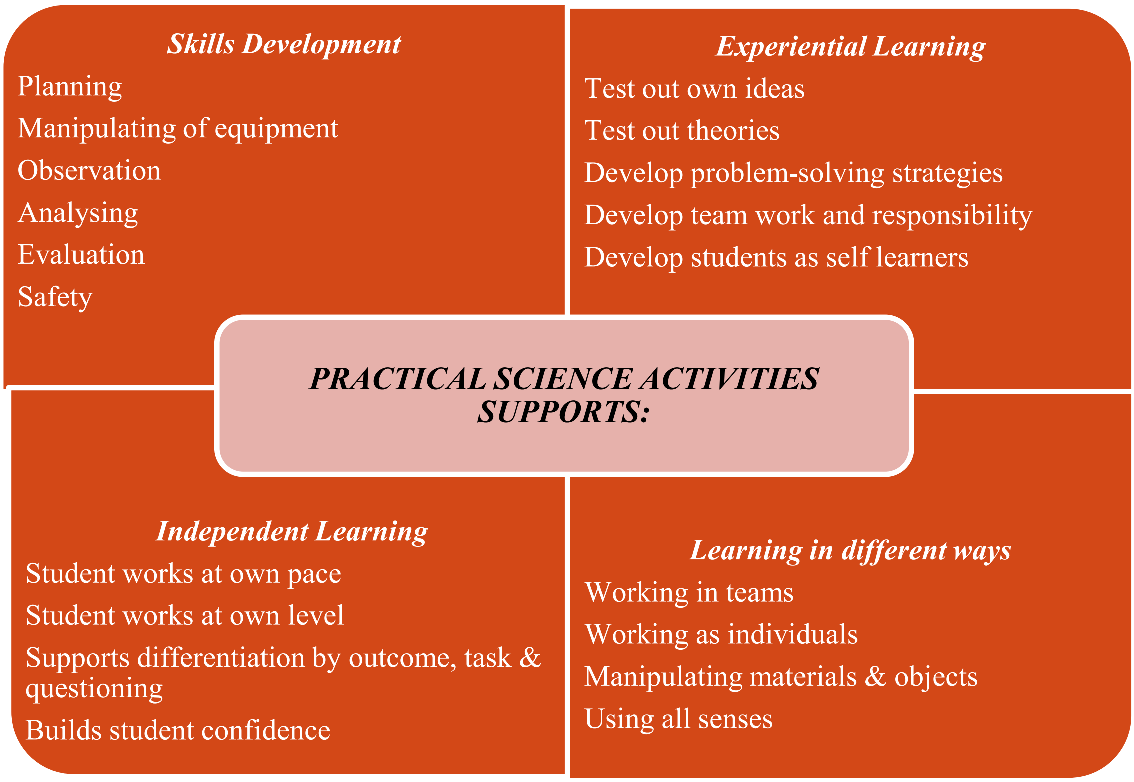

Figure 2.4: Importance of practical activities

Drawing from Figure 2.8.1 (Woodley, 2009, p. 50), it is suggested/implied that "if practical activities are planned and well-organised, the outcomes can be very rewarding in terms of meaningful learning". As a catalyst to achieve this, "everyday activities can be analysed for natural science characteristics, for example, gardening, cooking, recycling, map reading, and comprehending the daily weather" (Minnaar & Naude, 2016, p. 63). These activities can be effective for developing Scientific Process Skills in young learners.

Various scholars hold a similar view, for instance, Dehaene (2014, p. 22) observed how scientific thinking refines scientific literacy meaning, "science often progresses by carving out new distinctions that refine the fuzzy categories of the natural language". Consequently, when planning practical activities, these need to be thought out and at the same time teachers need to consider their learners' abilities and weaknesses in order to avoid misconceptions that may surface. Thus, following from these views it is apposite for me to discuss some weaknesses of practical activities.

To make practical activities a better learning experience and to develop scientific skills and knowledge, the following factors are required; practical work redistributes the responsibility of learning to learners in order for them to become active participants (Sedlacek & Sedova, 2017) in the construction of their own understanding of scientific phenomena (Zion & Slezak, 2005). Following from this statement, practical activities could be more effective when learners and teachers:

- Know and understand why they are doing the particular activity;
- When learners relate to the activity; having some personal background enlightens them about the activity. This means teachers have to start from the known (experiences of learners) to the unknown (more complex);
- Having feedback from learners is one of the opportunities as a teacher to see how learners have understood the practical activity and how you can improve in the next activity. This can be done in different ways: discussions allowing learners to speak freely, asking questions and conducting interviews;
- Using daily examples, especially the things they deal with almost every day is a great opportunity for learners to compare their new knowledge with their existing knowledge;
- Doing all these activities and processes with learners can lead to an effective way of doing practical work and being able to assimilate scientific knowledge;

- Furthermore, being able to ask the right questions at the right time is important. This means that teachers must ask questions that are linked to the activity and questions that will permit learners to develop critical thinking; and

- In the absence of the equipment, teachers should improvise, try to use what they have and even ask for help from other teachers**.**

Admittedly, the above requirements for effective practical activities in the classroom are in line with the principles of Inquiry-Based Approaches. That is, they both highlight the importance of having a set objective, giving feedback and using every day examples when doing activities.

Regarding teachers' roles in teaching science at Foundation Phase, it is recognised that for them to be able to optimally fulfil these roles there is a need for continuing professional development (Ngcoza, 2007; Eun, 2008) or professional learning communities (Brodie, 2016; Chauraya & Brodie, 2017). A professional learning community (PLC) is a model of professional development central to which is *learning*. That is, PLCs provide a reflective space whereby teachers come together to learn *with* and *from* one another. In such a space, they are afforded an opportunity to share ideas and even resources in order to improve their practice.

Katz and Earl (2010) refer to such spaces as networked learning spaces whereas Ngcoza and Southwood (2019) refer to them as webs of development. In both cases, teachers come from different schools to learn from one another. That is, as espoused by Vygotsky, the focus is not on individual learning but instead it is on collective professional learning within a context of a cohesive group (Stoll & Louis, 2005).

Networking thus provides a broader range of feedback and learning opportunities. I believe that when teachers work collaboratively, they are afforded an opportunity to grow together (Brodie, 2016; Ngcoza & Southwood, 2019). These learning opportunities in PLCs and collaborative spaces could lead to teachers' professional development resulting in teacher change (Schudel, 2017; Songqwaru & Shava, 2017; Tshiningayamwe, 2017; Tshiningayamwe & Songqwaru, 2017). These scholars, and in particular, Tshiningayamwe and Songqwaru (2017) accentuate that PLCs afford teachers an opportunity to come together to share and reflect on their practices.

Such collaborative and collegial reflective spaces have a potential to contribute to teacher change and, hence, their classroom practices. This is critical for Foundation Phase teachers.

For example, in their seminal work Brodie (2016) and her colleagues used learners' errors as a catalyst to stimulate conversations and hence learning amongst mathematics teachers. That is, the teachers' classroom practices informed the conversations within the PLC in order to improve instructional or pedagogical practices (Shulman, 1986). To Molefe (2016), teacher learning is akin to a process of active participation (Sedlacek & Sedova, 2017) in practice and collegial conversation foster learning resulting in PLCs being contexts of mutual co-engagement and co-learning (Ngcoza & Southwood, 2015). Admittedly, these discussions, albeit beyond the scope of this study, have relevance in my study whose focus was to explore how Grade 3 Foundation Phase (FP) teachers mediate the development of basic Scientific Process Skills using an Inquiry-Based Approach in their classrooms.

2.6 Chapter Summary

The above literature review sought to explore and present perspectives that underpin the researched topic of an Inquiry-Based Approach focusing on the discipline of science in Foundation Phase classrooms. In it, I set the scene by discussing Foundation Phase teaching in the South African context. In doing this, I drew from the curriculum policies and documents. Continuing the discussion, I also considered Life Skills as a subject, focusing on the 'Beginning Knowledge' study area in particular. In addition, science in early childhood/Foundation Phase was discussed with reference to the Foundation Phase teachers' perceptions and views on the teaching of science in this phase. Teachers' roles in making the teaching of science successful and effective was deliberated upon.

Through this review of literature, I interrogated the studies and discussions on an Inquiry-Based Approach in the teaching of science in the Foundation Phase. The Inquiry-Based Approach or learning is the focus of this study and hence the development of Scientific Process Skills through this approach was discussed in-depth. Lastly, I reviewed literature on the use and the importance of practical activities in developing Scientific Process Skills or inquiry skills. To achieve the goal of this study, I thus needed appropriate theoretical and conceptual frameworks to inform it.

CHAPTER THREE: THEORETICAL AND CONCEPTUAL FRAMEWORKS

> *Learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with peers.* (Vygotsky, 1978, p. 90)

3.1 Introduction

Trochim (2006) argues that there are two domains in research, namely, theoretical and empirical. He refers to theory as something that is going on inside the head of the researcher, while observation is what goes on in the real world where data is collected or where the observation is influenced by what is going on inside the researcher's head .

In doing that, the researcher needs to be clear on which components from the specified theory are attached to the study at hand. The components highlighted by the researcher form a theoretical framework for the study, and this can be defined as an architectural plan which informs every aspect of the research process (Merriam, 2009). Grant and Osanloo (2014) further define a theoretical framework as the 'blueprint' for the entire dissertation inquiry.

According to Grant and Osanloo (2014), a theoretical framework serves as the guide on which to build and support the researcher's study, and also provides the structure used to explain how the researcher will philosophically, epistemologically, methodologically, and analytically approach the whole study. Hence, Cohen et al. (2018) add that theory helps researchers to select, classify and organise ideas, processes and concepts from the research conducted. These scholars further argue that it is "through theory that researchers formulate and find causal relationships and that theory helps to predict and guide the direction of the research, identifying key fields, methods of working, key concepts and therefore serving as a basis for action" (p. 71).

My intentions in this research study were two-fold. First, I wanted to understand how the Foundation Phase teachers use an Inquiry-Based Approach in their classrooms; their understanding and their knowledge of an Inquiry-Based Approach was prominent in this research. The participants' understanding of this approach was revealed by the strategies and activities used in their teaching that are scientifically inquiry driven. Secondly, I wanted to understand how the participants developed the basic scientific inquiry skills in their learners. That is, the interactions, the strategies and engagements the participants promoted amongst their learners during teaching and learning activities were vital in this aspect.

As already stated above, in every learning or research situation, theory by and large informs the process the researchers or teachers take (Biesta, Allan, & Edwards, 2011). Vygotsky's (1978) socio-cultural theory underpinned this study. This study sought to give rich descriptions and analytical statements from what took place during the research process in relation to the main aim and objectives of this study. The data generated presented the link between *theory* and *practice* during the research process. Essentially, I used this socio-cultural theory to understand how the participants implemented or enacted an Inquiry-Based Approach in their classrooms.

In my view, the principles of an Inquiry-Based Approach aligned well with the theoretical concepts chosen from Vygotsky's socio-cultural theory, hence the motivation and use of this theory in this study. Additionally, Schulman's (1986) PCK, focusing specifically on Mavhunga and Rollnick's (2013) five components of Topic Specific Pedagogical Content Knowledge (TSPCK) as an analytical framework to supplement socio-cultural theory. The use of this analytical framework for the data gathered in this study was strongly supported by the alignment of inquiry-based principles (see Section 1.6.4). Largely, TSPCK was used with regards to the participants' understanding of Inquiry-Based Approach, basic Scientific Process Skills, the content or topics they taught, their learners, the context in which they teach and the topics they used in implementing the researched approach.

Thus, this chapter unpacks the socio-cultural theory in relation to this study. The discussion on how this theoretical framework was used in this study is provided. This discussion starts by giving a brief explanation about socio-cultural theory and its relation to constructivism. The historical background of this theory follows the discussion on constructivism. The historical background is followed by the concepts or conceptual framework that this study builds on from the socio-cultural theory. Next, how theory is used to analyse data generated from this research case study is intensively discussed. The PCK analytical framework, focusing on TSPCK in particular, is also discussed in relation to how it was used together with socio-cultural theory for data analysis in this study. Lastly, I give the summary and conclusion of this chapter.

3.2 Socio-Cultural Theory

Yilmaz-Tuzun (2008) states that the philosophy of constructivism evolved from dissatisfaction with traditional Western theories of knowledge. He further argues that constructivism sharply contrasts with objectivist epistemology and positivism. Constructivism postulates that knowledge cannot exist outside the minds of humans. According to Hendry, Frommer and Walker (1999), 'truth' is not absolute and knowledge is not discovered, but is constructed by individuals based on their experiences. The constructivist perspective further posits that knowledge is not passively received from the world or from the authoritative sources, but is constructed by individuals or groups making sense of their experiential world (Maclellan & Soden, 2004).

It could be argued that constructivism advances meaning-making and knowledge construction as its foremost principles (Schunk, 2004). It views knowledge as temporary, non-objective, internally constructed, developmental, and socially and culturally mediated (Fosnot, 1994; Vygotsky, 1978). For that reason, constructivist theories view learners as intellectually generative individuals with the capacity to pose questions, solve problems, and construct theories and knowledge, rather than viewing them as empty vessels waiting to be filled. Hence, scholars such as Mavuru and Ramnarain (2017) and Mhakure and Otulaja (2017) emphasise the importance of taking into consideration learners' socio-cultural backgrounds and culturally responsive pedagogies.

According to the constructivist's view, instruction should be based primarily on developing learners' thinking, and the locus of intellectual authority resides in neither the teacher nor the resources, but in the discourse facilitated by both teachers and learners (Maclellan & Soden, 2004).

Consequently, constructive pedagogy is said to be the creation of classroom environments, activities, and methods that are grounded in a constructivist theory of learning, with goals that are focused on individual learners developing deep understandings of the subject matter of interest and habits of mind that aid in future learning and teaching (Richardson, 2003). It is from this constructivist view that Vygotsky's theory came into play in shaping constructivist pedagogy (Yilmaz, 2008). Vygotsky's (1978) theory states that children learn through joint interactions with adults and more capable peers. Furthermore, it is through cooperative projects that children are exposed to their peers' thinking processes. It is further argued that this method does not only make the learning outcome available to all learners, but also makes other learners' thinking processes available to all in the class. To this end, Vygotsky noted that successful problem solvers talk themselves through difficult problems, and when children hear this inner speech, they can learn from each other in a social set-up or context.

From these arguments, it could be surmised that Vygotsky's key principles are aligned with the constructivist theory principles which speak to how learning should take place, how knowledge should be developed or constructed and how experiences and social interactions play a role in learning. It is through these discussed views and principles of pedagogy that Vygotsky's theories are regarded as constructivist theories. For this reason, socio-cultural theory as a theory of learning underpinned this study. Also, the principles of an Inquiry-Based Approach, the components of TSPCK (Mavhunga & Rollnick, 2013) and Vygotsky's principle of learning align well with the objectives of this research study; hence the use of these theories as lenses in this research.

Socio-cultural approaches to learning and development were first systematised and applied by Vygotsky and his collaborators in Russia in the 1920s and 1930s. They are based on the concept of human activities that take place in cultural contexts, mediated by language and other symbol systems, and can be understood when investigated in their historical development (John-Steiner

& Mahn, 1996). At the time, psychologists focused on giving explanations about human behaviour, and Vygotsky had an opportunity to develop a rich, multifaceted theory through which learning and development was one of the examined subjects, focusing on education of children with special needs (Vygotsky, 1978). As far as I am concerned, the power of Vygotsky's ideas lies in his explanation of the dynamic interdependence of social and individual processes. Vygotsky conceptualised development as the transformation of socially shared activities into internalised processes. In doing this, Vygotsky rejected the Cartesian dichotomy between the internal and the external world or environment. Because of the above explanations, socio-cultural theory is seen as an emerging theory in psychology that considers the important contributions that society makes to individual development. Socio-cultural theory stresses the interaction between developing people and the culture in which they live. It suggests that human learning is largely a social process (Vygotsky, 1981).

According to Vygotsky (1986), knowledge construction can be clarified by examining three themes: individual development, including higher mental functioning, having its origins in social sources; human action, on both the social and individual planes (McRobbie & Tobin, 1997), which is mediated by tools and signs; and the above two themes which are best examined through genetic, or developmental, analysis (Wertsch, 1991). In Section 3.1, I explained my two main intentions in using socio-cultural theory as my analytical framework in this study. For example, it provided me the means to understand the cultural context of each participant. It also assisted me to understand how each participant mediated learning in their classrooms to develop the basic Scientific Process Skills in their learners by using an Inquiry-Based Approach. The tools and signs (resources), the language, materials or the environmental context of learners that were used to develop and impact on learning were also important for me as the researcher.

To further support the argument for choosing the socio-cultural theory in this study, Gupta (2006) in her study on how children are raised and taught in India, critiqued the Western theories of child development that viewed the individuals as physically constructing cognitive models independently, without recognising the importance of the social and cultural processes at work. According to her study, human thought has been described to be essentially social in its origins, functions, forms, and applications, and thinking as largely a public activity occurring spontaneously and naturally in the yard, market place or town square. In my view, this aligns with the African culture where knowledge and experiences are built and developed in a societal space or community space (Gupta, 2006). Therefore, Vygotsky's views and principles on learning resonate with how learning is viewed in African cultures; hence this study focused on the following socio-cultural theory components: mediation of learning, social interactions, the concept of culture and development, focusing on the ZPD.

3.2.1 Mediation of learning

Research question two was the focus for this research process, and its generated data were from the observed video-taped lessons and from the stimulated recall interviews. This suggested that this theoretical and analytical framework had been intensely used to analyse data presented from this objective. In Vygotsky's approach, 'mediation' is the key to understanding how human mental functioning is tied into cultural, institutional, and historical settings. These settings shape and provide the cultural tools that are mastered by individuals to form this functioning (Vygotsky, 1978). As already stated in Section 1.8, Vygotsky states that the source of mediation is either a material tool, a system of symbols, notably language, or behaviour of another human being in social interaction. Signs are an "auxiliary means of solving a given psychological problem" (Vygotsky, 1978, p. 52).

In this study, how resources, how language (isiXhosa in particular) and how different approaches were used by the participants to develop basic Scientific Process Skills using an Inquiry-Based Approach, were key in how the mediation process took place in each studied context and in each classroom. In my view and as reiterated by Mavuru and Ramnarain (2019), learners' home language has a potential to be used as a resource rather than being perceived as barriers. Vygotsky argues that the mediational means are what might be termed the 'carriers' of socio-cultural patterns and knowledge. To my understanding, Vygotsky's explanation of mediational means, speaks to individual ways of doing things in a specific context. As this refers to how participants in each school context assumes their responsibilities which are influenced by their cultural context, which is the school and the classroom in the case of this research, I used mediation as a concept of teaching and learning processes that took place in this study. Mediation is the key to all aspects of knowledge co-construction (John-Steiner & Mahn, 1996).

Vygotsky (1981) lists a number of examples of mediation means: “Language; various systems; works of art; writing; schemes; diagrams; maps and mechanical drawings; all sorts of conventional signs and so on” (p. 137). John-Steiner and Mahn (1996) add that the other tools that are increasingly recognised in socio-cultural discourse are: the paintbrush, the computer, and calendars; symbol systems such as these are central to the appropriation of knowledge through representational activity by the developing individual. These types of tools add value to the aim of this study; in the Foundation Phase set-up or context, teachers use various types of resources to develop knowledge and cognition in their learners. The importance of developing learners cognitively, physically and emotionally is of utmost significant in this phase, hence the importance of various tools. Therefore, in the Foundation Phase, teachers are not supposed to focus on content knowledge development only but integration of pedagogies, knowledge and skills should also be catered for during teaching.

Again, I was interested in understanding how the participants in their different contexts or schools dealt with an Inquiry-Based Approach when developing basic Scientific Process Skills. That is, how participants viewed their relationship with their learners and themselves in their teaching space, spoke to the participants’ understanding of Inquiry-Based Approach principles. As explained in Section 1.6.4, these principles were used as analytical spectacles in each observed lesson in this study. These principles were in line with Vygotsky’s principles of socio-cultural theory in learning, hence the two were used as analytical frameworks in this study.

In the socio-cultural theory, emphasis is on the role of others in the individual construction of knowledge, which views learning as primarily a social process (Adams, 2006; Shepard, 2000; Vygotsky, 1978). This implies that, during the mediation process, while teachers have an important role to play in developing and arranging contrasts in order to stimulate discussions and thoughts, they need to take into account that learners are also important individuals in this process. In essence, socio-cultural theory views learning as dual-genetic: learner and teacher engage to co-construct the socio-cultural realm; their decision supports each other (Silcock, 2003). This theory emphasises the need for learners to be given time to talk (Lemke, 2001;

Sedlacek & Sedova, 2017), with the teachers' role being that of a listener and an observer (Adams, 2006).

This too supports the use of the concept of mediation in this study, the created opportunities for interaction between teachers and learners and between learners themselves by the participants gives evidence of the participants' understanding of how mediation of learning should occur in their contexts. Communication is one of the important skills that raises evidence of interaction in the classroom or during activities. Therefore, the types of materials or resources that enable learners to develop the basic Scientific Process Skills through an Inquiry-Based Approach substantiate the knowledge the participants had of their learners and which roles both the learners and the participants should play during activities.

As already stated above, mediation is central to Vygotsky's seminal work and his disciplines. In her discussion of teaching-instructional explanations of mathematical concepts, for instance, Leinhardt (1996) provides another example of mediation. She describes the role of representations when illustrating the concept of percent by discussing various representations. These include number lines, circles and squares. Representational activities, whether in the form of inner speech, imagery or kinetic concepts, are linked to cultural shared systems, such as language, and to developmental activities (John-Steiner, 1995).

These types of teaching methods suggested by Leinhardt also resonate with the TSPCK components as espoused by Mavhunga and Rollnick (2013). This is another strong reason why the socio-cultural theory and TSPCK are used together as theories and frameworks in this study. The participants in this study, to strengthen the development of the foundational Scientific Process Skills in their learners, used various representations to support their explanations. These assisted learners to further elaborate meaning and make sense of what was taught. Through the mediation process, some other concepts in Vygotsky's socio-cultural theory, came into play, hence the discussion of social interactions in this study is vital.

3.2.2 Social interactions in learning

Vygotsky (1981) perceived social situations as the source of development. He argues that any function in cultural development of a child appears twice in two aspects; first, in the social plane and then in the psychological plane. According to Vygotsky, the notion of development occurs first between two or more people as an intra-psychic category. Rubtsov (2016), in his study of Vygotsky's cultural historical theory, argues that social interactions appear to be genetically social, and any function in its primary form is shared among the participants of interaction. In Section 1.7.1.3, I defined social interactions as the mechanism of distributing functions and mastering those functions (Vygotsky, 1981). The impact of social interaction spaces in this study played an important role. It was through classroom observations and videotaped lessons that I could observe whether or not the participants created a space for social interactive activities for their learners and attached value to such activities.

An Inquiry-Based Approach, in the same view, promotes shared activities for learners as this mirrors what scientists do during their scientific investigations (Worth, 2010). Guided social interactions initially serve as instruments for social realisation for the process of cognition and communication and this later plays the role of the cognitive function of mental representations of various kinds of information (Rubtsov, 2016). In this study, the manner in which teachers were able to share roles with their learners during activities was seen as being crucial. Crucial in the sense that this benefitted their understanding of the scientific Inquiry-Based Approach and the kinds of roles played by both participants and learners in their teaching activities.

Rubtsov (2016) adds that social interactions activate the not yet developed cognitive level, the gap between that which a learner is able to do on their own (actual level of development) and that which they are capable of with proper guidance which is called the "Zone of Proximal Development" (p. 5). This further confirms the teachers' roles as well as the learners' roles during teaching activities and the roles played by learners' themselves amongst each other (Stott, 2016). This solely depended on the teachers (the participants in this research) and how they supported or created a space to support their learners and how learners were allowed to support each other.

According to Vygotsky, learning is only successful when it goes ahead of development. He argues that learning awakens and brings to life those functions which are still in the process of maturing or in the ZPD. In Vygotsky's (1978) view, it is through social interaction processes that education should play a role in development. He formulated two ideas that became cornerstones in the issue of learning activity; he first highlighted that the scientific community clearly realised that social interactions and cognitive development are neither mixed nor independent processes. These concepts are also not even equivalent processes; instead they are interdependent processes, since generation and development of the one internally depends on development of the other. Next, I discuss the ZPD in learning and its relation to this study.

3.2.3 Zone of Proximal Development in learning

To Vygotsky (1978, p. 86), "what a child is able to do in collaboration today, he will be able to do independently tomorrow". Children's learning begins before they attend school and any learning a child encounters in school always has a previous history (Vygotsky, 1978). Vygotsky argues that learning as it occurs in early years of pre-school, differs from school learning, which is concerned with assimilation of fundamentals of scientific knowledge. Accordingly, a child assimilates the names of objects in their environment, and in doing so a child is learning. For that reason, learning and development are interrelated from the child's very first day. In his theory, Vygotsky discusses two levels of development; the actual development and the potential development.

Vygotsky (1978) describes the child's actual development level as those functions that have already matured; if a child can do a task independently it means that the functions for that kind of a task have matured in him/her. He (1978) also describes the potential development level as the ZPD; those functions that have not matured but are in the process of maturation, and these are functions that will mature but are currently in the embryonic state. In this second level, the child can only do a task with assistance from the knowledgeable other and the child's functions at this level could be termed '*buds*' or '*flowers*' of development rather than fruits of development (Veresov, 2010; Zaretskii, 2016). The actual development level characterises mental development retrospectively, while the ZPD characterises mental development prospectively (Veresov, 2004, 2010).

Vygotsky (1978, p. 86) defines the ZPD as "the distance between the actual developmental level, as determined by independent problem solving, and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers". It is through this definition that the above argument on actual development level and potential developmental level has been made.

Veresov added that in school instruction, the distance between the actual developmental level as determined by independent solving of certain learning tasks and the level of potential development as determined through solving of certain tasks under adult guidance or in collaboration with more capable peers, can be detected. Certainly, Vygotsky's discussions on development have some implications for teachers and their classroom teaching (Veresov, 2010). Teachers need to work within the ZPD of their learners. This implies that teachers need to be aware of the developmental stages of their learners and be able to plan for qualitative changes in the teaching toward a certain goal (Bosman et al., 2016; Hedegaard, 1990). Although each child is unique, children share common traits with each other and being of the same tradition and in the same class, they have a lot of common knowledge and skills. This makes it easier for the teacher to understand his or her children's abilities and capabilities (Bosman et al., 2016).

Hedegaard's (1990) view is that instruction can build upon these common features and takes into account that learners vary in speed and form of learning. She argues that if teachers work in this manner, they would have worked within the ZPD, as a relation between the planned instructional steps and the steps of their learners' learning or acquisition process. The key contextual issue in this study is that learners are from more or less the same community, hence their experiences before coming to class might be of a similar nature. Also, their age group is of the same range. Thus, teachers have the opportunity to use such contextual factors to their advantage for their teaching.

Again, mediation played a huge role in learning and development in this study; how teachers used instructions, the materials and engagement with learners to develop their ZPD using an Inquiry-Based Approach, while making sure their learners acquired the foundational Scientific Process Skills, was crucial. Zaretskii (2016, p. 1) in his article, deliberates on Vygotsky's principle that “one step in learning represents a hundred steps in development”. Zaretskii believes that this principle of development is as important as other principles of Vygotsky’s work. Regarding Vygotsky’s idea that learning preceded development, according to Zaretskii, “many of Vygotsky’s disciples and researchers kept silent about the idea that learning did not just precede development but under certain circumstances, resulted in a qualitative advance measured by many steps” (p. 150).

Zaretskii adds that according to him, Vygotsky’s statement that learning may lead to many steps in development contains three main perspectives:

- “The first designates the need for actual implementation of the assumption that learning precedes development;
- The second represents the idea that learning ‘something special’, something relevant for a given case, may trigger beneficial developmental effects in several dimensions simultaneously; and
- The third perspective deals with an implicitly verbalised problem statement that learning can (and needs to) be performed in a way that it could facilitate development”. (p. 151)

Vygotsky’s statement that a single step in learning might mean a hundred steps in development was drawn from a direct analogy between science and child development (Zaretskii, 2016). Learning a new method of thinking or a new type of structure “produces a great deal more than the capacity to perform the narrow activity that was the object of instruction; this makes it possible to go beyond the direct outcome of learning” (p. 152).

For Zaretskii and his colleagues, the main question was: How could one conceptualise a hypothetical mechanism that ensures the child-adult collaboration that produces a quantum leap in development? To Zaretskii (2016), the mechanism’s functioning may be explained using a multidimensional model of ZPD. The model was developed in the Reflection and Activity Approach for supporting children’s development so that they can overcome learning difficulties. The Reflection and Activity Approach “identifies and provides the rationale for several conditions that enable the child to make the step-in collaboration with the adult; this means learning may precede development" (p. 155).

As part of the theoretical and analytical framework, I adapted the six conditions (Table 3.1) as a tool to observe how teachers mediate learning during the observed lessons. This helped me to understand how the participants enable the shift of knowledge and develop inquiry skills in their learners. The six conditions are tabled below and as already explained these were adapted as part of the analytical framework for this study (see Table 3.1 below).

Table 3.1: Six conditions that could enable a child to make a "step towards development" (Zaretskii, 2016, p. 155)

Conditions	Description/explanation
Condition 1	**Contact**: the adult/teacher should establish meaningful and emotional contact, wherein the child feels protected, supported and accepted by the teacher. Through this the learner should understand the meaning of his/her activity and the necessity for the adult's participation.
Condition 2	The development will occur if **a learner takes the position** of a fully-fledged and legitimate agent of overcoming difficulties and reflecting on the activity.
Condition 3	The **learner-teacher interaction** throughout the activity should be collaborative, with the teacher acting as an assistant to the learner.
Condition 4	The learner's development will result from the leaner's autonomous activity and his/her reflection of it carried out with the **teacher's help and support**.
Condition 5	This condition assumes that **through reflecting** on his/her own and shared modes of action, the child makes a step-in development through 'owning' modes of action implemented in cooperation with the teacher (according to Vygotsky, this is interiorisation).

Condition 6	The course of **joint activity** should be aimed at overcoming a challenging situation, in this aspect development may emerge in several areas simultaneously.

The six conditions were adapted as part of the analytical framework in this study. Essentially, these were used as spectacles to observe and analyse how the participants mediated the development of the foundational Scientific Process Skills in their learners. Even though this model was developed to work with learners with special needs, as stated earlier, its original idea came when Vygotsky investigated science learning and child development, hence the use of these conditions in this research. In addition, Zaretskii states that development could be represented as a "unique event in the child's life when a challenge creates the context for expanding boundaries of the zones of actual and proximal development in several vectors simultaneously, and a new quality emerges" (p. 155). It is argued that, when it comes to development, the child starts unfolding like a 'flower' as illustrated in Figure 3.1.

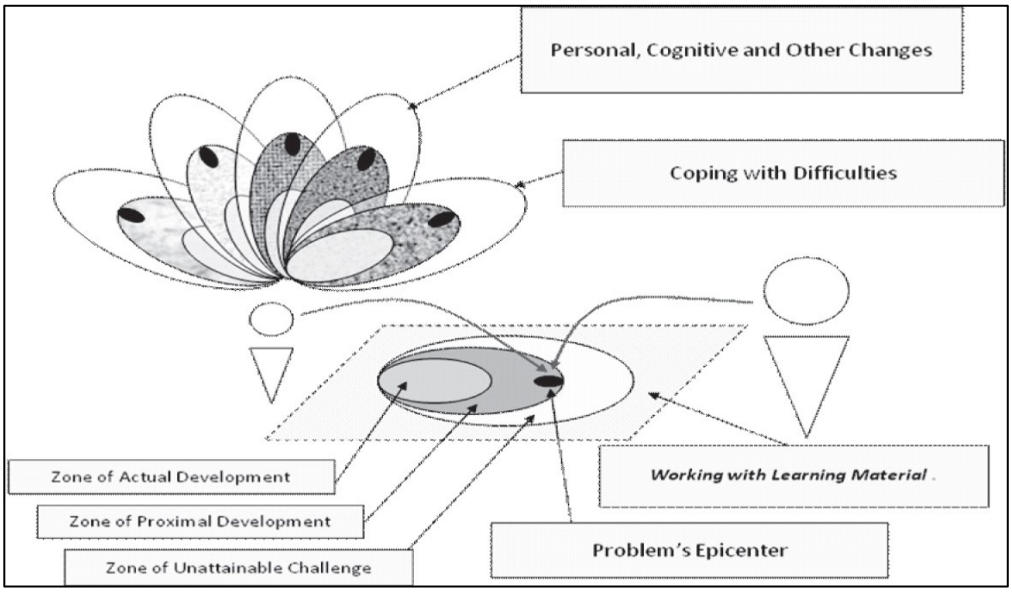

Figure 3.1: ZPD (1) as a generality of dimensions of potential developmental steps (Zaretskii, 2016, p. 155)

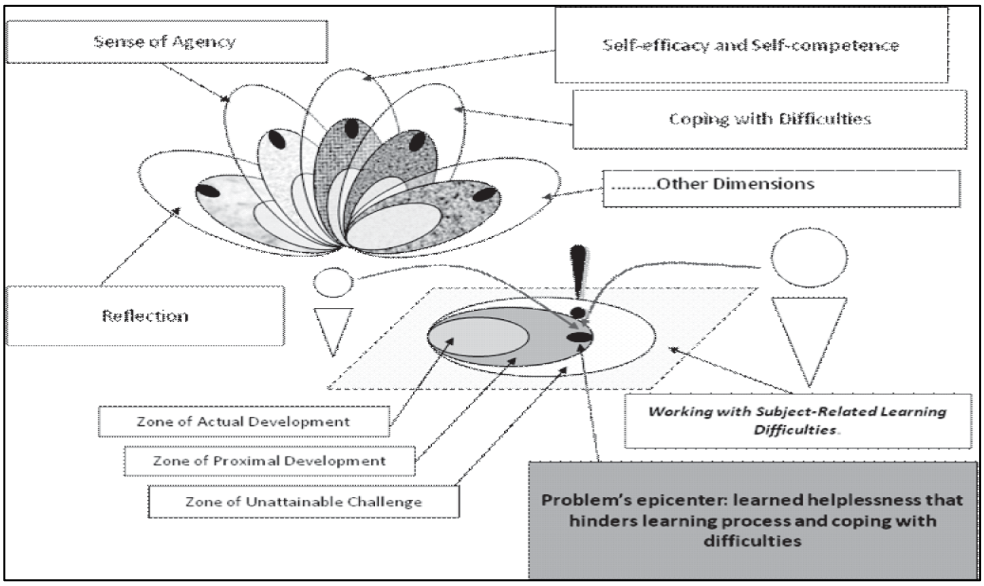

Figure 3.2: The multidimensional model of ZPD (1). Zaretskii (2016, p. 157)

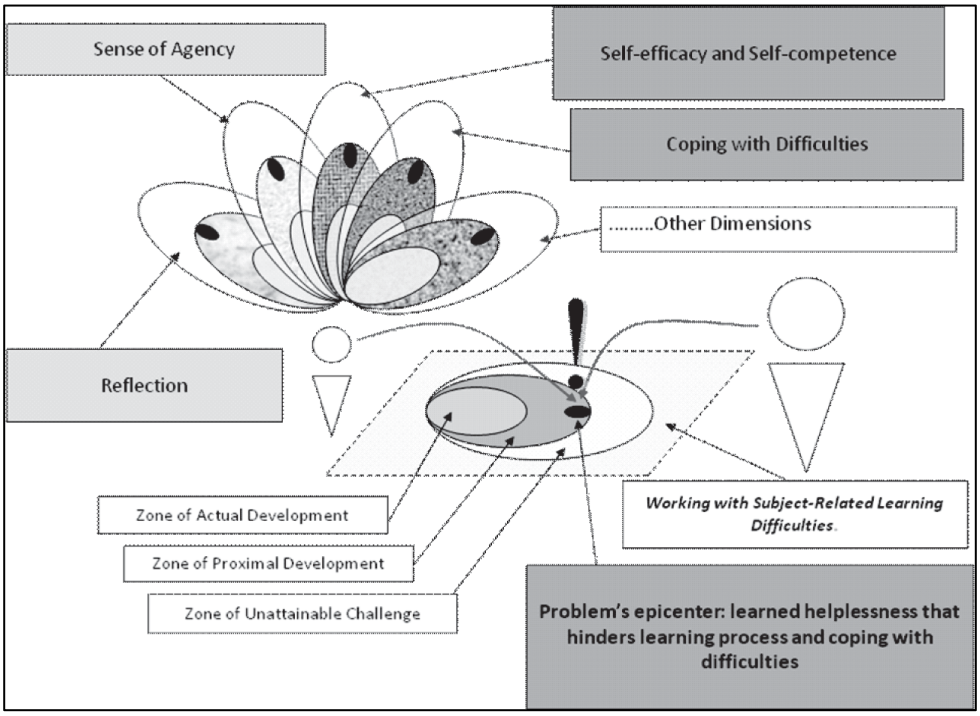

Figure 3.3: The multidimensional model of ZPD (3) (Zaretskii, 2016, p. 158)

The three figures 3.1, 3.2 and 3.3 illustrate Vygotsky's assumption or postulation that one step in learning represents a hundred steps in development, a multi-dimensional model from Zaretskii's work on learning and development. These models in this study are a representation of how learners should work in collaboration with their teachers or co-learners. Figure 3.2 demonstrates an opportunity for potential developmental steps within the ZPD of a learner. The importance of this illustration is how teachers could tap into this in order to allow a learner to blossom through engagement and co-working with the learner. Figure 3.2 illustrates the case when the problems of learning lie in the personality rather than on the plane of concrete modes. This explains that at times learners might be the challenge towards their own development. In this case, this is where joint activities play a role. To motivate a learner or to alleviate any challenge a learner can have, the teachers' role is vital. In addition, Figure 3.3 illustrates that with the help from an adult or the more knowledgeable other, the start of development through a difficult activity can begin with making it a joint learning activity.

Using the six conditions as an analytical lens assisted me to understand how teachers developed their learners' inquiry skills through using various activities in their classrooms. How the learning relationship between teachers and learners was built and developed, was also accounted for through use of the above conditions. In my view, how the six conditions of learner development (ZPD) or working within the zone of a child's development works toward the above illustrated figures, are related to the culture of learning.

3.2.4 Culture in learning

Vygotsky (1978) believes that the purpose of education is to pass on cultural tools, such as language, to enable learners to think clearly and creatively and develop self-confidence in their abilities to express their point of view. Vygotsky believes that culture plays an important role in influencing and shaping development, and therefore according to him, development is partly driven by culture. As a teacher, being sensitive to your learners' culture and their daily lives in your teaching strengthens the learning opportunities and developmental opportunities in the classroom environment (Mavuru & Ramnarain, 2017; Mori, 2014). It should be recognised and acknowledged that parents and teachers provide the cultural tools for children during social interactions. This notion directs what takes place in the classroom environment; the cultural materials or tools that are provided by teachers in the learning situation speak volumes on their understanding of their learners' backgrounds (Lee, 2015).

The teacher as the more knowledgeable other in the classroom, during the mediation process needs to display an understanding of her learners, their contextual backgrounds, the school culture and her classroom culture. According to this research, all the listed aspects played a role in preparing taught lessons. How the participants accommodated their learners in their teaching in developing the foundational Scientific Process Skills using an Inquiry-Based Approach spoke to their classroom practices and cultures. This implies that the learner is embedded within the cultural activities of the classroom, family, and the wider community. In this way, the learners learn to make sense of their world but also contribute their ideas (Fleer & Pramling, 2015). Vygotsky argues that the socio-cultural activities within the ZPD are where true learning occurs, providing opportunities for children to internalise higher psychological functions. Again, teachers (participants) were the key role players in affording their learners the activities that were within their ZPDs (Vygotsky, 1978). Overall, the concept of culture in this research referred to the materials used in the classroom, the language used during mediation, and the kind of relationships displayed by the participants towards their learners in achieving the intended objectives (Ajayi, 2009; Lee, 2015; Schwarzer & Jerusalem, 1995; Vu & Vu, 2012).

As previously described, socio-cultural theory underpinned this study and it contributed to the participants' teaching or mediation of learning in their classrooms, with regard to the use of an Inquiry-Based Approach and development of the foundational Scientific Process Skills in their learners. In doing this, it was also important to consider the participants' PCK on the understanding of the research topic, their knowledge, and the pedagogies they used in developing the required skills and the use of an inquiry approach. Both socio-cultural theory and PCK are concerned with knowledge construction and consequently support the socio-cultural theoretical framework; hence a discussion of PCK as the analytical framework is important in this study.

3.3 Pedagogical Content Knowledge

Pedagogical content knowledge is an educational theory formulated by Lee Shulman in the 1980s. Shulman changed the thinking about teacher knowledge by making the claim that teachers' subject matter knowledge and pedagogy were being treated as separate entities and should be joined in the approach to teacher education (Shulman, 1986). According to research, studies on teachers' knowledge can be traced back to the 1970s when researchers of information processing focused their studies on teacher planning and decision-making processes (Huang & Ariogul, 2006). The studies also compared the different processes of thinking between experienced teachers and student teachers (Huang & Ariogul, 2006). In the late 1970s, researchers started to examine the thought processes that teachers engaged in as they planned and delivered their lessons. This research was referred to as teacher cognition (Huang & Ariogul, 2006). In the 1980s researchers started to realise that teaching was more complex than it was once believed to be. Studies demonstrated that prior experience, practical knowledge, values, and the work environment were influential in shaping a teacher's teaching (Huang & Ariogul, 2006).

The basis of the epistemology of PCK comes from the understanding that educating is a complicated occupation that requires knowledge of many subject areas and cognitive skills that must be developed. Historically, teacher education has revolved around what the teacher's own specialty is. However, teacher education philosophy has changed from single subjects to pedagogy, emphasising universal classroom practices independent of subject matter (Mishra & Koehler, 2006). This shift in educational theory has led to a decrease in teacher content knowledge (Mishra & Koehler, 2006).

The Foundation Phase teachers in the South African context are faced with various changes in the curriculum, and this has resulted in teachers grappling with ways of transforming and transferring knowledge to their learners. This study was as a result of the recent curriculum change in South Africa, where teachers are required to teach Life Skills, especially the Beginning Knowledge study area, using an Inquiry-Based Approach in particular. Foundation Phase teachers are not trained as science teachers as such; in consequence, they are not specialists in science teaching as they teach various subjects in their classrooms.

As already explained, my interest was to explore the Foundation Phase teachers' PCK on the development of basic Scientific Process Skills using an Inquiry-Based Approach. For this research topic, understanding their own environment in which they taught, the knowledge of their learners, the understanding of the subject matter knowledge of each discipline they worked with and the understanding of how to implement an Inquiry-Based Approach was crucial in this study. In his theory of teaching or pedagogy, Shulman (1987) presents the teacher knowledge categories that teachers should have and refer to for successful teaching in their practice.

Table 3.2: Shulman's major categories of teacher knowledge (Shulman, 1987, p. 8)

General pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organisation that appear to transcend subject matter
Knowledge of learners and their characteristics
Knowledge of educational contexts, ranging from workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures
Knowledge of educational ends, purposes, and values, and their philosophical and historical grounds
Content knowledge
Curriculum knowledge, with particular grasp of the materials and programmes that serve as "tools of the trade" for teachers
Pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding

Shulman (1987) describes PCK as the capacity of a teacher to transform the content knowledge he or she possesses "into forms that are pedagogically powerful" (p. 15). Shulman further states that "comprehended ideas must be transformed in some manner if they are to be taught" (p. 16). Again, this definition supports the importance of this study, which was the pedagogy used by the participants when using an Inquiry-Based Approach to develop basic Scientific Process Skills in their classrooms. Nonetheless, PCK as a theoretical construct has become a popular hallmark for the teaching profession in many teaching disciplines including science (Juttner & Neuhaus, 2012; Mavhunga & Rollnick, 2013).

Mavhunga and Rollnick (2013) argue that it is commonly accepted that PCK has a topic-specific nature. However, its implementation in teacher education programmes has remained generic and tacit. They add that by locating PCK at a topic level, a refined theoretical description of the construct, sensitive to the specificity of the topic, is suggested and its validity is argued. To supplement this argument, Mavhunga and Rollnick (2013), drawing on Geddis and Wood's (1993) seminal work, state that teachers need to develop the awareness that teaching requires the transformation of their subject matter knowledge in general. As explained by Van Driel and Berry (2010), subject matter knowledge refers to the understanding of the discipline you teach.

In this study, the nature of science and how science should be taught using an Inquiry-Based Approach is important (Kidman & Casinader, 2017). Also, once this awareness is in place, the articulation of the kinds of knowledge needed to achieve such transformation becomes important. Knowledge of a multitude of particular things about subject matter knowledge that are relevant to how it is taught is required (Mavhunga & Rollnick, 2017). These particular categories are identified as: students' prior knowledge, including misconceptions; curricular saliency; what makes a topic easy or difficult to understand; representations including analogies; and conceptual teaching strategies (Geddis, 1993; Geddis & Wood, 1997).

The above particular categories are called components; content-specific components because of their relation to subject matter knowledge (SMK), and these require specific consideration to be made about SMK (Mavhunga & Rollnick, 2017). They explain these components as the understanding that provides the knowledge needed for Content Knowledge (CK) transformation in a particular topic. Again, in this study, how the participants taught the various topics to implement scientific inquiry was the key. Mavhunga and Rollnick further explain that, when a specific topic is taught, certain topic specific components of PCK are considered. Figure 3.4 is the model that shows the identification of the identified components in relation to PCK, especially the subject matter knowledge. The model is derived from the work of Davidowitz and Rollnick (2015); they identified the four knowledge domains as generalised knowledge from which a teacher draws from to inform PCK (Mavhunga & Rollnick, 2013).

According to Davidowitz and Rollnick (2011) and Mavhunga and Rollnick (2013), these four knowledge bases are influenced by the beliefs of the teachers teaching science. Adding to these domains, TSPCK suggests the five components, namely, students' prior knowledge, curricular salience, what is difficult to teach, representations and conceptual teaching strategies which were adapted as part of the analytical framework in this study. Again, these were used because of their relevance to the principles of an Inquiry-Based Approach (see Section 1.6.4) and the above mentioned Zaretskii's six conditions (Table 3.1).

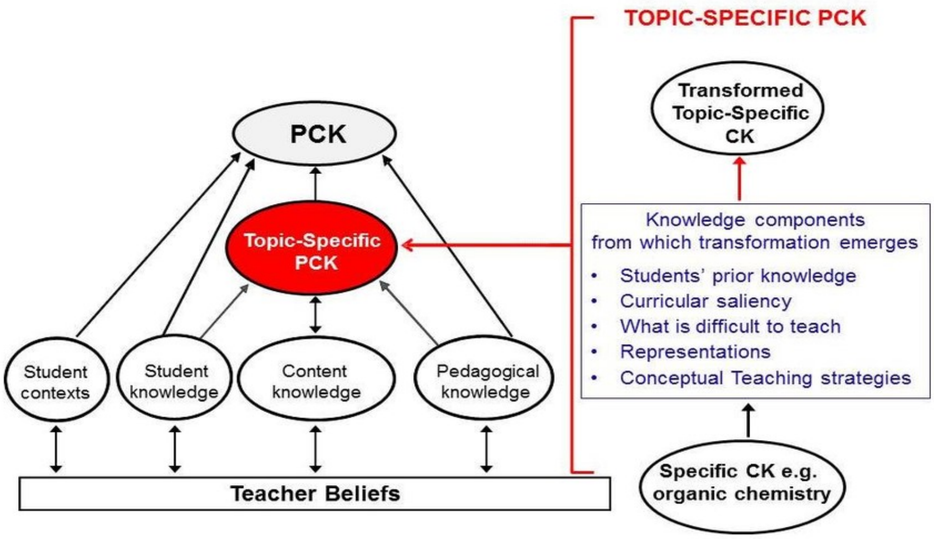

Figure 3.4: A model for TSPCK (Mavhunga & Rollnick, 2013, p. 115)

The model on TSPCK in this study represents or relates to the participants' understanding of an Inquiry-Based Approach with regards to how they teach science related topics to develop basic Scientific Process Skills. The relevance of what they teach to their learners' context and learners' ZPDs speaks to their understanding of content knowledge. In this case, the specific content varied according to each teacher. However, the pedagogical knowledge of an inquiry approach was vital. The teachers' understanding or beliefs about how they drew from their learners' prior knowledge, how they taught the topics planned, how they used an inquiry approach as a strategy and what analogies and representations they used were of importance in this study. I used this model in conjunction with Zaretskii's six conditions for development and the principles of inquiry approach as the analytical framework for this study.

Therefore, I used the two theories, Vygotsky's social-cultural theory and Shulman's PCK focusing on TSPCK as both the theoretical, conceptual and analytical frameworks. The concepts of mediation, social interaction, ZPD and culture from the social-cultural theory all speak to learning and development. It should be borne in mind that socio-cultural theory is not a teaching theory but rather a learning theory. Notwithstanding, in this study, socio-cultural theory assisted me in understanding how the participants' developed learning in their classrooms. On the other hand, PCK is a teaching theory. That is, it focuses on teachers' knowledge and how they create and transform that knowledge so that it is accessible to learners. This knowledge creation refers to the use of resources, transformation and transferring of knowledge. In addition to this, the strategies or pedagogies teachers used in this study, were part of their PCK. Thus, the purpose of utilising these two theories in this research study was for them to complement one another.

3.4 Chapter Summary

In this chapter, I discussed the theoretical support of the study I undertook. I presented theories and concepts that I regarded as crucial in addressing and supporting the data collected. In socio-cultural theory, I found a theoretical framework and concepts that I used as lenses to analyse and interpret classroom lesson observations and data from the participants. Mediation in relation to social interactions, culture and the ZPD were crucial socio-cultural concepts in this study. I also explained how I used each theoretical concept for data interpretation and analysis in this study. The explanation on the use of PCK focusing on TSPCK as a theoretical/analytical framework in relation to the study was discussed. Lastly, I explained the relationship of the two theories in the research process which is elaborated in the research design and methodology I used in this study.

CHAPTER FOUR: RESEARCH DESIGN AND METHODOLOGY

The research design identifies the evidence needed to address the research purposes, objectives and questions, the logic that underpins the connections between purpose, objectives, questions, data, and conclusions drawn. Evidence requires an indication of the warrants that will be used to support the case made from the findings of the research. (Cohen, Manion & Morrison, 2018, p. 175)

4.1 Introduction

This research study explored the pedagogical content knowledge (PCK) of Grade 3 teachers in developing basic Scientific Process Skills using an Inquiry-Based Approach in their classrooms. In this study the participants' schooling contexts and classrooms were vital and my interest was in the participants' teaching methods that fostered the development of basic Scientific Process Skills using an Inquiry-Based Approach. In this chapter, I thus provide the research design and methodology that I used to conduct this research study. The qualitative research paradigm that underpinned this study is discussed. In addition, I also discuss the sampling process or method in this study. In doing this, I start with the profile of participants and my positionality as a researcher. Importantly, ethical and validation issues are considered in this chapter. Furthermore, data generation procedures are described. These were document analysis; questionnaires; semi-structured interviews; lesson observations; videotaped lessons; stimulated recall interviews and teacher group reflections.

For this study, data generation techniques and the research process were clustered into different phases. Phase 1 was document analysis (Grade 3 Life Skills CAPS and teachers' lesson plans for the observed topics). In Phase 2, I administered questionnaires. These assisted me in profiling the participants and in gathering information about their understanding of teaching science, basic Scientific Process Skills and an Inquiry-Based Approach in their classrooms. Additionally, semi-structured interviews supported and strengthened the data generated from questionnaires. In Phase 3, lesson observations and videotaping of lessons took place and were completed in two cycles. Lastly, Phase 4 consisted of stimulated recall interviews and teacher group reflections that were informed by lesson observations and videotaped lessons that occurred in Phase 3. Phases 3 and 4 were conducted in two cycles. Cycle one was the initial stage of lesson observations. There were two observed and videotaped lessons from each participant. They were followed by stimulated recall interviews, participants' reflections and discussions. The same process took place in cycle two, but only one lesson per participant was observed. What was of interest in these two cycles was to observe the impact of the group reflections and discussions on the participants' individual teaching spaces. In total, there were 12 lessons observed, that is, three lessons per teacher. This was done in line with using an Inquiry-Based Approach in their classrooms. Based on the above, this chapter highlights the research goal and questions the study sought to address. The research goal and questions are stipulated below.

The research goal:

To explore how four Grade 3 Foundation Phase teachers mediated the development of basic *Scientific Process Skills* using an *Inquiry-Based Approach* in their classrooms.

Research questions:

1. What is the understanding of basic Scientific Process Skills and Inquiry-Based Approach by Grade 3 Foundation Phase teachers?
2. How do Grade 3 Foundation Phase teachers mediate the development of basic Scientific Process Skills through an Inquiry-Based Approach in their classrooms?
3. How do discussions and group reflections influence (or not) Grade 3 Foundation Phase teachers' understanding of basic Scientific Process Skills and Inquiry-Based Approach?

Table 4.1: Summary of questions and data instruments

Research Questions	**Data Instruments**
What is the understanding of basic Scientific Process Skills and an Inquiry-Based Approach by Grade 3 Foundation Phase teachers?	Questionnaires & semi-structured interviews
How do Grade 3 Foundation Phase teachers mediate the development of basic Scientific Process Skills and scientific knowledge through an Inquiry-Based Approach in their classrooms?	Lesson observations & stimulated recall interviews
How do discussions and group reflections influence (or not) Grade 3 Foundation Phase teachers' understanding of basic Scientific Process Skills, scientific knowledge and an Inquiry-Based Approach?	Discussions & group reflections

4.2 Research Design

A research design is a plan or strategy moving from underlying philosophical assumptions to specifying the selection of respondents, the data gathering techniques to be used, and data analysis to be done (Creswell et al., 2016). Maxwell (2008) asserts that the research design is not only influenced by goals, research questions, conceptual framework, methods and validity but by the research skills, the available resources, perceived problems, ethical standards, the research setting, the data and preliminary conclusions of the study. According to White (2013, p. 221), "research design is a logical rather than a logistical matter, that is, it is concerned with the overall blueprint"– the architecture rather than the 'nuts and bolts' of how to carry out that plan. The logic, according to White (2013), is the sequence that connects the data to the research questions and its conclusions. Maxwell (2008) and Burns and Grove (2003) argue that because a design for a specific study always exists, explicitly or implicitly, it is always important to make the research design explicit, to get it out in the open, where its strengths, limitations, and implications can be clearly understood.

It is for these reasons that this study adopted a qualitative case study (Stake, 2000). In the same vein, Cohen, Manion and Morrison (2018) argue that a case study focuses on practice, intervention and interpretation with the aim of improving a situation. In this research, four teachers from four different schools were selected. The teachers were equally drawn from the target schools. Two were from quintile 3 and two from quintile 4 schools. The two categories of schools were chosen because of the availability of teachers and their interest in this research. Also, the accessibility of these schools was the major factor. Lastly, even though two categories were chosen for this study, they were similar because they were both situated in the township. The two quintile 4 schools were in this category because of the fee contribution that is made by the parents of learners which ranges from R100 to R200 per month. A detailed explanation about this qualitative case study will be clearly articulated in Section 4.4 of this chapter. This qualitative study thus took the form of an interpretive paradigm. Hence, the next section discusses the research paradigm this study drew from.

4.3 Research Paradigm

According to Nieuwenhuis (2007), a paradigm serves as a lens through which reality is interpreted. Lending support is Maxwell (2008), who refers to the term paradigm as a set of very general philosophical assumptions about the nature of the world (*ontology*) and how we can understand it (*epistemology*). He also argues that as researchers we need to be explicit concerning which paradigm or paradigms our work is drawing on, since a clear paradigmatic stance helps guide our design decisions and justifies these decisions. Using an established paradigm allows a researcher to build on a coherent and well-developed approach to research, rather than having to construct your own. It is against this background that Maxwell (2008) acknowledges that the selection of a paradigm is a matter of free choice and therefore the paradigm chosen needs to be compatible with your conceptual and/or theoretical framework, research questions and methods to be used in a specific research study. The 'camp' that a researcher belongs to, outlines the assumptions, propositions, thinking and approach to research that he or she undertakes (Bakkabulindi, 2015).

This research study was conducted within an interpretive paradigm. Cohen et al. (2011) maintain that the interpretive paradigm aims at understanding the subjective world of human experiences and it assumes that people construct and merge their own subjective and inter-subjective meanings as they interact with the world around them. These arguments mirror those of Creswell et al. (2016) who agree that interpretivists recognise the complexity of the world and acknowledge that reality can only be accessed through social constructions such as language, consciousness and shared meanings. Sharing the same view, Wahyuni (2012) argues that interpretivists subscribe to what is called constructivism and recognise that individuals with their own varied backgrounds, assumptions and experiences contribute to the on-going construction of reality existing in their broader social context through social interactions (see Section 3.2.2), as espoused by Vygotsky in his socio-cultural theory. Also, this paradigm allows the researcher to be an insider, being able to uncover the perspectives or real meanings of the social phenomena from the participants themselves (Neuman, 2012).

With this view in mind, the interpretive paradigm resonates well with this study, as the participants taught in their own environments, using various strategies from their own experiences and beliefs about teaching science implementing an Inquiry-Based Approach in the Foundation Phase. In addition to this argument, the participants came from four similar schools but the individuality in these participants shaped what they did in their classrooms. The teaching environments and therefore what each participant did in her own classroom was influenced by their social and philosophical contexts as emphasised by Creswell et al. (2016) and Park and Oliver (2008). The commonality in these schools was that the language of teaching and learning was isiXhosa, the Home Language of teachers and leaners in this study. However, one quintile 4 school because of the school policy of using English as the language of teaching and learning used English and isiXhosa as an instructional method.

To support this choice of paradigm, I sought counsel from Creswell et al. (2016) because my interest was to understand the contexts that most of my students (pre-service teachers) in the Foundation Phase degree would practice teaching in, one day. It was through this study that I was in touch with the strengths and challenges that they might encounter when teaching science in their classrooms in the near future. For the reason of wanting to understand what works and what does not work when using an Inquiry-Based Approach and developing basic Scientific Process Skills, it was vital for me to engage in this type of study. Although I was doing this type of research, the findings from this context could also suggest solutions for finding possible ways of supporting teachers who are still in training for Foundation Phase teaching. Moreover, the findings of this study could assist by offering trainee teachers the requisite skills of teaching science using various methods in the Foundation Phase. Based on this, the study would likely have a bearing on how the students' scientific knowledge and scientific understanding could be developed in the Foundation Phase course.

Although interpretivist views underpinned this study, there are several criticisms about this paradigm which I had to keep in mind (Bakkabulindi, 2015). It has been argued that this paradigm is unscientific, too value-laden and subjective (ibid.). Furthermore, critics of this paradigm claim that it has a greater challenge in arriving at the 'truth' because of the need to negotiate meanings among social participants. Additionally, Bakkabulindi (2015) points out that findings produced in this kind of paradigm might not have external validity and data analysis is time consuming. According to Wahyuni (2012), the strongest view about an interpretive study is that both the researcher and the study participants substantially influence the collection of data and its analysis. For this research, data were collected from the participants' schools and their classrooms.

The participants chose to draw their own observation dates and times, as well as plan their own lessons. This allowed for the truthfulness and the richness of the data to be in its real form and directly from the participants themselves. This study considered/investigated/interrogated how Grade 3 Foundation Phase teachers developed basic Scientific Process Skills using an Inquiry-Based Approach within the Beginning Knowledge study area of the Life Skills Curriculum (see Section 2.3). It was for this reason that I focused on the actions and interpretations of the four Grade 3 Foundation Phase teachers who were the study participants. Last, in terms of axiology as already suggested above, I took the position of studying the social reality from the participants' views (Neuman, 2012). In doing this, the participants' views and the reality of their contexts were taken into account. In gathering the truth and evidence from the data, I needed to allow the participants' views to be alive. Walsham (2006) states that the research paradigm is strengthened by its theoretical methodology and its research methods and below I discuss the theoretical methodology that underpinned this study.

4.4 Methodology

Wahyuni (2012) defines a methodology as a model to conduct a research within the context of a paradigm. Further, it comprises of underlying sets of beliefs that guide the researcher to choose one set of research method over another. A research methodology is a theoretical choice that needs to complement the research paradigm and the research methods used in a study. Therefore, the importance of alignment between the research paradigm, the research methodology and the research methods are critical in one's study (Jonker & Pennink, 2010). For this research study, a qualitative case study approach was used. This is because the aim of the study was to allow me to study a situation in its real state and to facilitate a deep investigation of a contemporary phenomenon in its natural context (Stake, 2000; Woodside, 2010). A case study gives the researcher a chance to delve deep into the situation with participants, coming up with solutions that are reliable enough to be used in other studies (Yin, 2012).

Similarly, Cohen et al. (2011) confirm that case studies observe the effects in real contexts, recognising that context is a powerful determinant of both cause and effect. As already suggested in Sections 4.2 and 4.3, this was suitable for my study, as I wanted to understand how Grade 3 Foundation Phase teachers developed basic Scientific Process Skills using an Inquiry-Based Approach in their classrooms. In this regard, Maxwell (2008) illustrates five particular goals, which qualitative studies are useful for and he highlights them as follows, "understanding the meaning, for participants in the study, of the events, and of the accounts that they give of their lives and experiences" (p. 221). This again speaks to what Neuman (2012) says about axiology in a study. With regards to this study, the participants' understanding of an Inquiry-Based Approach of teaching was manifested in how they taught in their classroom space.

The strategies and methods they used were evidence of knowledge they had about their context, the curriculum, the discipline and the knowledge about their learners (Shulman, 1987). This was evident in the teaching materials and the intended objectives in each lesson observed. This was key in showing their understanding and knowledge of what they were doing in their classrooms. Likewise, case studies are essential for understanding the particular context within which the participants act and the influence that particular context has on their actions (Maxwell, 2008). In this research, this would translate to how the schools and the contexts within which the participants were working, shaped their actions and thoughts about what they did in their classrooms. Moreover, case studies are critical for identifying unanticipated phenomena and influences and generating new-grounded theories about the latter (Maxwell & Mittapalli, 2007). Lastly, case studies are important for understanding the process by which events take place and developing casual explanations (Snape & Spencer, 2003). The four cases were not representative of the whole population of Foundation Phase teachers in South Africa and yet they give an understanding of how Inquiry-Based teaching can be strengthened in the Foundation Phase.

The above theoretical discussions about qualitative research and case studies put forth the strong arguments and explanations on my part as the researcher, for choosing a qualitative research study. I had also hoped that this study would play a role in promoting the need for Foundation Phase teachers to be assisted and supported in the teaching of science topics in the Foundation Phase, as some might not be specialists in the teaching of Natural Sciences.

I thus believe that findings from this study might be of help for both pre-service and in-service Foundation Phase teachers. The strengths and challenges encountered by the participants in implementing an Inquiry-Based Approach in the teaching of Natural Sciences in this phase, could be used as a starting point to design strategies for supporting teachers when teaching Natural Sciences in their classrooms. Along the same line, this study might raise issues of concern on how pre-service teachers should be equipped with the relevant skills for the teaching of science in the Foundation Phase. The schools and teachers in this study were the primary sources of data in this case. Lastly, the section below discusses how the sampling process was done.

4.5 Sampling

According to Bertram and Christiansen (2015), sampling involves making decisions about which people, settings, events or behaviours to include in a study. Bertram and Christiansen add that researchers need to decide how many individuals, groups or objects (such as schools) will be observed. They further argue that researchers within the interpretive and critical paradigms are often not concerned with statistical accuracy or with the question of whether their data is representative of an entire population. The researchers are rather concerned with detailed and in-depth description, explanations and analysis. In this case, Grade 3 teachers in the Sarah Baartman district were participants in this study.

Four Grade 3 Foundation Phase teachers from four different schools participated in this research. I used purposive sampling as I chose these teachers because of various reasons as highlighted by Bertram and Christiansen (2015) and Maxwell (2008); namely, that all four teachers were teaching in public, historically disadvantaged schools in quintile 3 and 4. Despite quintile three and four schools belonging to the previously disadvantaged category, they are not as economically disadvantaged as quintile 1 and 2 schools. These quintiles determine the school environment, the school set-up and the money allocation per learner from the government (Hall & Giese, 2008). In addition, the four teachers have witnessed the various curriculum changes in their career of Foundation Phase teaching. Most of all, these are all female *IsiXhosa* speaking teachers who have also been part of both developmental and professional programmes and have been trained as Foundation Phase teachers.

The four teachers showed great interest during the research process. Importantly, they have experience of teaching in the Foundation Phase and in understanding the Foundation Phase curriculum better than I do as the researcher in this study. My appreciation and exposure in that I was learning from them, strengthened my relationship with them. Resultantly, they showed more interest in the study. This assisted in avoiding complications that may have resulted in drawbacks during the research process. Echoing similar sentiments, Maxwell (2008) argues that as a researcher, your relationship with the participants can be complex and changeable and this can necessarily affect your research process. Fortunately, the participants' interest in this research worked to my advantage as the researcher. We had a professional research relationship and yet because of commitment and interest in this project we respected each other. Besides working with teachers as research participants, I had other roles as the researcher that are outlined below.

4.5.1 The researcher: Background and positionality

In this research, my role was to facilitate the data generation process while at the same time for me, it was a learning process. My transparency towards my research participants made the journey fulfilling for the research participants. Indeed, I had to be humble as a researcher because I was never trained as a Foundation Phase teacher and yet in my career, I ended up coordinating a Bachelor of Education degree in Foundation Phase teaching. This was despite being a Natural Sciences teacher for Grade 4 - 9 for nine years and a Grade 10 Physical Sciences teacher for two years. My interest was triggered by the challenges faced in the upper grades in the learning of science. This prompted my interest in trying to understand how the Natural Sciences curriculum is designed and how it is taught in the Foundation Phase. This was done after being asked to develop and teach a Natural Sciences module for the above-mentioned degree.

Moreover, further interest was developed after I was invited to conduct a workshop for Foundation Phase teachers on "*Developing creative thinkers*" through science lessons. In the Eastern Cape, there is no evidence of teachers having any professional development workshops nor activities based on Inquiry-Based Approach in developing Scientific Skills in the beginning Knowledge of Life Skills subject. For this exercise, I had an idea of what I wanted to do for this module. Importantly, the feedback I got from the workshop opened further thoughts about both my research journey and my teaching in the Foundation Phase course. It was from this workshop that my relationship with Foundation Phase teachers was developed and it was from the resultant workshop that I shared my study ideas with the teachers present. Thereafter, I asked if there were teachers who were interested in working with me in my research. Teachers showed interest but because of time and space, they could not commit themselves. As a result, when I followed up at some of the schools, teachers were facing the challenge of being overwhelmed with work. Fortunately, the four participants of this study were willing and enthusiastic to be part of this work. When this study commenced, my role was solely that of an observer. I did not influence the participants' teaching, opinions and views in any way. My role as the researcher was to communicate with the participants to organise suitable times to meet and collect data, following the explained data collection procedures. In this way, participants were given the freedom to choose their own times and to make their own decisions with regards to data collection times and meetings.

As already stated above, although I am a university lecturer and the coordinator of the Foundation Phase course, I assumed my position as a researcher. It was a non-threatening position, as I had no experience in Foundation Phase teaching and little background of Foundation Phase teaching. Thus, the research participants had more practical teaching experience and a better understanding of what it means to be a Foundation Phase teacher teaching science. However, for all the Foundation Phase teachers in the Eastern Cape in South Africa, none of them had been involved in workshops that support their teaching of science related topics in their Life Skills Curriculum. As alluded to in the previous sections, having been trained as a senior primary teacher and specialising in Natural Sciences and Mathematics primary education, this research also intended to assist universities in training Foundation Phase teachers to assist closing the existing gaps in the teaching of science in the Foundation Phase in particular. Summarily, my role was to understand how the participants made meaning of what they did when developing basic Scientific Process Skills when teaching science related topics using an Inquiry-Based Approach in their classrooms. Due to the respect I had for my participants and understanding how a community of people should work for the success of the project, during the research process, every participant had a part to play. Below is a comprehensive description of the participants' historical backgrounds and profiles.

4.5.2 Participants

In this study, I had four participants and I gave each participant a code – T1 to T4. These I generated according to how I collected data from each participant and this was guided by the availability of each participant.

Teacher 1:

This female teacher was the youngest in the group and had seven years of teaching experience in the Foundation Phase. By the time of this research, she had taught both Grade 2 and 3 learners and worked in a small quintile 4 school. Before becoming a teacher, she did her initial degree in Bachelor of Social Sciences. Her majors were industrial psychology and industrial sociology. After some years of soul searching (after finding out what she really wants to do), she decided to enrol for a PGCE certificate as a Foundation Phase teacher. When interviewed she highlighted that:

> *There have been always issues with our education system and even back then with the little information I had about education, I knew that I wanted to become a better and a greater teacher that I wish I had and the kind of a teacher that I want my children to have. (T1)*

As a teacher she enjoyed the daily interaction that she had with her learners in assisting them to become problem solvers, to allow them opportunities where their self-esteem could grow and to be able to voice their opinions. Additionally, to also show them how to listen to others' views and work together with others utilising each other's strengths. Lastly, this teacher was passionate about her learners' growth and always sought for each learner to own his or her own learning experience. In her class, this was done through reflecting and making goals together with her learners while taking steps towards their growth. As the researcher, this was evident during my observations as she kept on asking her learners to participate and to consolidate their thinking during lessons and even during group activities. In the lessons, her learners were given roles and responsibilities as they worked together with others in the group.

Teacher 2:

This female participant was the most experienced one in the group. She had been teaching for 37 years and has never stopped since she started her teaching career. She experienced the numerous curriculum transformations in the country and was part of them. Even though she had been teaching for 37 years, she was still energetic and enthusiastic as if she was still a novice teacher. Her positive mind-set allowed her to work and grow in her teaching career. Her highest qualification was an Honours degree in primary education. Her school was classified as a quintile 3 school and was using *IsiXhosa* as the language of teaching and learning. From the informal interviews with her, it emerged that learners in this school were from the surrounding communities around the school and it appeared that the majority came from low-income households.

Again, most learners seemed to survive on grants and stay with their grandparents or in single parent homes. Besides being a classroom teacher, this participant was passionate about helping individual pupils in her school. She was a coordinator of all the sporting codes in the school, institutional support teams and a member of the school's governing body. Lastly, she was one of the leading teachers for the district in the region and therefore assisted district subject heads in conducting Foundation Phase workshops for teachers. As explained, her profile illustrated that she was a passionate and a dedicated teacher. Her teaching ethos was about respecting her learners always, observing them in all teaching activities in class and at the same time noting findings. The findings from her teaching always helped her give feedback accordingly and to plan to accommodate her learners through the use of different teaching strategies. She also valued her learners' parents' opinions as this assisted her in knowing her learners holistically. According to her, the involvement of parents in her teaching was evident when she asked learners to bring some recyclable materials from home and how even when she was no longer in need of these, they would still be brought by parents themselves.

Teacher 3:

The second female participant had taught for 11 years and was doing a Master's degree in languages. Ever since she started her teaching career, she has never looked back. These words were factored in her interview, *"Once I started teaching, I fell in love with it and have never looked back*" (T3).

These were her own words affirming her love for this career that she never saw herself doing. This teacher was a teacher who believed in change and was prepared to be part of the process that brings it. She was open to learning and willing to adjust and share her vision and opinions. One of her sentiments as a teacher was that, *"Not every learner learns the same way and so my pedagogy needs to vary"* (T3).

This was evident in her involvement with various stakeholders. She was always eager to be part of new developments and therefore this resulted in her willingness to be part of this research as she felt that Life Skills as a subject was not regarded as important as languages and mathematics in this phase. According to this teacher, to proceed to the next grade, the departmental requirements were not demanding learners to pass Life Skills. This statement also came out during our first interview. She was in a quintile 3 school and when it came to accommodating her learners, she indicated that she respected them and understood their needs.

> *I am involved in various NGOs that are working with schools to bring about change and improvement in the classroom and in education and I have worked with young writers to improve their writing and reading skills from various schools in the district (T3).*

Her enthusiastic character landed her an opportunity to study further and engage more with other teachers. She was passionate about language development in young learners and believed that if learners are good in language it would be easy to teach them any subject. Her ethos was about walking the extra mile, giving extra hours to her work to make sure that her teaching was productive and effective. She believed in creating networks with other teachers especially in the Foundation Phase. This helped her to learn different strategies and to expose her learners to better teaching spaces.

Teacher 4:

This participant was a female *IsiXhosa* speaking teacher whose age was between 46 to 50 years. She had been teaching Grade 3 learners for nine years. Her highest qualification was a bachelor’s degree in the Foundation Phase. She was the head teacher in that phase and responsible for all the academic programmes. Although all learners and 90% of teachers in this school were *IsiXhosa* speaking teachers, the language of teaching and learning was English. Based on this, teachers in this school used both English and *IsiXhosa* in their classrooms especially in the Foundation Phase. This school was in the quintile 4 category and the majority of learners in this school were from middle-class families. They payed R150 per month towards the daily running of the school.

The participant was a firm advocate of hard work and was committed to her work. She planned her work on time and respected every learner in her class. Having taught Grade 3 learners for nine years, this teacher understood the criticality of this grade in the learners' learning. This is highlighted through this extract: "*By the time learners finish Grade 3 they should be ready for the intermediate phase and be ready for all subjects to be taught in this phase*" (T4).

As the other teachers involved in this study, this participant was involved in various professional developmental programmes. She understood the importance of developing herself as a teacher and the need to come up with new teaching methods. Further, in her interview she mentioned the importance of working and involving all her learners in her class. "*It is not easy to accommodate all learners in my class, some they come from Grade 2 and are not ready for Grade 3 but because of their age they are progressed to Grade 3"*(T4).

She highlighted that this created challenges for her, as she needed to provide for all learners in her class. The prevalence of these challenges prompted her to initiate after-school classes to work with such learners. Table 4.2 is the summary profile of the participants in this study.

Table 4.2: Profile of the teachers involved in this study

DESCRIPTION OF TEACHERS INVOLVED IN THIS STUDY						
Teachers	**Gender**	**Age**	**Highest Qualifications**	**Teaching Experience**	**Teaching Experience in Grade 3**	**School Quintiles**
T1	Female	35 – 40	PGCE in FP	7 years	6 years	Q 4
T2	Female	50 – 55	BEd Honours	37 years	16 years	Q 3
T3	Female	46 – 50	BEd Honours	11 years	6 years	Q 3
T4	Female	46 – 50	BEd in FP	9 years	9 years	Q 4

As highlighted in Section 4.4, teachers and their classes were the primary sources of data in this study. The above table gives a contextual summary of the participants in this study. The process of data generation was effected systematically. The selected data generation methods are illuminated below.

4.6 Data Generation Methods

Creswell et al. (2016) posit that methods are the tools that researchers use to generate data and these are practical methods that can be used in any kind of study. The tools enable researchers to gather data about social reality from individuals, groups, artefacts and texts in any medium. Additionally, they supplement this argument by describing the methodology as the bridge that brings the researcher's philosophical standpoint (ontology and epistemology) and method (perspective and tool) together. Further, Creswell et al. (2016) emphasise that it is important to remember that the researcher travels this bridge throughout the research process and therefore claim that methodology serves as a strategic, but malleable guide. It has been highlighted that when using research methods, researchers need to be aware of the actual situation of the study that they are pursuing and keep in mind the overall research questions of the specific research study (Maxwell, 2008).

This alludes that as a researcher, it is important to keep the research questions in mind when deciding on a research design, as more than one method could be appropriate for the collection of data for a specific research question (Cohen et al., 2018; Creswell et al., 2016). The use of multiple methods (triangulation) to generate data increases validity and authenticity. For this study, four research instruments were used for data generation, namely, document analysis (Life Skills CAPS document, and teachers' lesson plans for taught lessons during this study); questionnaires; interviews (semi-structured interviews and stimulated recall interviews); group reflections and lesson observations of the lesson taught. During this research process, observed lessons were video recorded. Each research tool was used to assist to respond to the research questions on this study and the actual research situation or the main purpose of the study (Maxwell, 2008). Additionally, this research study was conceptualised into four phases and they are discussed below.

Phase 1: Document analysis and questionnaires

Bowen (2009) defines document analysis as a systematic procedure for reviewing or evaluating documents. The documents analysed can be both electronic and/or printed. Like other analytical methods in a qualitative research, document analysis requires data to be examined and interpreted to elicit meaning, gain understanding, and develop empirical knowledge (Corbin & Strauss, 2008). It is highlighted that when the researcher uses documents as sources of data, he or she will focus on all types of written communication that may shed light on the phenomenon that is being researched (Creswell et al., 2016). In this study, the Foundation Phase Life Skills CAPS document, and teachers' lesson plans were such documents. Document analysis and questionnaires were used together to gather baseline or contextual data in this study. Document analysis resulted in the understanding of the content taught in Grade 3 in the Beginning Knowledge Life Skills CAPS document.

Besides the topics or the content that should be taught, the major interest was on the interpretation of an Inquiry-Based Approach as a teaching method in this curriculum. This also helped in developing and formulating the interview questions for the semi-structured interviews in this research. Lesson plans of participants were analysed as documents, based on the participants' PCK of Life Skills curriculum (Shulman, 1986) and analytical framework on the Topic Specific component of PCK discussed in Section 3.3. As already discussed, the understanding of an Inquiry-Based Approach, and how teachers planned for the development of basic Scientific Process Skills and scientific knowledge in their learners and the participants' knowledge of their learners was the key focus in these lesson plans. Ary, Jacobs and Razavieh (2006) confirm that document analysis can provide the researcher with information about prevailing situations.

As stated above, document analysis in this study was used to understand the curriculum expectations and guidelines about teaching of Natural Science topics in the Foundation Phase. With regards to the curriculum document, my aim was to find out if the curriculum document had guidelines on planning and teaching of Foundation Phase science topics. In addition, I needed to know how science related topics were arranged in the curriculum so that I could have a clear understanding on how an Inquiry-Based Approach could be used to develop basic

Scientific Process Skills in this grade. The teachers' lesson plans helped me gain some insights into their planning and the understanding of their knowledge in the topics taught. More so, their knowledge about science and basic Scientific Process Skills, were illuminated. In the process, I gained insight into how they decided upon certain instructional strategies rather than others, for teaching a topic in science. This seemed to have been informed by their knowledge of the learners and knowledge of Inquiry-Based Approach principles. It is through proper planning that this approach can assist teachers in designing inquiry lessons (Park & Oliver, 2008). Therefore, document analysis in this study helped me as the researcher to uncover meaning, develop understanding and discover insights relevant to the research problem (Bowen, 2009). It is clearly stated that document analysis is often used in combination with other qualitative research methods as means to triangulate data in a qualitative study. Adding on to document analysis, questionnaires were used and are discussed in the Section below.

Bertram and Christiansen (2015) define a questionnaire as a sequence of listed questions for the respondents or participant to answer. The questionnaire was composed of open and closed-ended questions that focused on exploring teachers' profiles with regards to their academic qualifications, understanding of an Inquiry-Based Approach and their thinking and views on teaching of science topics in the Foundation Phase. Therefore, questionnaires helped me to better understand and describe the context of this study with regards to its goal and these assisted me in comprehending the participants' contexts and their teaching backgrounds. Their thoughts and understanding of an Inquiry-Based Approach and the teaching of science in this phase was explicit in the participants' responses. Also, because of the questionnaires it was clear to identify the education areas of these teachers and how they shaped their thinking towards the main goal of this study.

Irwin (2002) suggests that respondents are required to answer a series of questions in detail and in writing rather than verbally. To answer questions in writing gives the participants an opportunity to think critically before answering any questions and this gives a rich and an honest data set. As already stated, in this regard the questionnaires helped with the participants' profiles, their perceptions and experiences on science teaching in the Foundation Phase; the main aim being not to test the teachers' content knowledge on an inquiry approach and Scientific Process Skills, but rather to gain insight on their understanding and thoughts of an

Inquiry-Based Approach in the teaching of science in this phase. Therefore, the questionnaire and the semi-structured interviews were important research tools to gather data. The data from questionnaires assisted me with the formulation of semi-structured interviews.

The questionnaire and interview schedule were pilot tested and were reviewed by my supervisors, and masters and PhD scholars in science education (community of practice). As the main aim of the questionnaires and interviews was not to test the teachers' content knowledge on an inquiry approach and scientific process skills per se, I did not use a criterion based approach to validate these instruments. However, the research and use of the instruments were subjected to regular peer review via three national conference presentations, where I also received useful feedback that informed the study. How semi-structured interviews were used and how they benefited this study is discussed below.

Phase 2: Semi-structured interviews

An interview is a method of collecting data in which qualitative or quantitative questions can be asked. In a qualitative study, the interview questions can be both closed- and open-ended while in a quantitative study questions are only closed-ended questions (Schultze & Avital, 2011). It is further maintained that interviews allow participants to answer questions in their own words. Interviews generate an account of contextual interactions that take place between researchers and participants. These are beneficial to the participants in exploring events in their lives (Holloway & Wheeler, 2010). This confirms that the research design determines the method that is most likely to generate the data that will answer the research questions. There are various types of interviews – structured, unstructured and semi-structured interviews and these serve a certain purpose in a research study. Further, interviews have some advantages and disadvantages in research. This explains why some other data collection instruments need to be employed during the research process. As explained above, semi-structured interviews were employed for this study and they are discussed underneath.

Holloway and Wheeler (2010) recognise that semi-structured interviews are the most common of interviews that are used in a qualitative study. They maintain that this type of interview involves the use of predetermined questions where the researcher is free to seek clarification.

For these interviews an interview guideline is developed to collect similar types of data across participants and to create a sense of order as per data collected. In this study, individually semi-structured interviews were conducted with four participants. The aim of these interviews was to find out the participants' perceptions and approaches in the teaching of science. These were equally used as a follow-up method to the questionnaires as it was important to hear from the participants about their views, thoughts and experiences on how Grade 3 Foundation Phase teachers understood basic Scientific Process Skills, their view of teaching science in the Foundation Phase and their understanding of an Inquiry-Based Approach. There were six main questions for these interviews and the other questions varied per participant since they were follow up questions from individual explanations during the interview. The interviews were 30 to 40 minutes long and these times varied because of the individual responses. The main questions are presented in Table 4.3.

Table 4.3: Semi-structured interview questions and their purpose in this study

Questions	**Purpose**
How do you feel about the teaching of science in the Foundation Phase in the Life Skills Curriculum?	To gather data on the participants' views and thoughts about science teaching in the Foundation Phase.
What is your understanding of an Inquiry-Based Approach in the teaching of science?	To gather data on the participants' views and thoughts about an Inquiry-Based Approach as a teaching method.
What do you think is the role of a teacher when planning for an inquiry-based lesson in the teaching of science?	To gather data on the participants' understanding about their role as teachers in planning of lessons that focus on an Inquiry-Based Approach. The principles of an inquiry approach were my "spectacles" in this question.

What is your understanding of basic Scientific Process Skills?	To gather data on participants' understanding on basic Scientific Process Skills and their connection to an Inquiry-Based Approach.
What methods of teaching do you employ to develop basic Scientific Process Skills in your science lessons with your class?	To gather data on the teaching methods and approaches they use to develop basic Scientific Process Skills.
What is the role of the teacher when developing basic Scientific Process Skills in learners?	To gather data on the participants' understanding about their role as teachers in planning of lessons that focus on basic Scientific Process Skills and their link to an Inquiry-Based Approach.

To Wilkinson and Silverman (2004), open-ended questions allow a respondent to pronounce his or her own views, ideas or suggestions about the question posed. Concurring, Berg (2009) argues that semi-structured interviews are flexible and probe the views of the participants on a phenomenon. These interviews help the researcher to strengthen the data collected spontaneously because they allow the researcher to seek further clarifications on the spot. It is against this background that I employed semi-structured interviews in my study because I wanted to get the participants' views on the teaching of science and the use of an Inquiry-Based Approach when developing basic Scientific Process Skills in the Foundation Phase. Put differently, the advantage of using semi-structured interviews in this study was the fact that I could probe for more information and clarify unclear questions about the participants' thoughts and how they make meaning of the research goal which is the use of an Inquiry-Based Approach in developing basic Scientific Process Skills and science knowledge in Foundation Phase classrooms.

Similarly, Power et al. (2010) posit that during semi-structured interviews the researcher is free to vary the order and wording of the questions depending on the direction of the interview and ask additional questions. When conducting these interviews, the participants were free to use the language of their choice. This helped the participants to be more specific about their views as they could converse in their mother tongue and in English. Furthermore, the questioning was driven by how the participants narrated about themselves during interviews (Power et al., 2010). After writing a narrative of each interview and transcribing each interview, a follow-up was made with each participant to ensure the quality of data as per their interview questions. The transcript was given to each participant and they managed to add explanations to strengthen their answers in writing. The next stage of data collection for the study was lesson observation for all four participants and these are discussed in the next session.

Phase 3: Observations

Walliman (2006) defines observation as a systematic process of recording the behavioural patterns of participants, objects, and occurrences without necessarily questioning what they do or communicating with the participants while interacting with learners. Again, observation is a qualitative data-gathering method used to enable the researcher to gain deeper insight into and understanding of the phenomenon being observed. Along the same line, Bertram and Christiansen (2015) and Cohen et al. (2018) affirm that observation means that the researcher sees for him/herself the context and site of the research study and this even means that the researcher can gather information about a wide range of phenomena. For example, in this study, this would be the teacher's classroom practice, the interactions that take place between the teacher and learners, and the educational environment (teaching styles, the use of resources, and the curricula). Additionally, Zaare (2013) identifies classroom observation as a guide for teachers to reflect on their own teaching practices and those observing can learn from other, more successful teachers to improve not only in the classroom but at the school level.

Classroom observations played an important role in this study and all lessons were taught in IsiXhosa, the home language for both the teachers and learners. Extending on the seminal work of Msimanga and Lelliot (2014), Mavuru and Ramnarain (2019), posit that learners' home language has a potential to be used as a resource in science classrooms. As a result, not only did the observations inform me about the participants' understanding of the research goal but gave me an in-depth analysis of the classroom interactions between teachers and learners. It gave me a view on teachers' understanding of the Life Skills Curriculum especially the

Beginning Knowledge study area, teachers' methodology approaches in teaching of science topics and implementation of an Inquiry-Based Approach in their Foundation Phase classrooms. For this research, observed lessons were video-recorded and for all four participants these were conducted in two phases.

This afforded me an opportunity to observe across science topics and themes taught in the Grade 3 classroom. In phase one of observations, two lessons per participant were observed in all four sites. Phase two took place after group reflections and discussions about what occurred in phase one, focusing on how the participants felt about the research process and reflecting on their understanding of the research aim. However, the group reflections and discussions were not initially planned for this research process. However, the participants suggested coming together as a group, so they could reflect and present their observed lessons to each other. According to them, this process was to assist them in understanding if they were on the same level of understanding the research topic. As a researcher, I saw it as important to respect my participants' request. In phase two, one lesson per participant was observed in all four sites and this resulted in a total of 12 observed and video-recorded lessons.

The above inferences helped me to understand the participants' content and pedagogical knowledge on the development of basic Scientific Process Skills, scientific knowledge and the implementation of an Inquiry-Based Approach together with their strengths and weaknesses in different topics of Natural Sciences in the Foundation Phase. In the same vein, Cohen et al. (2011) claim that the observational data helps the researcher to generate information from real situations and they argue that during the observations there is a need for an observational tool or schedule since it develops a sense of ownership over the subject to be observed. Before drawing up an observation schedule, there should be clarity on the rationale of the observation, which can be attained through the following questions as proposed by Creswell et al. (2016): What is the purpose of the observation? What is the focus of the observation and what participants' behaviours are important to observe?

In this study, the concepts of mediation (Section 3.2.1), the ZPD in learners (Section 3.2.3), the social interactions (Section 3.2.2), the concept of culture (Section 3.2.4) and Vygotsky's socio-cultural theory (1978) were used as lenses on the participants' classroom practices during classroom observations. I used these concepts to observe and analyse how teachers in this study taught their learners in respect of the research goal. The PCK (Shulman, 1986; Shulman 1987) focusing on TSPCK (Mavhunga, Ibrahim, Qhobela, & Rollnick, 2016) was used to analyse the participants' ways of teaching and the knowledge they had with respect to the research aim. In ensuring in-depth analysis, stimulated recall interviews and group reflections took place simultaneously during the analysis of video-recorded lessons. These are discussed below.

Phase 4: Stimulated recall interviews and teacher-group reflections

Stimulated recall interviews and reflections are introspective research procedures that use data instruments such as audio recordings, video footages, photographs or other aids to assist research participants to recall their experience of an event during post-event interviews (Mackenzie & Kerr, 2012). In this study, stimulated recall interviews were employed as a way of giving descriptive explanations to the events that occurred during lessons taught. These also helped to clarify some questions that the researcher had after watching and analysing the lessons. Both the semi-structured and stimulated recall interviews were recorded for an in-depth analysis to give clearer descriptions of the participants' narratives. To analyse data from these interviews, field notes were written to guide the researcher when transcribing the data generated from the interviews. Additionally, the questions used in this phase of the research were non-interventionist, since the researcher did not intend to interfere with participants' views and explanations (Lyle, 2003).

In the same vein, participants' group reflections were not initially planned for this study. For instance, during data collection in the first phase of lesson observations the participants felt the importance of coming together and reflecting on the process, wanting to look at one another's video-recorded lessons. This came up as a suggestion and the reason was that the participants saw this as an opportunity to strengthen each other's understanding of their Life Skills classroom practices, especially as this was the focus of the study. It was clear in their view, that they did not get such opportunities with regards to the Life Skills subject.

It appears that this subject is unimportant to most teachers and the Department of Education. Their argument was that if the learners did not do well in Life Skills they could still progress to the next grade. This is even though there was so much foundational knowledge for the higher grades in this subject. Therefore, the participants' group reflections took place after the first phase and the second phase of lesson observations. I henceforth referred to this as a reflective space in which in my view the focus was on absenting the absences in this study (Chikamori, Tanimura, & Ueno, 2019).

Table 4.4 is the summary of data gathering tools and their purpose in this study. Furthermore, the process of this research is diagrammatically summarised. The data analysis session is also discussed after the summary process of this study.

Table 4.4: Summary of data gathering instruments

Methods	**Reason for using this method**
Document Analysis	To analyse how an Inquiry-Based Approach is discussed and how science topics are structured in the curriculum. To analyse how the curriculum assists teachers in their use of an inquiry-based teaching approach.
Questionnaires	Participants' profile and their thoughts on science and the Foundation Phase, basic Scientific Process Skills and scientific inquiry.
Semi-structured interviews	These were employed to solicit participants' understanding of an Inquiry-Based Approach, basic Scientific Process Skills and scientific knowledge. Additionally, they supported the data from questionnaires.
Lesson observations	These were carried out in two phases; they helped to understand how teachers were grappling with the use of an Inquiry-Based Approach and the development of basic Scientific Process Skills.
Stimulated recall interviews	To explain and clarify why the participants used the methods they used when teaching. To find out their intentions and aims per lesson taught.

Participants' group reflections & individual reflections	They helped to understand the participants' thoughts of and actions towards the process of this research which resulted in a second phase of lesson observations.

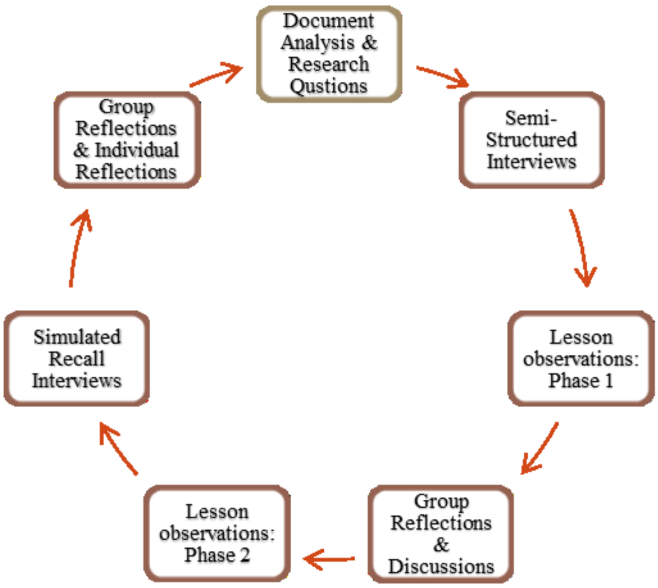

Figure 4.1: A summary of the research process in this study

Figure 4.1 shows the research process I undertook in this study. The research process was not a linear process; during the research process I had to go back and forth to understand the data and steps I took during this journey.

4.7 Data Analysis

According to Wahyuni (2012), data analysis involves drawing of inferences from raw data. It is also defined as the process of organising, accounting for, explaining and interpretation of the amount of generated data (Cohen et al., 2007). This process can involve multi-methods that are applied sequentially. The multi-method application in research is called triangulation (Patton, 2000). As for data collected in this study, various methodological instruments were used to supplement and to strengthen the data collected as stipulated by both the research goal and questions in this research. Data analysis of these instruments as explained in Section 4.1 were categorised and analysed in four phases as per research questions. This was done immediately and concurrently during the process of collecting data (Coffey & Atkinson, 1996). Simultaneous analysis of data while collecting it, enables the researcher to test or follow-up on any emerging conclusions from the data itself.

In the event of this study, document analysis of the Life Skills CAPS was employed to contextualise the study and to understand if this curriculum policy was clear on guiding teachers on how to use an Inquiry-Based Approach. The raw data from questionnaires and semi-structured interviews were analysed to understand the participants' views and perceptions on the use of an Inquiry-Based Approach in developing basic Scientific Process Skills and scientific knowledge in the Grade 3 classroom and in the Foundation Phase. Lastly, the raw data from the video-recorded lessons, observations and stimulated recall interviews and group reflections were used to understand the events that took place when the participants taught in their classrooms and to understand their thoughts on their experiences of doing this research. This raw data was stored safely in manual files, electronic files and in a locked cabinet (Boieje, 2010).

The raw data from the above sources was qualitative data aligned to the research paradigm and design of the study. According to Boieje (2010), performing data analysis on qualitative data involves dismantling, segmenting and reassembling data from meaningful findings to draw inferences. Moreover, the research aim and the research questions are used to guide the process of cutting the collected texts into pieces and logically recombining them. In this study, as the researcher, my first phase of data analysis was to extract the raw data using the research questions. This was inserted in all methodological instruments, questionnaires, semi-structured interviews, video-recorded lessons, stimulated recall interviews and group reflections. This assisted me to look at what came out as categories or episodes as influenced by the research questions and the research aim in the presented raw data. In starting the analysis of both the semi-structured interviews and the observed lessons, I wrote a narrative story for all the participants' data. This assisted me in having a bird's eye view of my data. This strategy of writing narrative stories from the data was a method of making sense of my data from both interviews and observed lessons.

The stories were then analysed into categories and themes arising from the data. To make arguments and discussions in this study, the next phase of data analysis was theory-based analysis. The data from the compiled themes was used for theory and literature-based discussions. This then resulted in the results of the study and the recommendations as per the research question and research aim. As stated above and in Section 3.2, Vygotsky's social cultural theory (1978) was adapted as a learning theory in this study. Drawing from the work of Vygotsky (1978) as mentioned in the discussion above, the concepts were the ZPD, social interactions, culture and mediation of learning. These concepts were used because of their alignment with the principles of an Inquiry-Based Approach, which was the key focus on this study. The focus of these concepts in relation to the study was on how participants mediated learning to develop learners' ZPDs and learners' knowledge in relation to an Inquiry-Based Approach when teaching science related topics in their classrooms. Mediation as a concept was evident in how the participants understood their curriculum, learners and the context in which they taught.

From Vygotsky's theory (1978), Zaretskii (2016) developed and adapted six conditions of teaching learners to reach their ZPD (see Table 3.1). The six conditions enable a learner to make a step towards holistic development and facilitate constructive engagement with the targeted concept during the learning process, in this case towards the development of basic Scientific Process Skills, and the implementation of an Inquiry-Based Approach. These six conditions as part of the analytical framework were adapted in this study. As state in Section 3.2.1, the six conditions resonate with mediation of learning in the classroom and complements the principles of an Inquiry-Based Approach in this study. Hence, these six conditions were adapted and combined as the first part of the theoretical framework.

The PCK (Shulman, 1986; Shulman, 1987) focused more on TSPCK (Mavhunga & Rollnick, 2013; Mavhunga et al., 2016; Mavhunga & Rollnick, 2017). This theory was used in conjunction with the social-cultural theory. With regards to the PCK and TSPCK, for analysis of data I used the concepts in this theory to understand the participants' interactions with their learners in relation to the taught topics in using an Inquiry-Based Approach in this study. This referred to the participants' understanding of their learners, of the curriculum, of their contexts, and of the discipline itself. As highlighted in Figure 4.6, the components of TSPCK were adapted as the analytical framework in this study. Therefore, the components of the analytical framework in this study were adapted from Vygotsky's theory, in relation to mediation and learning, as well as Zaretskii's six conditions in relation to ZPD of learners. Adding to this framework, the principles of an Inquiry-Based Approach were also adapted. As explained, the framework below in Table 4.5 and Table 4.6, were used as an analytical tool in this study.

Table 4.5: Social-cultural theory concepts AND explanation for data analysis

Concepts	**Explanation based on this study**
Mediation	Teachers' methods of teaching, the strategies they use in their classrooms during the observed lessons. The resources or materials they used to implement a scientific inquiry approach.
Zone of Proximal Development	This looked at how teachers used the teaching methods, the teaching strategies in implementing a scientific inquiry approach to develop leaners' ZPDs in this scientific approach.
Social Interactions	The ways in which teachers in the study used the mediation processes to promote and encourage social interactions amongst their learners and amongst themselves and their leaners for learning to take place.
Culture	Each teacher's way of doing things; how each teacher approached issues in her classroom speaks to her beliefs

	and understanding about learning. The classroom set up, learners' interactions, speaks to the culture of that teacher about teaching and learning in her classroom.

Table 4.6: An analytical framework for this study

Section A: Zaretskii's six conditions on how to develop learners' ZPDs when teaching				
In each observed lesson, the six conditions were used as lenses for each participant in this study:				
Participant				
Six Conditions	Lesson 1	Lesson 2	Lesson 3	<u>Summary of Findings</u>
How do participants make their learners **understand** and be **clear about the activity** and **instructions**?	***Teacher 1*** <u>Healthy eating:</u> Fruits	***Teacher 1*** <u>Insects:</u> Ants- ant holes	***Teacher 1*** Food-Testing for cooked and uncooked eggs	
How do participants encourage learners to take **full responsibility** of the activities at hand?	***Teacher 2*** <u>Insects:</u> Properties of insects	***Teacher 2*** Animal life cycles	***Teacher 2*** Plants	
	Teacher 3	***Teacher 3***	***Teacher 3***	

How do **joint activities (if any) assist learners** in achieving challenging activities?	Insects: Butterfly	Healthy eating: Fruits	Density and volume	
The **roles** of both the **participant** and the **learner** during the activity.	***Teacher 4*** Healthy eating: Food groups	***Teacher 4*** Insects: Properties of insects	***Teacher 4*** Natural disasters- Volcanoes	
How do participants **create a space for learners to reflect** on their own work?				
How does working or **cooperating with a teacher assist learners** to achieve the intended objective?				

In Chapter Three, Section 3.2, I discussed Zaretskii's six condition for the development of learners' knowledge and skills during the mediation process. In relation to the presentation of a 'flower-like' diagram by Zaretskii, these indicators assisted to observe how the participants worked with learners during the science activities. To add, these conditions were used as lenses in each observed lesson. Therefore, this was Section A of the analytical framework. Section A as I explained, had the above six conditions or indicators for developing learners' ZPDs. Indicator one, identifies how the participants made or guided learners to understand activities and tasks in their lessons. In addition, how participants made instructions clear to their learners. Condition two, looked at how teachers encouraged or supported their learners to take full responsibility for their activities in the observed lessons.

Condition three, identified the use of joint activities by the participants in their classrooms. How the participants worked with their learners during joint activities (group activities) and what purpose these joint activities utilised in achieving the difficult activities. The fourth condition looked at how the teacher divided the roles between herself and the learners. The fifth condition identified how the participants created a space for learners to reflect on the work or activity they were doing. Lastly, condition six looked at how the joint or cooperative activities with the teacher assisted learners to achieve the intended work. Next, Section B (B1 and B2) of this framework is explained.

Table 4.7: An analytical framework for this study

Indicators	Explanation for indictors:
The **starting point** is what learners already know about the phenomena.	How participants drew from leaners' already existing knowledge to start their lessons or building knowledge for the content taught.
Learners **must fully own and understand** the question or problem they need to solve.	This refers to how participants made sure that their learners understood and owned the problem at hand or to be solved.
There is **direct, hands-on experience** with the phenomena. Content is drawn from the environment in which learners live, allowing for direct observation.	Hands-on, minds-on, and words-on practical activities should be drawn from learners' environments.
Secondary resources (**books, internet, and experts**) complement the direct experience.	Other resources must be used to supplement or to support the practical activities or direct experience of learners.
Language and argumentation are developed in the **context of science.**	Language skills, scientific argumentations need to be developed through science activities.

Allow **learners to work in small groups** as science is a cooperative endeavour.	Participants must allow their learners to work in groups.
Science enquiry skills must be taught and developed.	Through activities, in this case basic Scientific Process Skills must be developed.

Section B1 of Table 4.7 on the analytical framework, identified the principles of an Inquiry-Based Approach in each lesson. How the participants implemented these principles was a guide to their understanding of the inquiry approach. Section B of this framework was divided into two, the last principles required the participants to develop scientific inquiry skills. Hence, Section B2 of this framework is developed below in Table 4.8)

Table 4.8: An analytical framework for this study

<table>
<tr><td colspan="7">SECTION B 2: Basic Scientific Process Skills developed in each observed lesson</td></tr>
<tr><td rowspan="2">Science enquiry skills</td><td colspan="6">Basic Scientific Process Skills Per lesson:</td></tr>
<tr><td>Observation</td><td>Communication</td><td>Classification</td><td>Measu-ring</td><td>Predicting</td><td>Comparing</td></tr>
<tr><td>Indicators</td><td colspan="6">(See Table 2.3) - the indicators were used to identify the BSPS in each observed lesson</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Lesson 1</td><td colspan="6">Lessons from participants:
Healthy eating- Fruits
Insects - Properties
Insects- Butterfly
Healthy eating-Food groups</td></tr>
<tr><td></td><td colspan="6"></td></tr>
<tr><td>Lesson 2</td><td colspan="6">Lessons from participants:
Insects- ant-holes
Life cycles
Healthy eating- Fruits
Insects-Properties of insects</td></tr>
<tr><td></td><td colspan="6"></td></tr>
<tr><td>Lesson 3</td><td colspan="6">Lessons from participants:
Nutrition- Food
Plants
Density and volume
Natural disasters - Volcanoes</td></tr>
</table>

Section B2 of this framework assisted me to identify individual basic Scientific Process Skills developed in each observed lesson. Using the indicators from Table 2.3 helped me to identify the teachers' knowledge of the process skills and how teachers developed these skills in their learners. Consequently, the indicators assisted me in identifying the challenges encountered by the participants when developing these basic Scientific Process Skills. The next section was vital in identifying the strengths and the challenges about the knowledge of the participants' practices.

Table 4.9: An analytical framework for this study

SECTION C: Shows components for transformation of knowledge (Adapted from Mavhunga & Rollnick , 2013 and Mavhunga & Rollnick, 2017)	
CATEGORY	**CRITERIA**
Learner Prior Knowledge	What learners already know and includes common misconceptions known in a topic.
Curricular Saliency	Refers to the identification of the most important meaning of the major concepts in a topic, without which understanding of the topic would be difficult for learners. It also includes the knowledge to logically sequence the learning and the knowledge of pre-concepts needed prior to teaching a topic.
What is difficult to understand	Refers to gate-keeping concepts which are difficult to understand often because they cause conflict with previously established understanding.
Representations	Refers to a combination of representations at *macro*, *symbol* and *sub-microscopic* levels that may be employed to support an explanation.
Conceptual Teaching Strategies	Refers to teaching strategies derived from the considerations made from the other components and excludes general teaching methodologies.

This section considered each teacher's knowledge on the overall research process; how in each lesson the participants drew from their leaners' prior knowledge and their knowledge of curriculum salience. In each lesson, it was also vital to understand how participants used conceptual teaching and representations. Lastly, the participants' ways of dealing with difficulties and challenges in each lesson was also crucial. As identified in the section above, these components were referred to as topic specific components of PCK. This meant that these components were an indication of teachers' holistic knowledge of their practice.

4.8 Validity and Trustworthiness

Creswell et al. (2016) argue that although not agreed to by many researchers, triangulation is often seen as a process of validation of the researcher's findings. They explain that validation of qualitative research depends on the presentation of solid descriptive data. In that regard the researcher leads the reader to understand the meaning of the experience under study. Additionally, Leung (2015) confirms the researcher's validity, reliability and trustworthiness, and highlights that the researcher has to ensure that the findings of the study are the actual findings, not the impression of the researcher. Echoing similar ideas are Bertram and Christiansen (2015) who argue that the researcher needs to make sure that the data gathering tools he or she uses can be used elsewhere, are systematic, credible and transparent. Likewise, Guba (1981) proposes that qualitative researchers in pursuit of validating their studies should consider four criteria: credibility, transferability, dependability and confirmability.

More so, Bertram and Christiansen (2015) explain the four criteria and how these criteria can be enhanced in an interpretive research or qualitative study. In their explanation, credibility can be improved by checking raw data adequately with the participants (for example, giving interview transcripts back to the participants to check and comment on whether they think it is an accurate reflection of what they said). Transferability of the research can be increased if the researcher focuses on how typical the participants are to the context being studied and a concern with providing a complete understanding of the context being studied. Furthermore, dependability can be increased by accounting for any variations in the study; for instance, between cases or it can also mean comparing the researcher's study to the previous studies in the field and explaining key differences. Confirmability can be improved by making the research process transparent, with enough details for the reader to check if they would have reached the same or similar conclusion.

For this study, the Life Skills CAPS curriculum document, lesson plans of participants, questionnaires to inform my study, semi-structured and stimulated recall interviews (both tape-recorded) and classroom observations (video-recorded lessons) were used to gather rich data which helped to construct credible findings. The Life Skills CAPS document also helped me to understand how the Natural Sciences study area of Beginning Knowledge was structured to guide teachers on what content to teach and how to develop basic Scientific Process Skills in their classrooms. In addition, I was interested in the clarity of the document and transparency of an Inquiry-Based Approach in the participants' classrooms. Lesson plans gave me an insight into how the participants planned and prepared the teaching of science in their classrooms. Further it highlighted their methods and strategies used to develop basic Scientific Process Skills using an Inquiry-Based Approach when teaching science. As already mentioned in the methodology data section, questionnaires helped to formulate the context of the study and to understand the teachers' views on the use of an Inquiry-Based Approach in their classrooms. Interviews were in two parts; semi-structured and stimulated recall interviews. They were used to understand and clarify participants' views and opinions about their planning and teaching.

Lastly, lesson observations and video-recorded lessons gave insights into the participants' real teaching environment and the interactions and the processes that took place when teaching science lessons. The group reflections served as validation processes of the research and to understand the participants' thinking around the whole study. Additionally, using one participant's video-recorded lesson 1 and 2, the adapted theoretical analytical framework was validated with six critical friends. Ethical permission to use this data was granted by the participant. In this process as the researcher, I made sure that this information was not shared with any other person. This process assisted me to think of follow-up questions and clarifications based on the lessons.

4.9 Ethical Considerations

According to Cohen et al. (2011), research respondents are subjects, not objects of research. Based on that, they need to be respected. Having been given informed consent to the research, the participants still had the right to withdraw at any time and were guaranteed that the research was not going to harm them in any way. In the same vein, Murray (2006) points out that consideration of ethics is of fundamental importance to all research. Again, Maxwell (2008) stresses the need for researchers to build a positive relationship with participants as this can be changeable and complex at times and can affect research instruments and have negative implications for other components of their research. Also, he highlights the need for systematic planning and reflection, if a research design is to be as coherent as possible.

With reference to this research study, the district, school principals, teachers involved, and parents of the learners, were formally requested and engaged, with regards to the conducting of this research. All participants in this study were made aware of the research process and from time to time the researcher and the participants reflected on the research process. This ensured the relationship between the participants and the researcher was strengthened and transparent. Although the research focus was not on learners, it was important to engage with their parents as the observed lessons were going to be video-recorded. For research completed through Rhodes University's Faculty of Education, an "*Ethical Approval Application*" form must be completed and submitted to the Education Higher Degrees Committee with the research proposal. The form requires the researcher to outline his/her approach to ensuring the ethical principles of:

- respect and dignity;
- transparency and honesty;
- accountability and responsibility; and
- integrity and academic professionalism.

In ensuring the above principles, as the researcher, I personally visited the participants and discussed their roles and rights as participants. In this visit, I assured the participants that their dignity and integrity would be protected throughout the research process. This visit helped me to create space for the participants to ask any questions they had concerning their roles in this research.

Bertram and Christiansen (2015) argue that ethics that have a bearing on the research participants should be given serious consideration. In the context of my study, since lessons were video- recorded, it was important for me to be part of the parents' meeting held in the beginning of 2017 where I personally asked for permission from the parents of Grade 3 learners whose teachers would be participants. This was a platform for me to explain my intention and my role as a researcher. In addition, I also requested to use the photographs of learners doing scientific Inquiry-Based activities and of the classroom set-up. Formal request letters were subsequently given to the district office, school principals, teachers and the learners' parents (see Appendices B, C, D & E).

Moreover, both the participants and I, as a mutual benefit process addressed the issue of positionality in this study. This came about as the participants raised their concerns and the need for support in the Life Skills curriculum. I was never trained as a Foundation Phase teacher and therefore as already mentioned above, I was also in a learning process and on an empowering journey. To give evidence of the mutual benefit of this study for both participants and I, the participants were given a report on their role in this study and that this could help in their SACE accreditation points. As the BEd Foundation Phase coordinator and a novice academic, this process assisted in strengthening the science module, as well as growing my academic journey.

4.10 Chapter Summary

In summary, this chapter presented the scope of the study through outlining the research paradigm, the research process and the methodological tools employed in this study. The chapter explained the type of study and its focus. The decisions made on the theoretical analytical frameworks in relation to the conceptual focus of this research were also outlined in this chapter. After giving detailed explanations on the research process and rigour of the research, I explained the background and the profile of the participants involved in this research. This was done in alignment with the theory informing the study. The last section of this chapter was dedicated to the ethical issues and steps followed to make sure that both myself as the researcher and the participants understood the research purpose and their roles in this research. Transparency was the key to this process and everyone involved were seen as important and valued individuals. This is reflected in the data presentation, analysis and discussion.

CHAPTER FIVE: DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSION: QUESTIONNAIRES & SEMI-STRUCTURED INTERVIEWS (PHASE 1 & 2)

> *The questionnaire is the medium of communication between the researcher and the subject, albeit sometimes administered on the researcher's behalf by an interviewer. In the questionnaire, the researcher articulates the questions to which he or she wants to know the answers and, through the questionnaire, the subjects' answers are conveyed back to the researcher (Brace, 2018, p. 5). In contrast, interviews elucidate respectively live experiences and viewpoints from the respondents' perspectives.* (Tracy, 2013, p. 132)

5.1 Introduction

In the previous chapter, I discussed the methodological instruments that I used to gather data for the research questions in this study (see Section 4.6, Phase 1 & 2). I gave a dense description of how each methodological instrument was used in this research project and for what purpose. To understand the participants' contexts, their views and perspectives, questionnaires and semi-structured interviews were used in the first phase of this study. Hence, this chapter explores an overview of data from both questionnaires and semi-structured interviews with the four participants involved in this study. The aim of the questionnaires and the interviews was to generate data about the participants' perspectives and their understanding about teaching science, an Inquiry-Based Approach and basic Scientific Process Skills in the Foundation Phase. As highlighted in the epigraph, the two data generating techniques helped to gather teachers' thoughts before observing lessons in their classrooms (Brace, 2018; Tracy, 2013). Again, the data from these two methodological instruments laid a foundation to understand the participants' understanding of what it means to teach science through an Inquiry-Based Approach in particular. This chapter thus presents, interprets and discusses data addressing research question 1 of this study:

What is the understanding of basic Scientific Process Skills and an Inquiry-Based Approach by Grade 3 Foundation Phase teachers?

The questionnaires, as already deliberated on in Section 4.6 assisted me to understand the teachers' contexts, their profiles and their teaching background. Following and supporting the data from the questionnaires, were the semi-structured interviews. That is, the semi-structured interviews assisted to triangulate and to validate data from the questionnaires (see Section 4.6). The interviews were used to generate data from all four individual participants. As a result, the participants' personal interpretation about the questions were explicit as these were face-to-face interviews (Cohen et al., 2018; Tracy, 2013). As I already explained in Section 4.6, the interviews lasted about 30 to 40 minutes long and these varied according to how participants explained themselves throughout the interviews.

This chapter is outlined according to each theme and discussion drawn from teacher 1 (T1) to teacher 4 (T4). For the structure of this chapter, with the help of literature on the scientific Inquiry-Based Approach and basic Scientific Process Skills, I used various categories to organise and synthesise data. This helped to make sense of the data; to see the data that is answering and talking to each sub-question from both questionnaires and interviews. The presentation of data is followed by rich discussion of the data summary from all themes. Based on the questions and the data, the following themes were used: perspectives about science; understanding of inquiry approach; understanding of scientific inquiry skills; materials or resources that can be used when teaching science through inquiry approach in FP; the role of the teacher and the role of learners. The data and results are pulled together using literature and theory in this study. Lastly, the summary in this chapter presents the results and findings from the overall chapter. Next, I discuss how themes were developed for this chapter.

5.2 Development of Themes for This Research Question

As already explained in the preceding chapter and in the above section, I used questionnaires and interviews as an initial method in understanding the participants' perspectives about the sub-question presented in Section 5.1 above. I developed both questionnaires and interviews using the research goal, literature and theory in this study. Sub-question 1, as noted above, looked at teachers' understanding and perspectives of the use of scientific inquiry, basic Scientific Process Skills and science teaching in the Foundation Phase (FP). This sub-question aligns well with the main goal of this study, which explores how the participants mediate the development of the foundational Scientific Process Skills using the scientific Inquiry-Based Approach in their FP classrooms (see Sections 1.4 and 4.1). In preparation for lesson observations, the data from both questionnaires and interviews assisted to understand each participants' perspectives about the research topic and to get an idea about how they do things in their classrooms.

In developing the questions for the initial data from questionnaires and interviews, the literature and theory in this study assisted me to develop the prompt and the necessary questions that were in line with the main goal of this study. Beni et al. (2012), Bosman (2006), Ebrahim (2013) and Plaatjies (2014) in their research, presented challenges faced by Foundation Phase teachers in the teaching of science content in their classrooms (see Sections 2.1, 2.2 and 2.3). In addition, this study has not only focused on the perspectives of the participants, but it went into the participants' classroom spaces in order to observe how they grapple with the teaching of science using an Inquiry-Based Approach in the Foundation Phase. Moreover, in this study, the language of teaching and learning was isiXhosa and both teachers and learners in this study are isiXhosa speakers. Hence, this study, compared to the various studies conducted in South Africa, is dissimilar. This study unlike other studies on an inquiry approach in South Africa, was conducted in the Foundation Phase and not at High School.

Likewise, the participants' understanding of a scientific inquiry approach was of importance in this sub-question. Hence, the questions were explicit in the teachers' understanding of a scientific inquiry approach, their understanding of basic Scientific Process Skills and the roles of both teachers and learners when using this approach (Buxton & Provenzo, 2011; Kidman & Casinader, 2017; Lederman et al., 2014; Worth, 2010). Consequently, as already explained above, the themes highlighted below from both questionnaires and semi-structured interviews were developed. The themes are arranged according to the questions asked in both the questionnaires and interviews.

Table 5.1: Themes emerging from questionnaires and interviews

<table>
<tr><td colspan="3">Research Question: What is the understanding of basic Scientific Process Skills and Inquiry-Based Approach by Grade 3 Foundation Phase teachers?</td></tr>
<tr><th rowspan="2">Themes</th><th colspan="2">Theory</th></tr>
<tr><th>Literature</th><th>Conceptual/Theoretical Framework</th></tr>
<tr><td colspan="3"></td></tr>
<tr><td>Views about science teaching in Foundation Phase.</td><td>Ebrahim (2013); Green, Gordon & Brown (2014); Parker & Hall (2011).</td><td rowspan="6">The participants’ views about teaching of science in FP, refers to the mediation process they undertake in their classrooms.

Their understanding of development of SPS through mediation of SIBA in science lessons in FP refers to their understanding of how they develop learning in their lessons, the six conditions in this regard are the key focus (ZPD).

How participants understand the use of SIBA, the development of SPS, the use of various materials during the process of learning in each lesson speaks to the participants’ (culture) of doing things in their classrooms.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Understanding of an Inquiry-Based Approach.</td><td>Kidman & Casinader (2017); Bosman et al. (2016); Mkimbili et al. (2017); Pedaste et al. (2015).</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Understanding and development of basic Scientific Process Skills.</td><td>Chabalengula et al. (2012); Worth (2010); Ogu & Schmidt (2009); Lederman et al. (2014); Mbewe et al. (2010).</td></tr>
<tr><td></td><td></td></tr>
</table>

Roles of teachers in using an Inquiry-Based Approach when developing basic Scientific Process Skills.	Charlesworth & Lindt (2013); Fraser-Abder (2011); Buxton & Provenzo (2011); Kovalik & Olsen (2010); Worth (2010); Kidman & Casinader (2017).	How participants understand their roles and the learners' roles speaks to how the participants create social interactions between themselves and learners.
Roles of learners in an Inquiry-Based Approach when developing basic Scientific Process Skills.	Pollen (2009); Worth (2010); Tunnicliffe (2013); Bosman et al. (2016); Chabalengula et al. (2012).	
Use of materials or resources when using inquiry approach.	Bosman et al. (2016); Louca et al. (2013); Kuhlane (2011); Asheela (2017).	

Table 5.1 above shows the relationship and the alignment of the emergent themes from both questionnaires and interviews with literature related to science teaching in the Foundation Phase, an Inquiry-Based Approach, basic Scientific Process Skills and socio-cultural theory that informed this study. The literature and the theory assisted me in discussing the findings in this chapter. With this in mind, I used the participants' voices to present their thoughts from both questionnaires and interviews. The next table presents the themes from questionnaires and interviews in relation to PCK, focusing on TSPCK components in particular.

Table 5.2: Themes emerging from questionnaires and interviews with TSPCK components

Themes	**Topic Specific Pedagogical Content Knowledge**
Views about science teaching in Foundation Phase.	•How the participants draw knowledge from learners about their understanding of teaching science topics. •How the participants view science as a subject. •How participants view the science curriculum in FP. •The participants' understanding of scientific inquiry, basic Scientific Process Skills and the materials used by the participants. •The methods and strategies used by the participants, speaks to their understanding of: • Their students' contexts • Their students' knowledge •Content knowledge and pedagogical knowledge
Understanding of an Inquiry-Based Approach.	
Understanding and development of basic Scientific Process Skills.	
Roles of teachers in using an Inquiry-Based Approach in developing basic Scientific Process Skills.	
Roles of learners in an Inquiry-Based Approach when developing basic Scientific Process Skills. .	
Use of materials or resources when using an inquiry approach.	

As already mentioned in Section 5.2, using the themes that emerged from the data, I now present, interpret and discuss data from both questionnaires and interviews.

5.3 Presentation, Interpretation and Discussion of Data

In this section, to discuss and make sense of the data, I use various codes for data and for the participants. For the participants, for instance, I use the following codes: Teacher 1 (T1), Teacher 2 (T2), Teacher 3 (T3) and Teacher 4 (T4). For data interpretation and presentations, I use the following codes: for questionnaires (Q) and for semi-structured interviews (SI). In each theme, the data from both questionnaires and semi-structured interviews were assembled and coded according to the likeness and differences of views and answers. This assisted me to see the similarities and differences of thoughts between the participants (see Appendices G and H). Next, I present and discuss the perspectives of the participants on science in the Foundation Phase.

5.3.1 Perspectives about science in Foundation Phase

This section presents, interprets and discusses the teachers' perspectives in teaching of science in the Foundation Phase. To start the section, I firstly present the data from both the questionnaires and the interviews.

Table 5.3: Perspectives of the participants about science teaching in FP (Q & SI)

	T1	T2	T3	T4
SCIENCE TEACHING IN FP	• In FP we do not use the word science, we use themes. These or some themes have a scientific angle. (Q & SI) • It is about observation, analysing, and exploration of what is around us. Meaning, our bodies and their functions, the environment, plants and electricity, etc. (Q & SI) • Science opens eyes for learners to the fact that science is all around us. It speaks to their curiosity and encourages them to ask questions to think critically and logically. (Q & SI)	• Science lessons need to allow learners to experiment and observe things. (Q) • Science should really start at this phase as learners are curious and still young. (Q) • Lessons need to allow the leaners to explore. (Q) • Science is important. (SI) • It helps learners to understand their world. (SI)	• Science in FP should be done practically and it needs to start from Grade R. It is embedded in Life Skills curriculum. (Q) • Science is important in this phase because it can help learners to understand it better in higher grades. (Q & SI) • It forms a foundation where more abstract and complicated scientific processes will be built on. (Q & SI) • From my experience, FP teachers do not take science seriously and learners find it difficult in higher grades "*We do not*". (SI)	• A very important subject (Q & SI) • Must be taught early age. (Q) • FP teachers need to give foundation knowledge for higher Grades. (Q & SI) • It develops learners' thinking and knowledge. (Q) • It assists leaners to think critically. (Q) • In FP we teach the basic knowledge; sets them [up] for difficult knowledge at higher grades. (SI)

Table 5.3 above shows the views of participants about the teaching of science in Foundation Phase. The participants had some common and different perspectives about science teaching at this phase. For instance, when asked about her understanding of science, in both the questionnaire and the interview, T1 explained that at Foundation Phase the term 'science' in the South African curriculum is not used. She commented that the term 'theme' makes better

sense. In her own words, she stated that: "*It is difficult to say, because once you use the word "science" I think of the laboratory and experiments"* (T1QSI).

To her, the term 'science' brings about thoughts of *laboratories* and *experiments*. When asked about teaching science in the Foundation Phase, she revealed that she relates the concept with high school learning. T1 further highlighted that she uses themes to promote language and numeracy in her class. The integration of these subjects affords her more time to spend on the Life Skills themes. When she teaches Life Skills, she does not only focus on the themes during the six hours allocated for Life Skills. Almost everything she does with her learners in class revolves around the Life Skills themes. She gave examples of the following topics as themes that she uses in her class: *food, life cycles, insects,* and *safety*. In this case, she spoke broadly about the teaching of Life Skills but was also explicit on how she views the teaching of science in the Foundation Phase.

Again, in the view of T1, science related topics assist learners to understand what is around them. She elaborated that science is about analysing, exploring and observing what is around us. In agreement with T1, T2 added that science assists learners to understand the world around them. Furthermore, she elaborated that science allows learners to *experiment* and to observe things. Concurring, T3 expressed that science should be taught practically and should start as early as Grade R. T4 also expressed the same sentiment that science in the Foundation Phase level should be taught to build foundational knowledge for learners and to prepare learners for high school. T3 and 4 highlighted that science in the Foundation Phase should prepare learners for high school learning. The two participants (T3 & T4) further narrated that in the FP, teachers should set the basic knowledge so that learners understand the difficult concepts that are taught in higher grades. T1 and T2 noted: *"Learners in this level like to be hands on and they are curious to know more. So, science needs to be more exciting for young learners"* (QSI).

Similarly, to T3 and T4, T2 also believed that science teaching is very important in the Foundation Phase. According to her, learners in this phase have very little knowledge about science and therefore they need teachers who will guide and equip them with information. She stated that learners in the Foundation Phase level must be engaged in hands-on activities since learners at that level are curious to know more. T3 further added that in the Foundation Phase, hands-on practical activities are important because they prepare learners for more abstract activities that they will encounter in higher grades. According to these participants (T1, T2, T3 & T4), science is a platform to allow learners to learn and *investigate* more. The curiosity in young learners is an advantage for lessons as it pushes them to explore things on their own (T2Q).

> *Science is a subject that needs to be taken seriously and taught in the Foundation Phase. The reason most learners see science as a difficult subject in higher grades, is because we do not take it seriously in the Foundation Phase. (T3S1)*

T3 also pointed out that the Beginning Knowledge started in Life Skills promotes science teaching and yet most teachers neglect this area. She stated that when it comes to Life Skills teachers only focus on physical education and taking learners to play outside the classroom and do not take the opportunity for learning through play. She strongly believes that this is compounded by the Department of Education (DoE) which does not have external examinations for Life Skills, while they do for Language and Numeracy. According to her (T3), how the Department of Education views Life Skills as a subject influence how teachers see the value in this subject. Yet she believes that: *"Through science learners can think critically"* (T3Q).

T1 and T4 pointed out that through science teaching, learners can become creative and critical thinkers. According to these participants, if taught effectively, science develops learners' thinking and knowledge. Science sets the foundation for higher learning. Again, teachers need to be aware of the basic knowledge they need to impart to their learners (T4Q). T1 further gave examples of how she makes sure science is catered for in her class. Even though science is under the Beginning Knowledge area in Life Skills, most topics are science related topics, as she reiterated. She concluded by stating that both content knowledge and basic Scientific Process Skills in science are vital for science development.

5.3.2 Participants' understanding about an Inquiry-Based Approach

Table 5.4 below shows the participants' understanding about the method of an inquiry approach. The data from interviews is used to bring in the participants' voices in the discussion about their understanding of this approach.

Table 5.4: Understanding the method of an Inquiry-Based Approach

	T1	T2	T3	T4
METHOD OF INQUIRY APPROACH	• It is all about finding out about specific objects. (Q) • It is about observing, analysing etc. (Q)	• Learners are asked to find out about the given topic, for example growing a bean. (Q) • Visiting museums to explore and to observe those things that we do not have in my school. (Q)	• It is a task-based process and it prepares and develops science knowledge step by step. (Q) • The teacher explains instructions and activities as learners are working. (Q) • Teacher sets questions to be answered. (Q)	• It is about asking questions. (Q) • Solving a problem. (Q) • Discovery learning. (Q) • Practical activities or being hands-on. (Q)

The four participants had to explain and give their perspectives on a scientific inquiry approach. In their explanations in their questionnaires, they highlighted that an Inquiry-Based Approach is about finding out about objects, and asking questions (T1, T2, T3 & T4). T1 further explained that observation and analysis are part of an inquiry approach. T2 went on saying that visiting the museum assisted her to make those things that were not visible to her learners, visible. For T4, an Inquiry-Based Approach is about solving problems, discovery learning and doing practical activities with learners. In support of T4, T2 stated that the use of learners' senses is important during an inquiry approach. In agreement, in her questionnaire and interview, T1 also noted the importance of physical activities when using an inquiry approach: "*In my* *understanding, it is when learners are given the opportunity to make sense of what they are learning by engaging in physical activities and real experiences"* (SI).

In this participant's understanding, an Inquiry-Based Approach is about giving learners an opportunity to make sense of what they are learning by engaging them in physical activities and real experiences. When asked to elaborate on what she meant about physical activities, she expanded by highlighting that it is about working with different materials that learners need to learn about. She gave an example of learning about shapes, where she made sure that she had various shapes as teaching materials in front of learners so that they were able to experience what they were learning. She concluded by saying that in her lessons she makes sure that she gives her learners real experiences that engage as many of their senses as much as possible, so that learning is tangible and caters to many learning styles. All four participants are in agreement that an Inquiry-Based Approach allows learners to use their senses and to be engaged in tasks that make them actively involved. To do this, T4, noted the importance of drawing from learners' everyday experiences.

5.3.3 Participants' understanding about basic Scientific Process Skills

Table 5.5 below shows the responses from the questionnaires of the participants on their understanding of basic Scientific Process Skills. To strengthen the discussion and presentation of what came from the participants' understanding of an Inquiry-Based Approach to basic Scientific Process Skills, I used analytical statements from interviews. This assisted me in bringing in the *voices* of participants on their views about basic Scientific Process Skills in particular.

Table 5.5: Participants' understanding about basic Scientific Process Skills

	T1	T2	T3	T4
BASIC SCIENTIFIC PROCESS SKILLS	• It is about finding out and investigating (Q) • Working with real life experiences. (Q)	• The process of experimenting. (Q) • To explore, and find out, observe. (Q) • To answer questions. (Q)	• The kind of thinking that is required to acquire scientific knowledge through tasks, practical activities set, and questions asked. (Q) • They form a foundation for the necessary skills for acquisition of science knowledge. (Q)	• Process of inquiring. (Q) • It involves observing, comparing, classifying, measuring, experiments and communication. (Q) • These skills widen learners' thinking. (Q) • Expose leaners to do practical activities. (Q)

In the questionnaire, teachers were asked to explain their understanding of basic Scientific Process Skills and how these skills can be developed in the classroom. All four participants (T1, T2, T3, & T4) highlighted the importance of investigations. T1 noted that basic Scientific Process Skills are about finding out and working with real life experiences. In her interview, to follow-up on her explanation she further narrated that basic Scientific Process Skills,

> *Include investigations and experiments, where learners predict, record and observe. Also, learners are given the opportunity to come up with their own ideas and thinking around a specific investigation or an experiment. (T1S1)*

She additionally stated that learners are given the opportunity to come up with their own ideas and thinking around a specific investigation or an experiment. In agreement with this understanding, T2 defined basic Scientific Process Skills as the process of experimenting, exploring and finding out answers. Again, during the interview T2 narrated that: "*It is about observation, making sure that learners do observe what you teach them*" (T2SI).

Moreover, T1 gave some practical examples of how she develops basic Scientific Process Skills in her class. For example, she explained about how she recently taught the topic of food whereby learners were taught how food is processed and what food processing is. In doing that, she confidently gave a narrative of when she used a video on processing of wheat (*Ingqolowa)* in her own terms. According to this participant, practical activities or experiments are used in her class to develop these process skills. She also added that she gives her learners an opportunity to discuss around the topics taught. She does this through the question and answer method to promote engagement amongst her learners.

Again, T1 concluded this question by giving an example of a dough experiment she did with her learners. She had groups with different ingredients that could make bread. In one group, she had warm water, yeast, salt and bread flour and in another group, she had warm water, no yeast, salt and bread flour. The third group had the same ingredients as group one but used cold water. Throughout this process, her learners had to discuss and compare their ideas. Afterward, groups reflected on their findings and compared their results. This teacher gave her understanding of basic Scientific Process Skills and at the same time narrated her teaching experiences about these process skills (T1SI).

T2 explained basic Scientific Process Skills as skills that are able to expose learners to various experiences like discussion, describing objects and explaining their facts of observation. According to T2, allowing each learner to use his or her senses allows him/her to develop basic Scientific Process Skills. As a teacher, she acknowledged her role in exposing learners to real objects and providing real materials that are at the level of the learners. She further explained that, learners needed to be engaged and to be involved in tasks in such a way that they would understand the activity presented to them. To this participant, basic Scientific Process Skills are a way of promoting experiments and thought-provoking tasks. She added that, visiting a science museum assists her a lot with some topics.

T3 saw scientific inquiry skills as developing the kind of thinking that is required to acquire scientific knowledge through tasks, practical activities and questions asked. She added that basic Scientific Process Skills form a foundation for the necessary skills required for science teaching and learning in higher classes: *"Scientific skills form a foundation for the necessary skills required for the acquisition of knowledge with regards to science teaching"* (T3SI).

To support her definition about inquiry skills, she narrated an example of a lesson on using an inquiry approach, and she explained how she taught the types of soil through a practical task. Learners observed and compared the different characteristics of soil. According to her, this involved processes of observing, comparing measurements, experimenting and communicating. She stated that in order for teachers to do this well, they need to research the topic to be taught and be sure about it. This participant concluded by highlighting the importance of giving clear instructions when doing science tasks. T4 in her questionnaire, defined basic Scientific Process Skills as the process that involves observing, comparing, classifying, measuring, experimenting and communicating. During the interview, she explained that basic Scientific Process Skills assist learners to understand the real world: *"The scientific process skills widen the thinking of learners and expose them on how science is and to real world experiences"* (T4SI).

This participant also believed that the school environment was a perfect space to develop basic Scientific Process Skills especially in the Foundation Phase. She concluded by saying that there are many opportunities for Foundation Phase teachers to effectively teach science in their classrooms.

5.3.4 Participants' understanding about the roles of teachers and learners in an Inquiry-Based Approach

In this section, I present data from the participants' questionnaires and semi-structured interviews about their views on the roles of learners and teachers during an inquiry approach. Table 5.6 presents data from T1 to T4 of this study.

Table 5.6: Participants' views on the roles of teachers and learners in an inquiry approach

	T1	T2	T3	T4
Role of a teacher in science inquiry approach	• Assist learners in activities • Plan materials and lessons • Understand the topic that I am going to teach (Q & SI)	• To guide learners • To assess leaners • To assist during the activity • To understand my learners as a teacher (Q & SI)	• Plans lessons • Ask and explain questions • Explains instructions • Sets tasks and activities (Q & SI)	• Need to plan lessons and investigate the topic • Provide materials • Create comfortable space for learning (Q & SI)
Role of learners in Inquiry Approach	• To work as a team when necessary • To answer questions and to ask questions • To record findings • To give feedback • To ask for help during activities • (Q & SI)	• Learners at this level like to be hands on and curious to know more • Learners like to touch and smell at this stage • Lessons need to allow the leaners to explore (Q & SI)	• Answer questions (Q & SI)	• Giving feedback • Being active in a lesson • Collaborate with others (Q & SI)

When the participants were asked about their roles and the learners' roles during the use of an inquiry approach, T1 saw her role as vital and important. Her philosophy as a teacher is to develop learners who are creative thinkers. According to her, the development of creative thinkers is one of the intended aims of the Life Skills curriculum. Because of this curriculum objective, she sees her role in her class as important and always tries her best to adhere to the intended curriculum's aims and objectives. Stating her roles as a teacher, she highlighted the following:

- To raise questions during her teaching;
- To come up with planning and teaching ideas;
- To give learning examples;
- To assess her learners; and
- To promote language and numeracy while teaching Life Skills (T1QSI).

As for her learners, she confirmed that she respects them, sees them as part of her teaching activities, and engages them during class activities. According to this participant, she observed that her learners are often scared to make mistakes when they work independently in groups. Because of this observation, she has learnt to encourage them to make mistakes as mistakes are part of the learning process. Lastly, as mentioned above, the participant uses materials that are familiar to her learners so that she can promote effective learning in her class. This was evident from the examples she gave in the above sections (see Sections 5.2 & 5.3). T3 drew from her own class experience and stated the importance of integrating or using learners' prior knowledge:

> *When planning lessons, as a teacher I make sure I draw from learners' prior knowledge and therefore I give my learners outside-classroom experiences. I also use what is familiar to them. (T3SI).*

According to this teacher, her role when using an inquiry approach is to draw from learners' prior knowledge, to use familiar materials and to use outside-classroom experiences. She further narrated that when using an inquiry approach and developing basic Scientific Process Skills in her class, she sees the following factors as important: planning is the core factor when preparing inquiry-based lessons. As a teacher, she emphasised, it is important to find suitable materials for learners and give them experiences that will afford them opportunities to learn, to guide learners during activities and to ask thought provoking questions. This teacher also revealed a very important point, she noted that during the teaching process a teacher needs to see herself as a learner because learners have varying knowledge and backgrounds that a teacher can learn from. With respect to her learners, she sees them as co-learners in the process and as having an opportunity to ask their own questions as well as learning from each other.

Explaining her role, T2 also highlighted the importance of integrating numeracy and language together with science topics. To her, this helps to strengthen the content for Life Skills themes or science topics. For instance, she commented that: *"Through asking questions, I use Life Skills themes (science topics) to integrate Language and Numeracy. This helps me to develop the necessary skills for both subjects"* (T2S1).

When it comes to her role as a teacher, she sees it as vital, especially when it comes to planning and making sure she has all the required teaching aids for each specific lesson. She further narrated that when working with her learners she observes each individual and notes findings about each learner. T2 claims to understand the differences in her learners; she uses different teaching styles and strategies to accommodate them and to cater for the developmental levels of her learners. Regarding her learners, she stated the value of respecting their views and their opinions. For instance, she allows them to participate in activities, in pairs or in groups; according to her this assists in the sharing of views and ideas during teaching. Therefore, this teacher considered her learners as participants in her class and saw them as valuable in her teaching. This participant shared the same sentiments as teacher one.

Likewise, T3 was very clear about her role as a teacher when implementing an Inquiry-Based Approach in her class. She highlighted that planning and researching are important. Gathering appropriate and easily accessible materials for learners is a necessity for her as a teacher. She also added that at times she asks her learners to bring things like fruits and vegetables for teaching purposes. She added that she allows her learners to participate and to engage in her lessons. According to this participant, this could be the reason why most teachers are ignoring the knowledge that is embedded under Life Skills. Lastly, she highlighted that Life Skills is a subject that develops the learner holistically. Next, I discuss the participants' understanding about the use of resources when using an inquiry approach.

5.3.5 Participants' understanding about the use of resources in an Inquiry-Based Approach

In this section, I discuss the teachers' perspectives on the use of resources when using an inquiry approach. The participants were asked their understanding and views on how they would use materials when teaching using a scientific inquiry approach in their classrooms; their responses are documented in Table 5.7 below.

Table 5.7: Teachers' responses on the use of resources when using an inquiry approach

	T1	T2	T3	T4
Resources/Materials during Inquiry	• Use materials from home and around the environment (Q) • Everyday materials from home (SI) • Things like food from home, water, kettle etc (SI) • Recycling materials, magazines, newspapers (SI)	• To use everyday resources (Q) • Recycling materials (Q) • From home materials (Q) • Posters (Q) • The school surroundings, magazines, models, posters and newspapers etc. (SI)	• Everyday materials, like soil, baking powder, coke, glycerine, vinegar, bread and beans, etc. (Q) • Posters (SI) • Pictures, models, recycling materials etc. (SI)	• Posters (Q) • Actual substances/ materials (Q) • Samples of what is taught (Q) • School surroundings (Q) • Use models (Q) • Resources from home, (SI) • computers, fruits, vegetables, magazines, posters etc. (SI)

The four participants in this study in their questionnaires and interviews projected the need to use everyday materials and easily accessible resources when teaching science in their classrooms. T4 explained how she values the school environment when teaching her learners:

> *Drawing from my school environment is the key, I use outside classroom to explore and to engage learners. Their use of senses in my lessons is very important. I use models, pictures and other everyday resources to strengthen my teaching. (T4SI)*

As already mentioned above, this teacher was very positive about using the school environment, posters and concrete objects that might allow learners to learn from them. The example of teaching about insects brought clarity about what kind of a teacher she was. She made an example of bringing real life experiences for her learners. Models of animals, recycled materials and books are used in her class as teaching resources. She made it clear that in the Foundation Phase she believed in the use of easily accessible resources as they could help learners at this age to be comfortable with learning. She believed that learners engage better in class when they are using objects that they know or are aware of. When she was asked to give some examples of materials that she might use in her class, she mentioned the following: soil, recyclable material like plastic bottles, empty containers, fruits, coke, vinegar and vegetables might be brought to class for learning objectives. According to this participant, easily accessible resources are important at this level and learners will be more comfortable when using materials that are familiar to them.

T1 indicated that she likes to have the freedom of planning and using her own thinking. Her teaching strategies are characterised by a sense of being creative, using the context of her learners. This was evident from the hands-on practical activities she gave when engaging her learners in various activities. She highlighted the use of her learners' socio-cultural contexts, everyday resources that are familiar and surrounding her learners. In the above section, the participant gave many examples of the resources she uses in her class. These are resources like: bread flour, salt, sugar, soil, boiling water she used when demonstrating the water cycle and how vapour turns into water again; and she always uses the school environment as a teaching resource. Further to this question, she narrated on how critical her role is when teaching in her class. T2 also highlighted the importance of knowing learners' levels of understanding when using teaching resources: *"Collecting the right material and providing my learners with the correct information, it is my role as a teacher. Also, I need to make sure the resources are at the level of my learners at all times"* (T2SI).

Posters and many teaching aids are used and these were the words of this participant (T2). She highlighted the difficulty she has in collecting the teaching materials. She stated that most of her learners come from economically struggling families and therefore at times it is not easy for her to ask them to bring some of the materials she would love to use in her class. As a result, she collects things beforehand and asks those who can to bring some used objects that can assist in her teaching. The good thing about her learners, as she narrated, is that learners in her class even bring materials after she has done the lesson. For her, this is evidence that her learners do want to assist her. Nonetheless, most of the time she uses the kind of materials and resources that might be familiar to her learners. Concurring with T4 about the use of resources, T3 noted the use of the school environment or the outside classroom experience as resource for teaching: "*When planning lessons, as a teacher I make sure I draw from learners' prior knowledge and therefore I give my learners outside classroom experiences. I also use what is familiar to them"* (T3SI).

Adding to the above statement, easily accessible resources that are familiar to learners are what this participant promotes about teaching of science at this level. She believes that learners engage better in class when they are using objects that they are familiar with. When she was asked to give some examples of materials that she uses in her class, she mentioned the following: soil, recycled material like plastic bottles, empty containers, fruits, coke, vinegar and vegetables might be brought in class for learning objectives. According to this participant, easily accessible resources are important at this level and learners can be comfortable when using materials that are familiar to them. Overall, this participant, just like other participants, was in agreement with the use of everyday materials and easily accessible resources. Following, is the discussion on the perspectives of teachers on teaching related topics in the Foundation Phase.

5.4 Teachers' perspectives on teaching science related topics in the foundation phase

As already highlighted in the previous sections, in the questionnaire there was a section on the teachers' perspectives and thoughts about the teaching of science in the Foundation Phase. Using the statements on science teaching and the Foundation Phase, the participants had to rate their views according to their level of agreement or disagreement. Table 5.8 below shows the participants' indications about their views.

Table 5.8: The participants' indicators and perspectives about teaching science in FP

Statements	Strongly Agree	Agree	Not sure	Disagree	Strongly Disagree
It is necessary for science to be taught at Foundation Phase.	T1, T2, T3, T4				
I enjoy teaching science in my class.	T1, T3	T2, T4			
I do not teach science in my class.				T2, T3, T4	T1
I do not have any challenges with science teaching.	T1		T4	T2, T3	
I use practical activities and demonstrations when developing basic Scientific Process Skills.	T1, T3	T2, T4			

I use everyday resources when doing science practical activities in my class.	T1, T3, T4	T2			
I understand how to develop all the basic Scientific Process Skills when teaching.		T2, T4	T1, T3		
I do planning for science lessons.	T3	T1, T2, T4			
I understand the method/approach of inquiry.		T1, T2, T3, T4			
I do assess my learners in science activities.	T3	T1, T2, T4			

Table 5.8 above shows responses from the participants. This indicates the positive and negative understandings that the teachers had about the aspects of this research study. Analysing the responses, I used the varied statements about how teachers agreed or disagreed about each statement. To compare, I used numbers and percentages as per the statement and the level of indicators. This section of the questionnaire was important as it summarised and gave the overview of individuals' thoughts in relation to the topic researched in this study. The next table quantifies the results from Table 5.6 and makes sense of the data using numbers.

Table 5.9: Quantified results from Table 5.6 (teachers' perspectives on science teaching)

Statements	**Strongly Agree**	**Agree**	**Not sure**	**Disagree**	**Strongly Disagree**
It is necessary for science to be taught at Foundation Phase.	4/4				
I enjoy teaching science in my class.	2/4	2/4			
I do not teach science in my class.				3/4	1/4
I do not have any challenges with science teaching.	1/4		1/4	2/4	
I use practical activities and demonstrations when developing basic Scientific Process Skills.	2/4	2/4			
I use everyday resources when doing science practical activities in my class.	3/4	1/4			

I understand how to develop all the basic Scientific Process Skills when teaching.		2/4	2/4		
I do planning for science lessons.	1/4	3/4			
I understand the method/approach of inquiry.		4/4			
I do assess my learners in science activities.	1/4	3/4			

To interpret data, Table 5.9 above used quantitative analysis. In statement one, where I asked the participants about their views on the necessity for science teaching in the Foundation Phase, all four participants strongly agreed that it is necessary to teach science at this phase. The second statement looked at their attitudes about teaching science topics; two teachers (T1 & T3) strongly agreed that they do enjoy teaching science in their classrooms and T2 and T4 only agreed that they do enjoy teaching science in their classrooms. With statement three that looked at whether or not they do teach science in their classrooms, three teachers disagreed with such a statement, disputing the fact of not teaching science in their classroom. T1 strongly disagreed with the same statement, also disputing the fact that she is not teaching science in her class. Regarding statement four, about the challenges they have with teaching of science in their classrooms; T1 responded that she had no challenges with the teaching of science in her class. T3, in contrast responded that she was not sure; T2 and T4 agree that they do have challenges in the teaching of science; in highlighting this they both disagreed with the statement that said, '*I do not have challenges in teaching of science'* (statement 4).

Statement five looked at whether or not teachers do use practical activities or demonstrations to develop basic Scientific Process Skills in their classrooms. In responding to this, T1 and T3 strongly agreed with the statement on the use of practical activities. T2 and T4 agreed that they also use practical activities in their classrooms. About the use of easily or everyday resources, three teachers (T1, T3 and T4) strongly agreed that they use everyday resources in their classrooms. T2 also agreed that she does use everyday resources in her class.

On the statement about how to develop basic Scientific Process Skills, teachers T2 and T4 agreed that they do understand how to develop these skills, T1 and T3 were not sure about the development of these skills. Concerning the planning of science lessons, three teachers (T1, T2, and T4) agreed that they do plan science lessons for their teaching and T1 strongly agreed with this statement on the planning of science lessons. When asked to rate their understanding of an inquiry approach, all four teachers strongly agreed that they understand an Inquiry-Based Approach. Lastly, on this part of the section, teachers had to rate if they do assess their learners in science activities; T1, T2 and T4 agreed that they do assess their learners in science and T3 strongly agreed with the statement. Overall, this section on the questionnaires gave an overview of what the participants' views were about the use of an inquiry approach and teaching of science in the Foundation Phase. The following Section gives a summary of findings from both the questionnaires and semi-structured interviews.

5.5 Summary of findings

In this section, I summarise the participants' views about an Inquiry-Based Approach, basic Scientific Process Skills, and learners' and the teachers' roles when using an inquiry approach as a teaching method in their classrooms. The teachers' views on teaching science in the Foundation Phase were not the focus of the study, but nonetheless it was important to gather the participants' views about its value and teaching in this phase. Below, I discuss the participants' thoughts as an overview of what they thought about science in the Foundation Phase. Their perspectives about the importance of teaching science at this level gave an understanding of what they do with regards to using an Inquiry-Based Approach in their classrooms.

I chose to use Tables 5.5 and 5.6 to compare the teachers' views regarding their thinking about the main goal of this study. The tables were designed to show the participants' perspectives and the influence of what they thought about each theme. Table 5.5 looked at the teachers' thoughts about an Inquiry-Based Approach and basic Scientific Process Skills. At the same time, Table 5.6 looked at the roles of the teacher and of the learner when implementing an Inquiry-Based Approach in their teaching. The relationship between an Inquiry-Based Approach and basic Scientific Process Skills presented by the participants highlights a strong sense of their level of understanding regarding an inquiry approach. Overall, the tables are a summary of the participants' thoughts, ideas and perceptions about how they view an inquiry approach. As already stated, the participants' views gave an idea of how the participants did things in their classrooms before the actual observation of their lessons. Sub-question 2 of the study gives a clear understanding of how these views were implemented or not into practice and therefore Chapter Six gives clear narratives of data from the participants' lesson observations on the use of an Inquiry-Based Approach in their classrooms.

I must highlight that even though the participants seemed to have an idea of what an inquiry approach is, that does not necessarily mean that they do not encounter any challenges when using this approach in their classrooms. This is further illuminated in Chapter Six.

Table 5.10: Summary of teachers' views on an Inquiry-Based Approach and basic Scientific Process Skills

T	IBA	SPS
T1	Learners to make sense of what they are learning; Learners to be engaged in physical activities; Learners need to have real experiences; and Learners need to use their senses.	Investigations and experiments; Predict, record, observe and compare; Promote discussion and engagement in class.
T2	Both the teacher and learners prepare these tasks; About instructions and questions; Practical activities; and Learners observe, answer questions, learners' scientific knowledge is developed.	Teacher asks questions; Practical activities; Foundational Skills for science knowledge; and To engage learners.
T3	It allows learners to find their own answers; Learners to use their senses; To make the invisible visible; To conclude findings; and Can be done inside and outside the classroom.	Allow learners to use their senses; Promote discussion, observation; and Experiments.
T4	It starts from home; Starting from what learners know;	Different kinds of knowledge;

	Learners' experiences; Using textbooks as a supporting resource; and It is about problem solving.	About observation, comparing, measuring, experimenting and communication; and Widen their thinking.

Regarding the above table, the teachers' responses show a relationship between an Inquiry-Based Approach and basic Scientific Process Skills. All four participants highlighted the value of the following skills: observation, comparing, measuring, discussion, recording and prediction. Moreover, the participants indicated the importance of drawing from learners' experiences while using an inquiry approach and doing investigations in their teaching practice. In addition, these teachers also raised the use of learners' senses and making sure that learners are active participants in the lesson. Whether or not these teachers do understand how to teach science using an inquiry approach is discussed in the next chapter, using lesson observations and videotaped lessons. Overall, the participants in their interviews and questionnaires did highlight some principles of an Inquiry-Based Approach.

Table 5.11: Summary of teachers' views on the roles of both teachers and learners when using an Inquiry-Based Approach

	Teacher's Role	**Learner's Role**
T1	Develop learners who are creative thinkers; Ask questions in class; Planning ideas; To assess learners; and To promote numeracy and literacy through LS.	Active learners; and Engage in lessons.
T2	Plan lessons; Find suitable materials; Draw from learners' prior knowledge; and Ask thought - provoking questions from learners.	Co-learners; Ask their own questions; and Engage and learn from each other.
T3	Planning lessons; Find teaching materials; Observe learners;	Learners as participants; Learners' views are part of her lessons; and Learners work together and assist each other.

	Apply different teaching styles; and Draw learners' views and opinions.	
T4	Planning and researching about the topic to be taught; and Gathering appropriate materials.	Engaging in lessons; and Learners to bring materials in class.

Again, Table 5.11 above presents the participants' responses on the teachers' and learners' roles during using an inquiry approach. What seems to have come out is that these teachers see planning as vital and important. As teachers, they consider themselves as researchers before teaching the topic and have to prepare suitable materials for their learners. Likewise, the participants valued their learners' participation and engagement in their lessons. Despite learners being learners, teachers highlighted the importance of leaners sharing ideas amongst themselves and being allowed to ask their own questions during activities. Lastly, the four participants saw a need to cooperate with their learners when planning and teaching in their classrooms.

5.6 Views of Participants on the Use of Resources during an Inquiry-Based Approach

The four participants (T1- T4) gave their opinions and views regarding the use of resources when using an Inquiry-Based Approach. In addition, their thoughts about science in the Foundation Phase were presented. These teachers, as highlighted under each participant above, believed that easily accessible resources were important to use when teaching science in the Foundation Phase (T1- T4). They also mentioned that the school environment played an important role when teaching science related topics. From the four participants, some went further, drawing from their experiences of how they used the school environment as their teaching resource (T1, T3 & T4). In addition, the participants valued the teaching of science in this phase (P1-P4). They related it as being the foundation for scientific knowledge in the upper grades (T4).

The curiosity characteristic of their learners was one of the major reasons these participants highlighted the importance of teaching science in this phase (T1& T3). They even mentioned that young learners like to ask questions and to explore what is around them. Even though the term science is not normally used in this phase the teachers valued it as an important subject (T1). For them, the term science related to high school as it made them think of laboratories and experiments (T1). Overall, the participants were aware of the importance of science at this phase and yet they were also aware of the challenges that existed in their classrooms or teaching practice. Summarising the findings on this chapter, the following section concerns data synthesis and makes sense of data using literature and theory.

5.7 Data Synthesis and Implications for This Study

In the curriculum, it is highlighted that Foundation Phase teachers are required to teach science through an Inquiry-Based Approach, which promotes basic Scientific Process Skills (Mkimbili et al., 2017; SA. DBE, 2011). With reference to my sub-question 1 of this study, it was therefore my interest as the researcher, to understand the teachers' perspectives about an Inquiry-Based Approach. Drawing from the data, participants referred to an inquiry approach as doing investigations, practical work, asking questions and developing basic Scientific Process Skills when teaching science content (Gillies & Nichols, 2015; Lederman, 2009). With regards to their understanding of an inquiry approach in science teaching, the participants noted the above components. Whether or not the participants understood how to use an inquiry approach to develop basic Scientific Process Skills was not evident at this stage. This was the first phase of the research that looked at participants' understanding and perspectives about the research study.

The participants further stated the need for effective planning of inquiry lessons that would allow learners to develop and use basic Scientific Process Skills (Charlesworth & Lindt, 2013; Worth, 2010). In giving evidence on her understanding of how to develop basic Scientific Process Skills, T1 in her interview gave evidence of how she develops these skills in her class (see Section 5.3). In addition, the participants indicated several process skills that could be developed during an inquiry approach and these are skills of observing, comparing, classifying, measuring, predicting and communicating (Abrams & Miller, 2008; Bosman et al., 2016).

To implement an inquiry approach, teachers need to be aware of their roles and the learners' roles (Buxton & Provenzo, 2011; Mkimbili et al., 2017; Worth, 2010). In their questionnaires and interviews, the participants highlighted the roles of both teachers and learners that could be played by each during the implementation or the use of an inquiry approach. The participants noted the need for teachers to bring resources that are familiar to learners, and that these needed to be on the level and in the context of their learners (Asheela, 2017; Kuhlane, 2011; Mavuru & Ramnarain, 2017). The participants further highlighted the importance of resources in schools (Chabalengula et al., 2012; Mkimbili et al., 2017). Many scholars that have researched on the implementation of an inquiry approach at high school level have noted the lack of resources as one of the negative impacts for the successful implementation of this approach (Jiang & McComas, 2015); hence, the use of easily accessible resources and those familiar to the learners (Davis & Smithey, 2009; Worth, 2010).

Bosman et al. (2016) also support the use of easily accessible resources in the Foundation Phase and further state that learners at this level are curious about their surroundings. Teachers in this study alluded to the curiosity of learners at this level and the importance of developing cognitive skills in this phase (Bosman et al., 2016; Worth, 2010). Sackes et al. (2010) state that children develop a fundamental understanding of the observed phenomena and essential Scientific Process Skills during their early years of learning. They further argue that the cognitive and developmental stage is of significance and therefore experimental science is important for young children.

Concurring with this, the participants mentioned the use of hands-on practical activities or experiments as the instructional method to implement an inquiry approach in their classrooms (Abrahams & Miller, 2008). In support of this, Kidman and Casinader (2017) situate science as a subject that allows one to see the world but doing so in its special concepts. They further state that in teaching science, learners are lead to see phenomena and experimental situations, in particular ways to learn to 'wear' scientists' conceptual spectacles. From the data, the participants further pointed out the following reasons why it is fundamental to teach science in early childhood: young children are naturally curious and constantly exploring the world around them and classroom science provides the opportunity for children to extend this natural curiosity and build theories (Halverson, 2007).

It is therefore clear that both teachers and learners play an important role in this approach. Teachers' understanding of their learners and their context is vital (Kidman & Casinader, 2017). Overall, the teachers' interpretation of science in the Foundation Phase, an Inquiry-Based Approach and basic Scientific Process Skills, highlighted how they implement the approach in their classrooms. These interpretations became the window and the spectacles through which to view what might take place in their classrooms. Few studies that have been conducted in the South African context have highlighted challenges of FP teachers being negative towards teaching of science in this phase (Bosman, 2011; Koen & Ebrahim, 2013; Kok & van Schoor, 2014; Plaatjies, 2014).

Despite their experience of being Foundation Phase teachers, these teachers seemed to be positive towards the teaching of science in Foundation Phase classes. Additionally, the teachers in this research in their interviews mentioned some of the principles of an inquiry approach and yet the Life Skills curriculum is not explicit about these (Boeije, 2010). Below, I present a summary of this chapter.

5.8 Chapter Summary

This chapter presented data on the participants' views about the teaching of science in the Foundation Phase, their interpretation of an Inquiry-Based Approach and their understanding of basic Scientific Process Skills. Even though the four teachers claimed that they do not use the term 'science' in this phase, they seemed to show some understanding of science content embedded in the Beginning Knowledge study area of the Life Skills curriculum. They mentioned that in the Foundation Phase the term 'science' is rarely used, instead they use the term 'theme' for the topics taught in Life Skills. Apparently, these themes are used to teach across all Foundation Phase subjects. As far as their interpretation of an Inquiry-Based Approach, these teachers raised some of the principles that should be considered by teachers when using this approach in their classrooms. In addition, these teachers recommended the importance of using easily accessible resources.

Despite the omission of what an inquiry approach is, in the Life Skills curriculum, the four participants were able to show some understanding of the use of this method of teaching. The challenges highlighted by teachers during the interview and in the questionnaires seemingly were the result of how Life Skills is viewed by the Department of Education that influences how teachers deal with this subject in their schools. The question discussed in this chapter was in preparation for understanding the focus of the study that looked at how Foundation Phase teachers mediate the development of basic Scientific Process Skills using an Inquiry-Based Approach in their Grade 3 classrooms. This is illuminated in the data presentation, analysis and discussion provided in the next chapter.

CHAPTER SIX: DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSION

(PHASE 3: LESSON OBSERVATIONS)

> *Observation, in its different forms, tries to understand practices, interactions, and events, which occur in a specific context from the inside as a participant or from the outside as a mere observer. In observation, different starting points are taken to reconstruct the single case. The events in a specific setting, the activities of a specific person, and the concrete interactions of several persons together* (Flick, 2014, p. 296).

6.1 Introduction

In this chapter, I present data for research question 2 of this study. The question was as follows;

> *How do Grade 3 FP teachers mediate the development of basic Scientific Process Skills using an Inquiry-Based Approach in their classrooms?*

To achieve this, in phase one of this study, I gave the participants questionnaires. In phase two, I conducted semi-structured interviews. The purpose of phase one and two, as explained in Section 4.6 and Section 5.1, was to understand the participants' perspectives, thoughts and pedagogical understanding in teaching of science using an inquiry approach and in developing basic Scientific Process Skills in Foundation Phase (see Chapter Five). Research question 2 was based on phase three of this study (see Section 4.6), the main focus of this research. That is, how participants grapple with the use of an inquiry approach in developing basic Scientific Process Skills in their learners as it is expected by the Life Skills Foundation Phase Curriculum (Grades R- 3) was the key focus of phase 3.

In this phase of the study, I observed and videotaped lessons from the four teachers who were participants in this study. From each teacher, I observed three lessons. In this process of lesson observations, I had two cycles. In the first cycle, I observed two lessons from each participant. In the second cycle, I observed one lesson from each participant. In total, there were 12 observed lessons for this study. To analyse data from this phase, I wrote *narrative stories* for each videotaped lesson, followed by transcriptions of each lesson. From each narrative story, using a colour-coding method, I categorised the data using the sections (themes) from the analytical framework (see Appendix I).

In this chapter, I present data from all four participants (T1, T2, T3 & T4). As already highlighted in the epigram, during the process of lesson observations I was a non-participant observer (Cohen et al., 2018; Flick, 2014). My role was to gather data and at the same time, making sure the process of collecting data ran smoothly. As explained in Section 4.5, the participants were from quintile[10] three and four schools; therefore, for data analysis, presentation, interpretation and discussion in this chapter, all observed quintiles are presented. Thus, I present data from two quintile three schools and from two quintile four schools. In Section 4.5, I explained that quintiles in the South African schooling system are categories that differentiate the schools according to the standard, quality and the location of structure and equipment in each individual school. Moreover, quintiles are also categorised by the fee structure of the school, whereby parents have or not a role of paying their children's fees to the school.

Having explained the above, teacher one (T1) and teacher two (T2) are unique in this study because of their positions in this research. Participant one (T1), for instance, is from a quintile four school, and compared to the other three is the youngest and had recently qualified as a teacher. On the other hand, participant two (T2) is from a quintile three school and is a more

[10] As explained in Chapter One, South African schools are categorised into five groups, called **quintiles**, largely for purposes of the allocation of financial resources. **Quintiles** 1, 2, and 3 schools are non-fee paying schools and get substantial funding from the government to support their needs, while **quintiles** 4 and 5 are the fee paying schools but differ in the amount paid and the resources they have.

experienced teacher. It could be argued that the two teachers are a true reflection of where our South African education is coming from and where it is going. The other two participants (T3 & T4) are relatively in the same level. T3 is in a quintile 3 school and T4 is in a quintile 4 school. As the researcher, I view them (T3 & T4) as being as more or less at the same level in terms of teaching experience (see Table 4.2). Overall, in relation to research question 2 of this study, this chapter presents the data from all four participants. As already highlighted above, the analytical tool/framework was used to draw themes and conclusions from the observed lessons (see Appendix O).

6.2 Chapter Outline

As stated in Section 6.1 above, the focus of this chapter is on four participants in this study. Equally, this chapter starts by giving a table of the observed lessons from all four teachers, a classroom context of each teacher and short narratives of the twelve observed lessons from the four participants (T1, T2, T3 & T4) in this study. Afterwards, drawing from the analytical framework, I present and discuss the themes that emerged from the data of the four participants. Literature and theory are used in pulling the threads together. The analytical statements from each participant's transcribed lessons are used to give the *voices* of the participants and give a view of what took place in their lessons.

As discussed in Chapter Three and Four, the analytical framework has four sections used to analyse each lesson. To start the discussion on analysis, for sections of the analytical tool/framework I drew data from each teacher. After each section of the analytical tool, I discussed teachers' emerging findings. To summarise the overall findings, Vygotsky's socio-cultural theory is used to discuss findings through the lenses of the theoretical concepts that informed this study. Lastly, the chapter summary gives the conclusion of this chapter. As stated above, to set the scene I outline the lessons taught by all four participants in Table 6.1 below. To make sense of the data, I use the following codes for discussions in this chapter, Teacher 1 (T1), Teacher 2 (T2), Teacher 2 (T3), Teacher 2 (T4), Lesson 1 (L1), Lesson 2 (L1) and Lesson 3 (L3).

Table 6.1: Observed Lessons from the four participants (T1, T2, T3 & T4)

Lessons	TEACHER 1 (Female)	TEACHER 2 (Female)
L1	Healthy Eating: Fruits	Insects: Characteristics of insects
L2	Insects: Anthills (Homes of Ants)	Animals: Life Cycles
L3	Food: Eggs	Plants: Shapes of leaves & flowers
Lessons	**TEACHER 3 (Female)**	**TEACHER 4 (Female)**
L1	Insects: Butterfly	Healthy Eating: Food groups
L2	Healthy Eating: Fruits	Animals: Insects
L3	Density: Volume and Mass	Disasters: Volcanoes and Earthquakes

6.3 The School and the Classroom context

This section presents a brief background of the four schools in which the teachers in this chapter work. The classroom contexts of the all teachers are described. Each context for each teacher gives an overview of the classroom arrangement and the learners' contexts.

6.3.1 Teacher 1 (T1)

This participant as already highlighted in Section 4.5.2 and is a female teacher in a quintile 4 school, which is a small farm school that serves most of the surrounding areas. It starts from grade R and goes up to Grade 3. Therefore, it is solely a Foundation Phase (FP) school and this makes the school a feeder school for various other schools in the district. To support itself, the school gets funding from various non-governmental organisations (NGOs), including the Department of Education. Additionally, however, the parents are required to contribute monthly tuition fees of R1200 each month towards the well-being of the school. The language of learning and teaching (LoLT) at this school is the vernacular language of learners, which is IsiXhosa. The school is situated around the farming areas and, because of this context, it has small class sizes made up of both boys and girls. Unlike most schools, the learners at this school do not wear the usual uniform but instead wear comfortable clothes (blue denim jeans and red t-shirts) and this is intended to enable learners to do all required activities in and outside classrooms (see Figure 6.1) below.

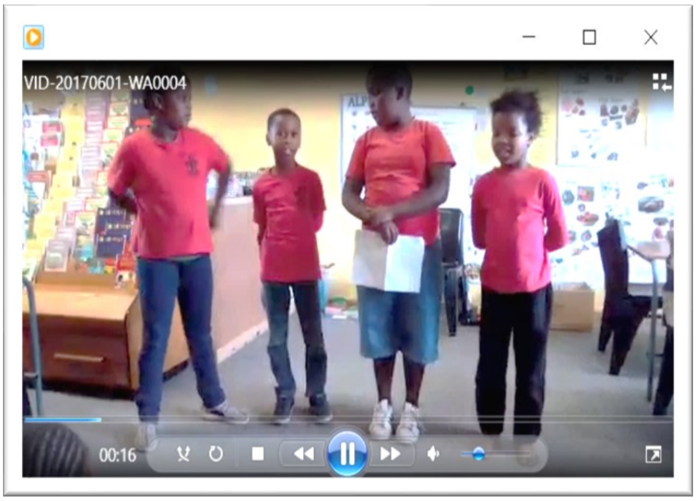

Figure 6.1: School uniform

The grade 3 class for this study is comprised of 13 learners and it is organised for various learning settings. This class is organised in a manner that learners and their teacher are able to be productive. For example, there is a small corner library for independent and guided reading; there is a corner with a hand sink, which is used mostly to wash hands after some hands-on activities; there is a science or a Life Skills corner and there are various posters on the wall that promote learning for all three subjects in the Foundation Phase. Also, next to the teacher's table, which is next to the window on the right hand side of the classroom, there is a carpet that is used for learning and for reading purposes. The equipment on the table is used for teaching and learning activities. There are resources like lead pencils, pencil crayons, scissors and old magazines and so forth. Mounted on the wall, is a television set with a video player. This assists the teacher to show her learners learning programs that help learners to make sense of what is taught in class.

Figure 6.2: Library Corner in the classroom

Additionally, a removable white board is utilised for notes and other writing purposes. Lastly, the desks are arranged for learners to sit in pairs and there is one group of three learners. Moreover, as mentioned in Section 4.5.2, this teacher has been teaching grade 3 for three (3) years, and she loves interacting with her learners. Of the four participants in this study, her years of teaching make her the least experienced teacher. According to her, she takes her teaching responsibility seriously and is committed to developing learners who are creative thinkers.

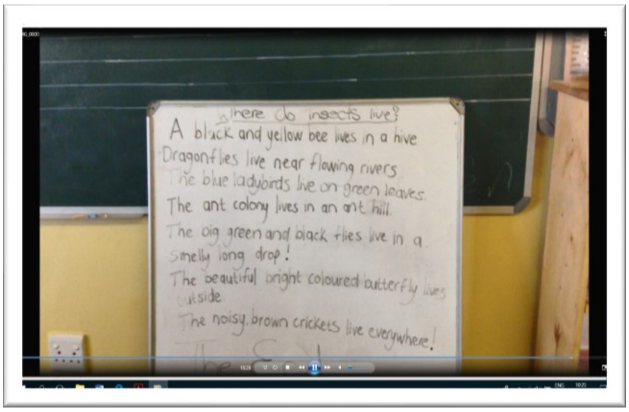

Figure 6.3: Removable/mobile white board

6.3.2 Teacher 2 (T2)

This is a female teacher in a quintile three (3) school, where the language of learning and teaching in Foundation Phase is IsiXhosa, a home language of learners in this school. This is a non-fee paying township[11] school and is comprised of grades R to 7. The school promotes discipline and respect, both amongst teachers and learners. This respect is also extended to the community around the school. The participant's classroom is arranged in such manner that it promotes group work and engagement between learners. Each group has eight learners seated in pairs. The desks are facing the teacher's working table in front of the class, which is next to the chalk board. The walls are covered with posters, which promote learning and focus on all three Foundation Phase subjects.

Figure 6.4: Teacher 2's classroom arrangement

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[11] Township Schools are classified as under resourced schools and are mostly in quintiles 1 to 3.

At the back of this class there are boxes under the table full of recycled materials. There is a carpet and a small bookshelf that is used for reading purposes on the other side of the classroom. The recycling materials on the floor in front are resources for developing teaching and learning. The textbooks are packed on the windowsills of the class according to each Foundation Phase subject. Unlike T1's class, T2's class has 40 learners (girls and boys). This teacher has been teaching Foundation Phase for more than 35 years, and for most of her career she has been involved in *professional development* programmes. For successful learning, the participant believes in working together with parents and involving both learners and parents in her teaching.

Figure 6.5: Teacher 2's classroom arrangement

6.3.3 Teacher 3 (T3)

Participant 3 is also a female teacher from a quintile 3 school. Her school is in the center of the township, surrounded by houses and three other primary schools. It is one of the under-resourced schools in the district. However, the school is known for its performance in music. During choir competitions, for instance, this school is known for its success. As already highlighted in Section 4.5, this teacher has been teaching for 11 years and is also doing a master's degree in languages. Ever since she started her teaching career, she has never looked back. Similarly to T2, she has a class of 40 learners with both girls and boys. Her class is full of desks and chairs arranged in groups of six or eight learners in each group. Unlike T1, who has most of the basic resources in her class, this class is crowded with learners and there are less charts and pictures on the walls that can promote learning. When teaching, however, this teacher tries to bring resources by herself as the school does not have many teaching resources.

Figure 6.6: Teacher 3's classroom arrangement

The computer lab that the school has assists this teacher a lot as she is able to make some of the resources she needs, like worksheets assessment tasks. As already explained above, the classroom arrangement in this class is assumed to promote group work and sharing of resources when necessary.

Figure 6.7: Teacher 3's classroom

6.3.4 Teacher 4 (T4)

Teacher 4, like the other participants, is female and an IsiXhosa speaking teacher. She is in a quintile 4 school, the same category as T1. This school is known of its commitment to promoting good learning and teaching. Unlike schools 2 and 3, this school, like school 1, has its own scholar transport. This enables most learners to be transported to and from their homes. In addition, the school has a resource center or a mini-library with a television set and various teaching DVDs. This room is utilised to support classroom teaching. Like schools 2 and 3, the school is in the center of the township and is not far from the other two primary schools.

Figure 6.8: Teacher 4's classroom arrangement

This class is full of various resources that can be used to promote learning, there are charts, recycling materials and books. Again, the class has 40 learners; the same numbers as in T2's and T3's classes. Learners are arranged in groups facing the front of the class, where they can see the writing board. Each of these participants utilised their space of teaching differently, and yet there are similar classroom arrangements. Next, I give lesson summaries observed from each participant in this study.

6.4 Summary of lessons

In this section, I give short narratives of each lesson taught by the four teachers in this chapter. The narratives give a short description of each lesson, and these help to understand how the teachers taught each of the twelve lessons in this chapter. Teacher one (T1), taught the following topics: fruits, focusing on how to prevent fruits from changing colour, insects, focusing on anthills, and food, focusing on eggs. Secondly, teacher two (T2), taught the following lessons: characteristics of insects, life cycles, and plants, focusing on different types of leaves. Teacher three (T3), taught these topics: insects, focusing on the butterfly, healthy eating, focusing on fruits, and the topic of capacity, focused on volume and density. Lastly, teacher 4 (T4), taught the following topics: healthy eating, focused on food groups, animals, focused on insects, and the topic of disasters, focused on volcanoes and earthquakes. In addition, the figures used in this chapter narrate the activities that took place in each lesson.

6.4.1 Teacher 1

Teacher 1, as already explained in the preceding section, is the youngest of the four participants and has a Post Graduate Diploma in Foundation Phase. This participant is from a quintile 4 school.

Lesson 1: Fruits (1hour long)

Her first observed lesson was on *Healthy Eating*, focusing on the topic of fruits. This lesson started on the carpet. The teacher told a story of what happened the previous afternoon after she has gone home. When she left her peeled apple on the table, 'something happened'. She allowed her learners to guess or predict on what happened but eventually they all came up with fun but wrong answers. The apple had changed colour and she encouraged learners to suggest ways that can prevent this from taking place again. Hence, the main topic of the lesson was *how to prevent fruits from changing colour*.

Both the teacher and the learners decided on three solutions to be tested on which would work the best to prevent colour change in fruits. They had a lemon, some sugar and a salt solution. They tested these on three kinds of fruits; an avocado, a banana and an apple. For these three fruits, each group chose a different fruit to test or to work with. The teacher suggested that the experiments should be left until the next day. According to the teacher, in leaving the experiments overnight the learners were going to get the correct and the appropriate results from the experiment. The reflections on the experiment took place the following day. Throughout the lesson, both the teacher and the learners worked together and had different roles to play in this lesson. *From a story to a chemistry science lesson*, that is how I view this lesson. The pictures below show the activities that took place in this lesson.

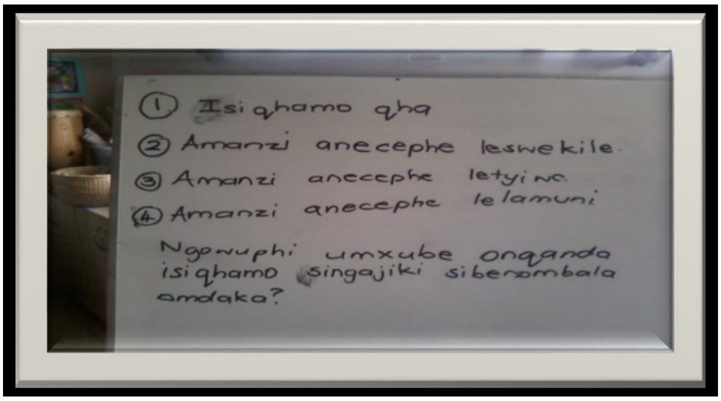

Figure 6.9: Instructions to guide the learners on what to do in Lesson 1

Figure 6.10: Testing which solution will work best to prevent fruits from changing colour

Lesson 2: Ants (50mn long)

Lesson 2 for this participant was on insects. She focused on ants and their homes. The previous day, she took her learners around the school and outside the school community, where they looked at different anthills. Learners were encouraged to look at the sizes, the shapes and how ants build their homes. Facts on why ants needed to build their homes were discussed in the previous lesson. Afterwards, learners were asked to collect different types of materials to use to build their own ant houses. They collected anything from sticks to small rocks and grass. For this lesson the teacher asked questions that connected the previous lesson and the present lesson. This was very helpful in reminding the learners on what happened the previous day.

The main activity of the observed lesson was for learners to build their own ant homes. In doing this, the teacher asked learners to group themselves and to design their ant houses on A4 paper.

Each group presented their design explaining the type of the materials they would use for their structures. Next, learners and the teacher went outside the classroom to build their structures. Learners needed to make sure that the structure could withstand the weather conditions and that ants would be able to come in and out to store their food. This lesson was indeed exciting for both the teacher and the learners. The pictures below show the different structures and work done during this lesson.

Figure 6.11: Building structure number 1

Figure 6.12: Building structure number 2

Figure 6.13: Building structure number 3

Lesson 3: Food-Eggs (50mn long)

As she always does, this teacher asked the learners to sit on the carpet and started to explain to themthe camp she thinks they might have as a class. However, as one of the things, she thought about what she needs them to have for a potato salad. She asked the learners how to prepare a potato salad and which ingredients she should have in order to make the dish. Her learners were excited about this, as some of them claimed to love the dish. Learners gave her several answers. As one of the learners mentioned an egg, the teacher was happy and confirmed to the class that in this lesson she wanted them to talk about using eggs when making potato salad.

Her next question to the learners was: *How does one boil an egg*? One learner explained that you put water in the pot and put your eggs inside until they boil; after some time you will know that they are cooked. The main task for this lesson was to investigate how to identify cooked eggs amongst uncooked eggs. The teacher narrated a *story* of how her cooked eggs mixed up with the uncooked ones while she was practicing to make a salad for their camp. She suggested two ways, to spin the eggs and to use salt and sugar solutions. In my view, the missed opportunity here is that T1 did not ask her learners to *think* of ways to identify the cooked eggs from the uncooked eggs. The two solutions had a *control*, which was clean water. Therefore, the teacher asked her learners to work in groups and in each group, they had to do the investigation.

Main investigation Question:

Which method can identify or tell which egg is cooked? (Ngeyiphi indlela enosichazela ukuba nagawaphi amaqaqanda avuthiweyo, kwezidlela zintathu?)

1. In each group learners had to spin the two eggs and see which egg spins faster than the other and what that means for each egg.
2. Learners had to put the two eggs in a salt solution and observe if there is any reaction in each egg.
3. Learners had to put the two eggs in sugar solution and observe any reaction between the two eggs.

4. For each case there was a control (clean water), where both eggs were put in to see if there is any difference.

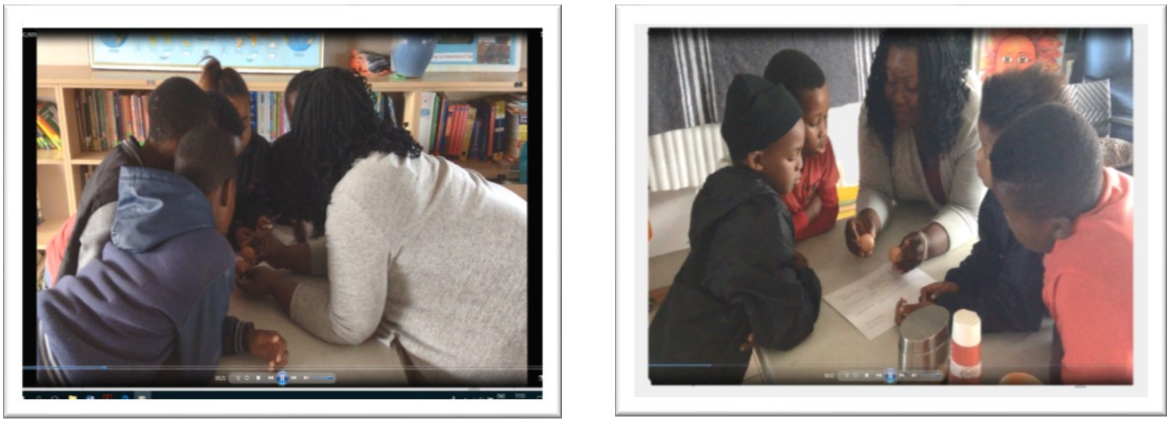

Figure 6.14: The teacher explaining the instructions during the investigation activity

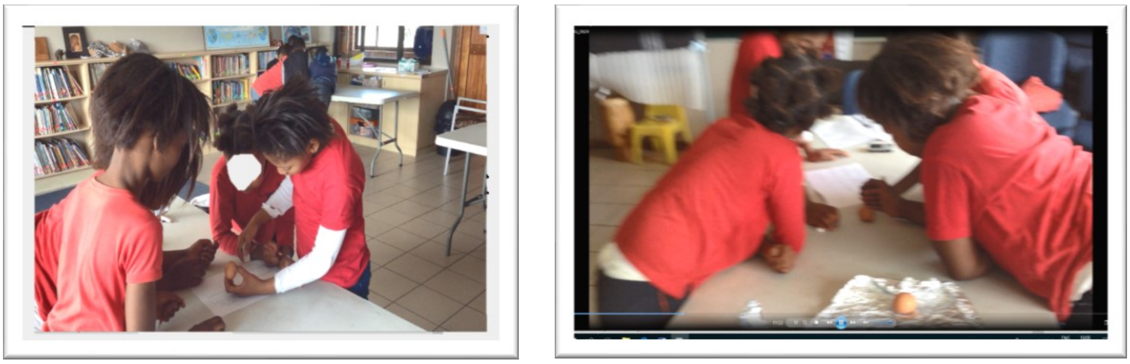

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Figure 6.15: Learners discussing the activity during the investigation task

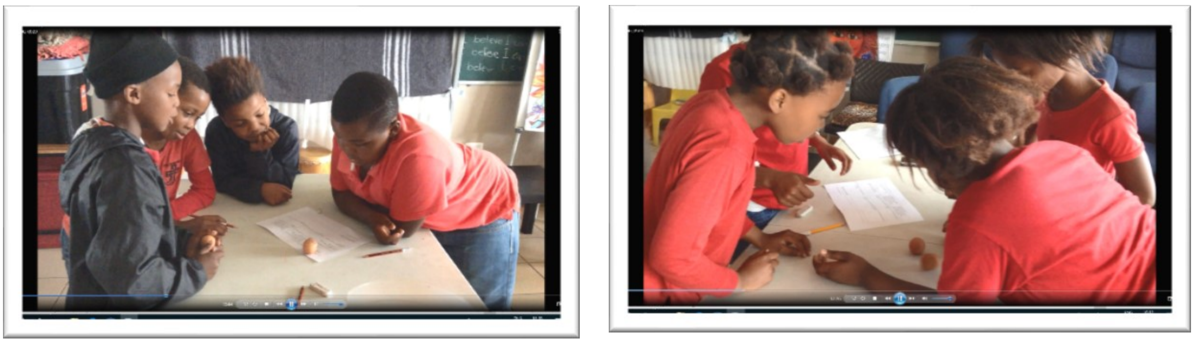


Figure 6.16: Learners observing their spinning eggs during the investigation

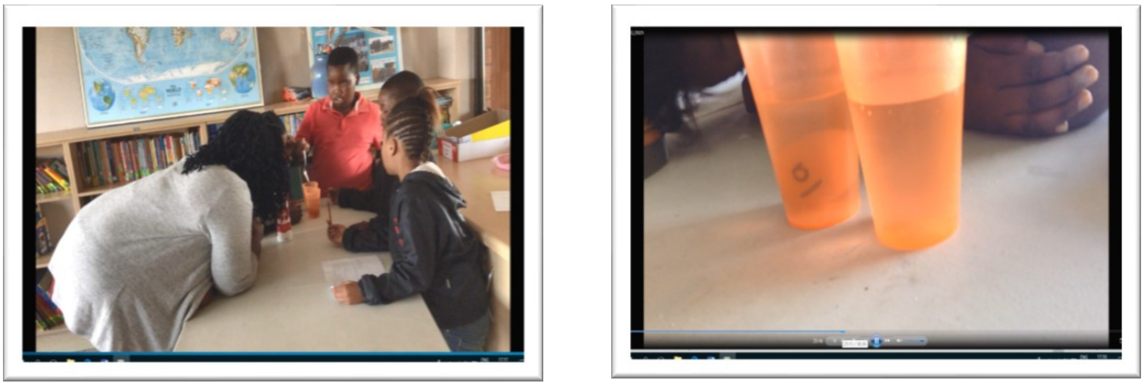


Figure 6.17: Observation of eggs in salt and sugar solutions

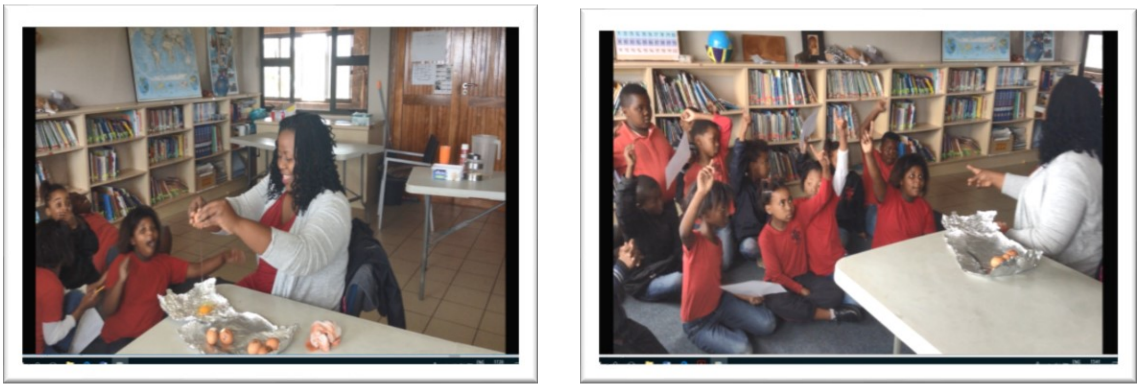


Figure 6.18: Demonstration, reflections and concluding results about the investigation

6.4.2 Teacher 2

Lesson 1: Characteristics of insects (1hr 10mn)

The first lesson for this teacher was about insects. She started the lesson by asking her learners if they knew anything about insects. Learners gave few names of the small animals they were familiar with from home. The teacher followed this by explaining what an insect is and asked learners if they understood the definition. The teacher's main focus in this lesson was for learners to understand the names of various insects, the definition of what an insect is, how insects differ from other animals, insects that learners are familiar with and to understand the body parts of insects. She did this by using insect models, which helped the learners to understand the characteristics of insects and how they are different from other small creatures.

For identifying and discussing the characteristics of insects using the models, she made her learners work in groups. To integrate *reading* and *writing*, a *story* about an ant was read by learners as a group. The teacher used this story as a vehicle for learners to narrate their own stories of those insects they knew from their homes. Secondly, she individually gave learners a task to match the names of the insects with the correct insects. In this lesson, the teacher made sure, through the writing and reading of names of insects on the board, that the lesson promoted language learning while teaching the topic of insects. She made the learners read the words continuously and spell them. She concluded the lesson by recalling and summarising the whole lesson and asked the learners a few questions to see if they understood.

Figure 6.19: A box with different models of animals to choose the insects from

Figure 6.20: Activities during lesson 1 (insects)

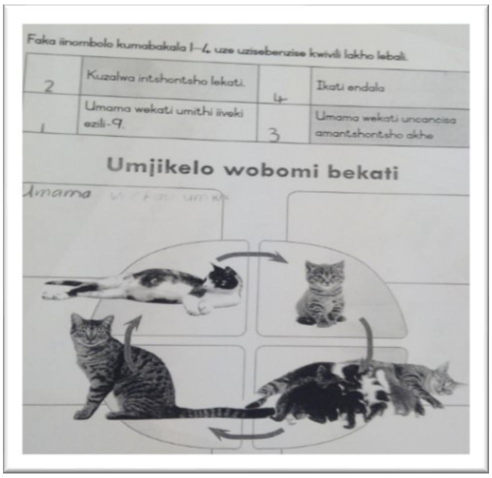
Figure 6.21: Learners reading a story about ants

Lesson 2: The life cycle (50mn long)

Lesson 2 was about the life cycles of different animals. To start the lesson the teacher asked questions that drew from the learners' understanding of the term, 'life cycle'. She followed by giving her understanding of the life cycle, giving an example about human growth. When she made this example, the learners understood what she meant by the word life cycle. She further made an example demonstrating how learners play hoola-hoop, reminding learners of how they play this *game*. This gave learners a clear understanding of the life cycle. Together the teacher and the learners demonstrated how to play hoola-hoop.

To teach the content on this topic, she firstly spoke about animal babies. Whether or not all animals give birth to babies that look the same as them was the second point of discussion in this topic. She continued by using posters that showed the different life cycles of animals. She used a butterfly, a frog, a chicken and a dog. The focus of the posters was to teach the content of the different life cycles of animals. Through discussion and engagement, she made sure that her learners understood how the life cycle works for animals. To conclude the lesson, the teacher gave learners activities to do individually. These activities were intended to enhance understanding of the topic taught.The figures below show the activities and the materials used in this lesson.

Figure 6.22: A demonstration of a life cycle



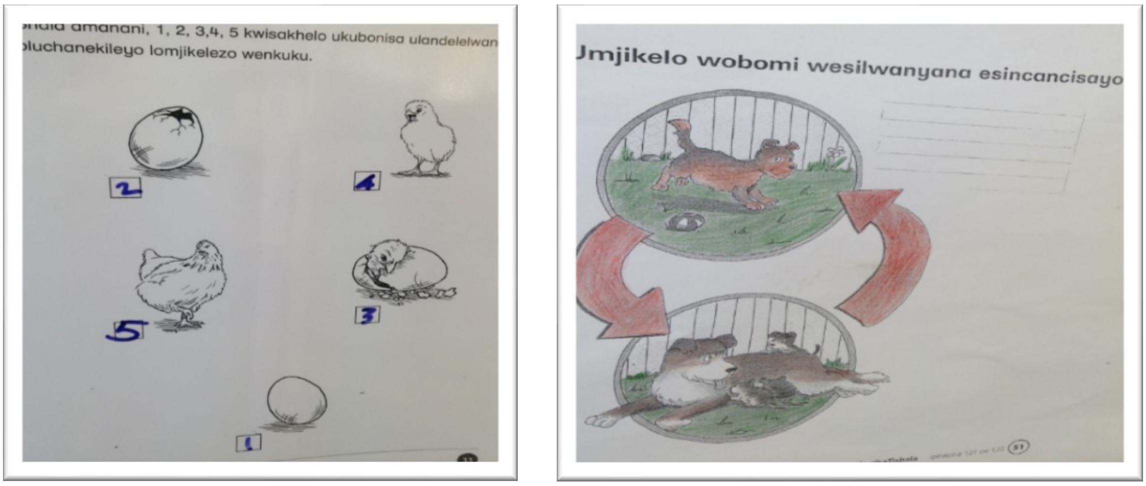


Figure 6.23: Diagrams of Life Cycles used in this lesson

Lesson 3: Plants (1hr 20mn long)

Lesson 3 was on plants. Similarly to the other two lessons, the teacher started this lesson by eliciting learners' understanding of plants. She encouraged learners to think of the different plants they knew. For effective teaching of this topic, she brought a plant to class and used various pictures of leaves and plants. Although this lesson was on plants, the larger part of it was on different types of leaves. In addition, she used various leaves to show the learners the different types so that they could see the differences. To engage her learners in this lesson, she took them outside the *school ground*. For the outside activity, the teacher grouped her learners according to the task she wanted them to do. The first group looked at tree leaves and had to describe the colour, the shape and the type of leaves in that specific tree. The second group looked at the shrubs around the school and did the same. The third and the last group did the same but worked with a different type of tree thanthe first group.

Afterwards, learners had to reflect and present their findings from their observations to the other learners in class. Each group had a group leader that was responsible for making sure that everyone participated in the activity. For the next and final activity, learners had to do the following: draw leaves using paintbrushes and paint and summarise their findings of their outside task and to label the parts of the plants. In conclusion, the teacher summarised the whole lesson, reminding learners of what they learnt. The figures below show the activities that took place in this lesson.

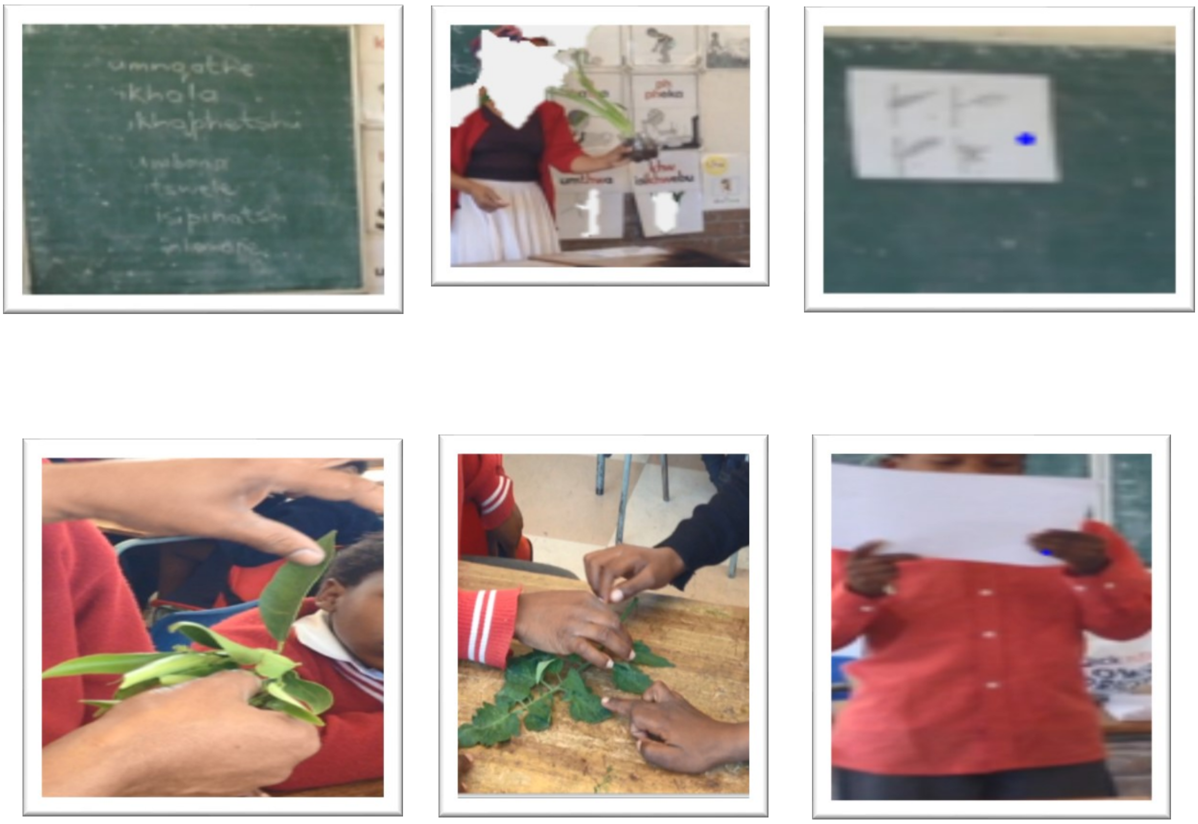


Figure 6.24: Teacher and learner activities for lesson 3 of teacher 2(T2)

6.4.3 Teacher 3

Lesson 1: This lesson was on insects focusing on the butterfly (1hr)

To begin the lesson, the teacher laid out papers with various pictures of different insects and asked her learners to look at the pictures and establish what was on the pieces of paper. Learners were asked to identify what was on the paper and they collectively answered '*Izinambuzane*' (Insects)." She then posed a question to her learners; "Why are you saying that these are insects?"

The learners attempted to give various answers such as, *they are small*, *some of them can fly* and *others crawl and walk, and others are poisonous*. Interestingly, the learners agreed that the butterfly was also poisonous. To start teaching about the characteristics of insects this teacher asked learners about whether a crab was an insect or not? A group of learners agreed that a crab was an insect. She then continued to explain to her learners about the texture of its exoskeleton which is hard and rough. This discussion was left without any concluding remark as to whether or not a crab was an insect.

Figure 6.25: Teacher and learner activities for lesson 1 of teacher 3(T3)

The teacher then focused on the butterfly and asked the learners to point out a butterfly amongst other insects. It was enthusiastically pointed by a learner. She posed another question, asking whether or not butterflies are helpful to humans. Learners attempted answering by saying it helps with flowers and planting new ones. Learners basically talked about the cross-pollination process. Learners also said that butterflies eat other insects such as mosquitoes. The teacher added that, butterflies have an anti-repellent poison that kills insects such as cockroaches, flies and other irritating insects. It kills them with the powdery substance on the surface of their bodies. She also told her learners that butterflies prefer the spring season because it is warm, and plants are beautiful.

Figure 6.26: Teacher 3, writing sentences about how butterflies are useful to humans

Teacher 3 continued to explain about the helpfulness of butterflies; how they also help to determine whether one's flower garden is clean or not, because even if one's garden is beautiful and filled with bright flowers, if there are no butterflies then it is a vivid indication that the garden or the soil is not clean. Butterflies do not stay in dirty environments. Butterflies also help with showing changes in the weather, when it is cold you rarely see them but when it is warm you find them flying around. She then moved on with the lesson and talked about the birth of butterflies, explaining how butterflies are not born as butterflies, but are born firstly as eggs and that overtime eggs change their form. She carefully explained this in detail to the learners. She drew on the chalkboard and divided the board into four squares, with each square illustrating the stages of the butterfly's life cycle.

Figure 6.27: Teacher 3, explains the life cycle of a butterfly

She then explained that butterflies, unlike some other animals that give birth to eggs, do not build nests but rather lay their eggs on top of leaves. Some eggs are circular, and some are oval shaped, she explained. She drew a distinct comparison between chickens and butterflies; she said butterfly's eggs are closer to each other and stay like that until the caterpillar stage. She then emphasised that it takes 5 days for the eggs to hatch. As she explained this process of transformation of the butterfly, she had pictures of those stages and showed the learners exactly what she was talking about. She explained to them how the patterns on the wings of the butterfly are formed in stage 2 of the birth and transformation of the butterfly. She explained that in stage 3, the caterpillar rests and eats a lot in this stage. It camouflages its outer body to protect itself from predators and humans. In stage 4, she highlighted that the butterfly needs to pump blood into its wings for it to be able to fly. She compared this to humans who have veins pumping blood to various parts of the body. Finally, to conclude the lesson, she went back to the mating process where the male butterfly meets a female butterfly and the cycle starts all over again, ensuring the survival of the butterflies through the process of reproduction. She then tasked learners to do an activity in pairs about the stages of the cycle of the butterfly to show that they understood the lesson.

Lesson 2: This lesson was on fruits, focusing on different fruit types and their characteristics (50mn)

The teacher started this lesson by asking learners about the different food groups that learners knew of. She continued to ask her learners to name various fruits they knew. This was an introduction that lead to the actual lesson.

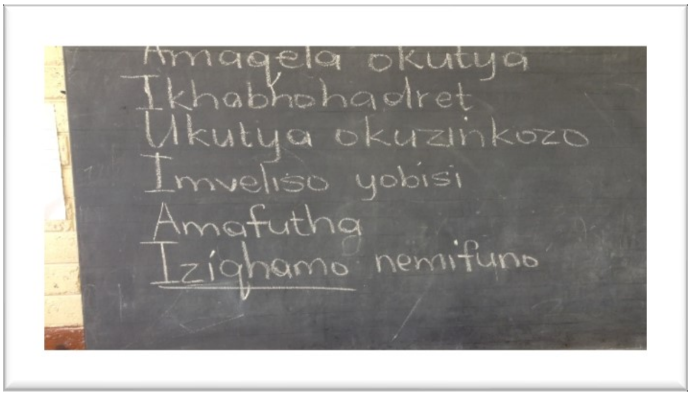


Figure 6.28: Teacher 3, introducing a lesson on fruits

She had three types of fruits in her plastic bag. She continued to explain that the lesson was about looking at and identifying the characteristics of different fruits and how these fruits help people. The six groups in class had to choose which fruit they had to work with, and this meant that two groups were focusing on one fruit type. She had the paw-paw, the kiwi fruit and the pineapple fruit. These were divided in half so that each group had a fruit to *observe*. Before the actual observation of each fruit, the teacher asked learners to identify the fruit they were not familiar with and they pointed out the kiwi-fruit. This was exciting for those who worked with this type of fruit as they were curious to find out about it.

Learners had to look at the shape of the fruit, the texture of the fruit, the size of the fruit and how the fruit looked inside. In this lesson the teacher made sure she gave questions to allow her learners to work in groups and investigate each fruit, so that they found answers on their own. Each group of learners had to choose one learner that was to present their findings to other learners in class. The presentation was based on each fruit that they worked with.

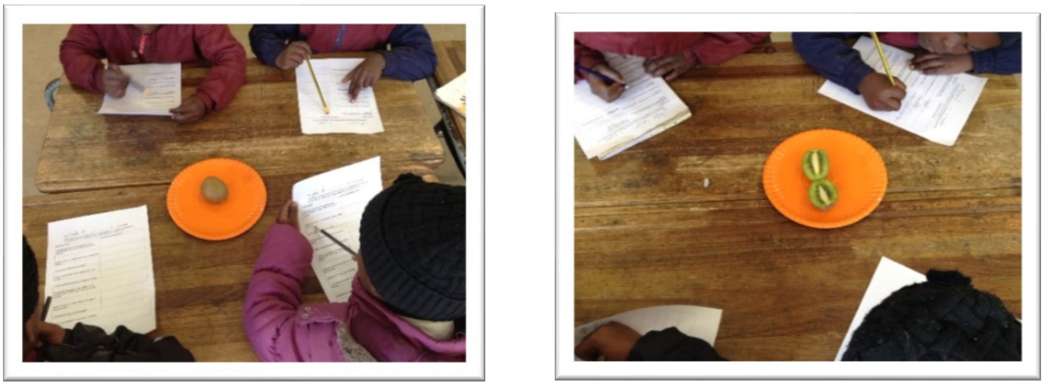


Figure 6.29: Teacher 3, learner activities about the characteristics of the three fruits

The last activity on this lesson was based on how these fruits help people and what nutrients people get from these fruits. The teacher further explained that there are certain fruits that one ought to peel before eating them, whereas some fruits only need to be rinsed and can be eaten with their skin on, as these fruits' skins have some health benefits. After each group presented their observations and findings, the teacher concluded the lesson by summarising the health benefits of eating these fruits, and an activity on this was given to the learners.

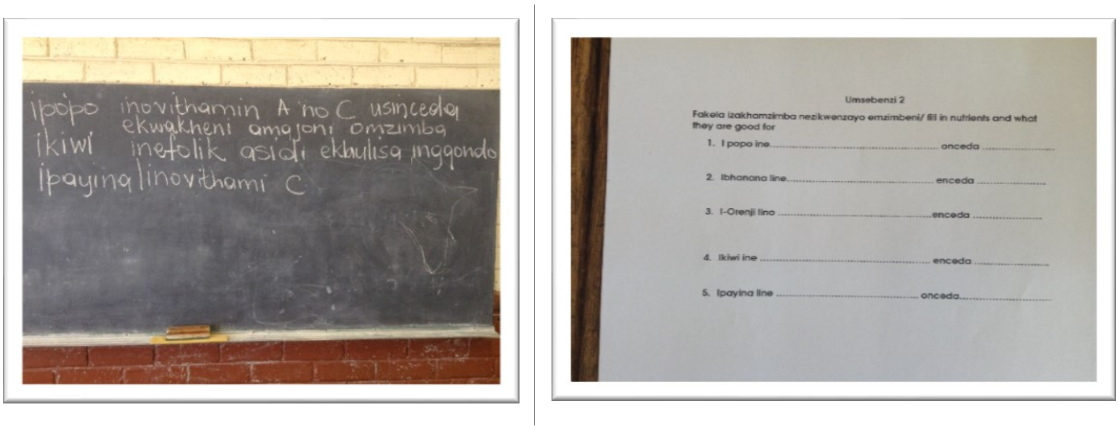


Figure 6.30: Teacher 3, learner activities on health benefits of eating the three fruits

Lesson 3: This lesson was on density, focusing on volume and mass (50mn)

This lesson was derived from a mathematics lesson focused on the concept of volume and mass. According to this participant (T3), the CAPS document stipulates that teacher need to concentrate on the concept of measurement, which is about the units of litres, mililitres, grams, kilograms and centimeters. The teacher decided to integrate this topic with Life Skills so that volume, capacity and mass from mathematics could make more sense to her learners. She explained the concepts using the native language of learners, which assisted her learners in understanding the concepts and the terminology.

Learners explained density as *ukuxinana, ukusondelelana, ukufuthaniselana kwezinto eyenziwe ngazo lo nto kubhekiselwe kuyo*. To conclude the lesson the teacher proceeded to ask questions, *enjengoba, ukuxinana kwento ngaphakathi, ingaba kunamiphumela mini na, kubunzima okanye ubukhaphukhaphu bayo? Ingaba ukuxinana buyabuchaphazela ubunganani (size) bento?*

The above questions and discussions were about the concept of density and how it relates to mass. Below is a brief structure of how this lesson was taught by this participant (see Table 6.2).

Table 6.2: Lesson 3 on density, focusing on volume and mass

Teacher	**Learners**
Introduction: Unpack the two terms, sink and float, by asking from the learners what they mean.	Discuss and answer questions in their groups.
Plenary: Groups share their description of the 2 terms (teacher asks questions for more clarity and adds more information if any left out.)	Report back and listen and answer questions as per need.
Prediction: Ask them what the objects are, if they think they will sink or float, and record. Probe for reasoning.	Naming objects, predicting and recording if they will sink or float.
Plenary: Groups share what they discuss in their various groups (Teacher uses questions where more explanation is needed, to clarify certain points/facts.)	Report back, listen and answer questions if needed.
Body: observation stage:	Observe and record.

Ask them to observe as the teacher puts the objects in the bowl of water, one by one, and record what they see.	
Thinking/reasoning stage: Ask them to think of reasons why certain objects sank or float. Could be a group discussion /pair discussion.	Think and discuss/rationalise.
Plenary: Share findings and reasons for what was observed and discovered. (Teacher asks and adds any information that may be left out.)	Report back, listen and answer questions if required.
Conclusion: Teacher explains density. Lightly dense and heavily dense. Weight might come in; linked to Maths. Ask them to write what they have learnt.	Listen, ask questions and write information learnt.

6.4.4 Teacher 4

Lesson 1: This lesson was on healthy eating focusing on different food groups (1hr)

The lesson was on healthy eating, and particular focus was given to different food groups. To introduce the lesson, the learners were asked about the different food groups they knew, and the teacher wrote them down on the chalkboard. The different food groups that were mentioned were; vitamins, dairy, proteins, fats, sugars and carbohydrates. The teacher had set out different food products on the countertop in the front of the classroom; the food products ranged from cereal and fruits to pilchard cans. She asked her learners to help her group these different products into their correct food groups. She asked for volunteers from the class to firstly put all the carbohydrate food types on one side of the countertop, and a learner stood up and demonstrated their knowledge by putting all the carbohydrates on one side. Some of the products they were asked to name were corn flakes, oats, weet-bix, bread and potatoes.

Figure 6.31: Teacher 4, learner activities on food groups (materials used for the lesson)

They were then asked to choose the different protein foods; eggs, beans and pilchards were part of the protein food group. Vitamins were the next group that was sorted, and learners took fruits like apples, pears, and cucumbers. Next were dairy food products, and the learners put aside a tub of yoghurt, a carton of milk and moved on to the last food group. For fats and sugars, learners put aside margarine, oil and a bar of chocolate. Out of all the products that learners grouped into their respective food groups, they were left with one food product which was a packet of peanuts and raisins. Learners were told by the teacher that that particular product was a combination of two different food groups, proteins and vitamins, because the peanuts were rich in protein and raisins were a source of vitamins because they come from grapes.

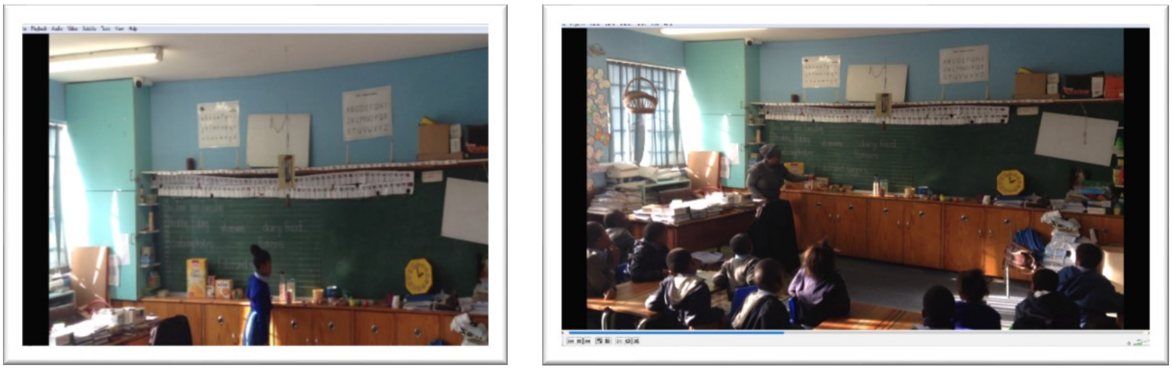


Figure 6.32: Teacher 4, learner activities on food groups (learners and the teacher grouping the materials as per required food groups)

After all the food products were grouped, the teacher asked learners about how these different food groups help people when they eat them. She started with carbohydrates and a learner answered, saying, "*Carbohydrates help give us energy.*" They moved on to vitamins and they said that vitamins help people to protect themselves against illnesses, and proteins were said to make people strong. Lastly, dairy foods help people with two things; they make both teeth and bones to be strong. As the lesson drew to a conclusion the teacher handed out papers to the learners so that they could do an activity individually to show that they understood what was taught during the lesson; the different types of food groups and their benefits. The activity had different foods; for example, potatoes, onion, fish, bread, rice, milk and beans, and learners had to choose a food and list it under the correct food group. In the second part of the activity, learners had to write down the function of each respective food group.

Lesson 2: This lesson was about insects, focusing on different characteristics of insects (1hr)

To start the lesson the teacher asked her learners to name the different insects that they know, and she wrote them down on the chalkboard; ladybird, ant, bee, dragon-fly, praying mantis, the grasshopper and many more. She then continued with the lesson and hung up a big poster or chart on the chalkboard that had images of almost all the different insects known to mankind. There was a disagreement initially when the learners were naming insects. For example, when one learner called the caterpillar an insect, the classroom disagreed with her, but when the poster was up the class discovered that the learner was correct about the caterpillar. The teacher promised to further explain this to her class at a later stage of the lesson.

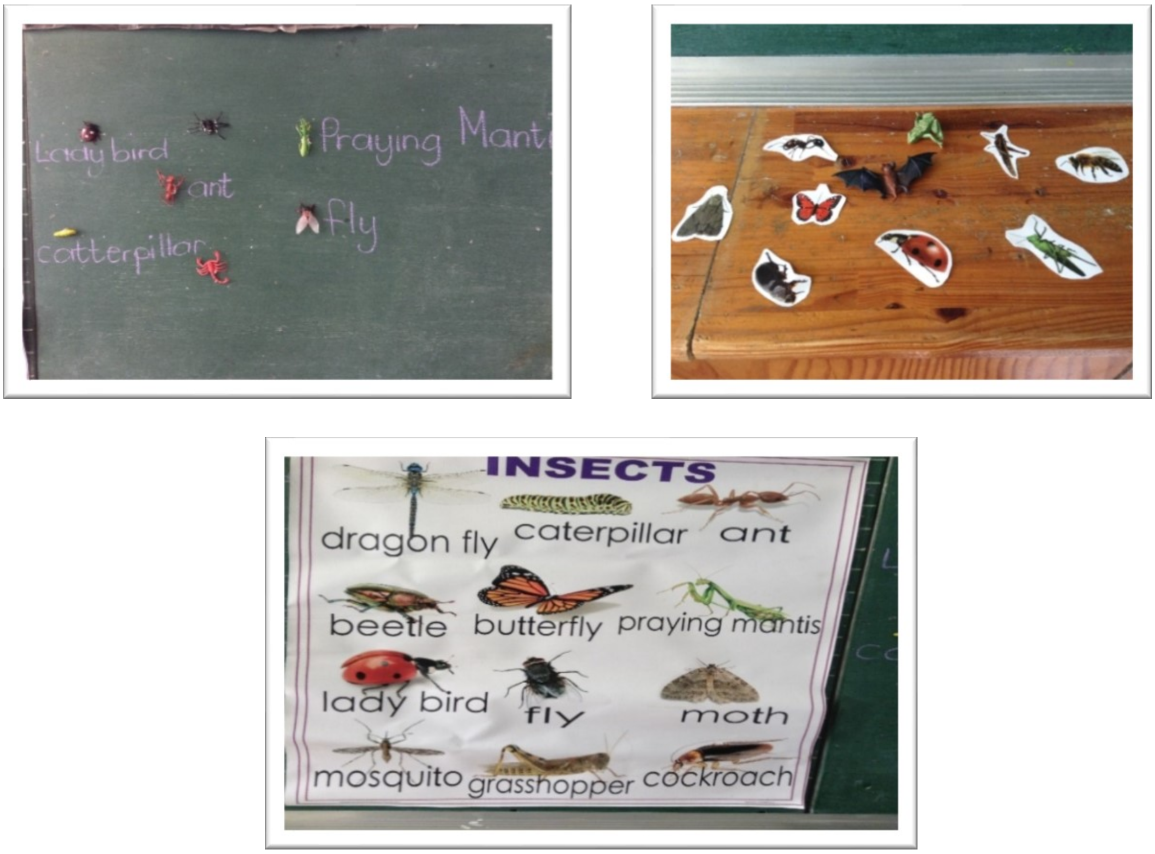


Figure 6.33: Teacher 4, teaching materials on insects used for lesson 2

She asked for two learners to come forward to the front of the class to draw insects on the chalkboard; one learner volunteered, and the second learner was instructed to do the same. When finished with their drawings, they were asked to tell the class what the name of the insect they had drawn was. One learner had drawn a butterfly and the second learner had drawn an ant. The learners were then instructed to refer to their workbooks and turn to the instructed page (p.33). On this page they were told that there is a drawing of a dung beetle and they had to work in pairs to *read* all the labelled body parts of the dung beetle. Learners were told to carefully study all the body parts of the dung beetle, and this was done for a short while. The next instruction was to *count* the body parts of the dung beetle. Afterwards, a learner was asked to go to the chalkboard and label any body part they remembered from the worksheet, which the learner did.Other learners correctly labelled the head, eyes, legs, exoskeleton, upper body (thorax), lower body (abdomen) and the tail of the insect on the board.

To conclude this part of the lesson, the teacher recapped what she taught to make sure the learners understood the body parts of insects. Next, the teacher used insect models and asked her learners to individually name the insects. They left out two of the models, not labelling them based on their knowledge that insects have 6 legs and not more. As a result, the scorpion and the spider were not labelled as they both have 8 legs. The teacher explained that those that have 8 legs and above are not insects, but that they are called arthropods. As the lesson drew to an end, she then handed out worksheets that she wanted the learners to complete that would demonstrate that they understood what was taught in the lesson.

Lesson 3: This lesson was about natural disasters, focusing on volcanoes and earthquakes (50mn)

The lesson was on different kinds of natural disasters, focusing on volcanoes and earthquakes. The lesson started with the teacher asking her learners to mention the different types of natural disasters they knew and normally heard about. Learners mentioned lightning, hurricanes, storms and volcanoes. As already highlighted, the teacher particularly focused onvolcanos and earthquakes. She explained the differences between a volcano and an earthquake.

She continued to focus more on the volcano, explaining what it is. She told learners that volcanoes are mountains of connected melted rocks under the earth’s surface. A volcano happens under the ground, unlike an earthquake which happens on the earth’s surface. Explosions under the earth’s surface shoot out gas rocks, lava and ash out of the mountain.

After the eruption, it can cause mud slides and earthquakes. This is how the teacher explained the two natural disasters.

Part of the lesson on natural disasters was an experiment or modelling about the eruption of a volcano. Set out in front of the learners were apparatus that they used to carry out the experiment about volcanoes. Each group had their own demonstration and with the assistance of the teacher learners had to work as a group to make their own volcano. As part of the task, learners were asked to go *outside the classroom* to gather moist soil, fill up their dishes with it and then followed the teacher's instructions to do their models of how a volcano erupts.

Figure 6.34: Teacher 4, teaching materials and activities in lesson 3

6.5 Data Presentation and Discussions of lessons Taught

As highlighted in Section 6.2, this section presents data for research question 2. This question is the key focus of this research study. The data from these four teachers illustrate how the mediation process (Vygotsky, 1978) took place during the science lessons, using an Inquiry-Based Approach to develop the basic Scientific Process Skills in four Foundation Phase (FP) Grade 3 classrooms. In Phase 3, Chapter Four, I explained the purpose of lesson observations in this study.

As defined by Cohen et al. (2018), observations can enable the researcher to access interactions in a social context and yield systematic records of these interactions in many forms and contexts and to complement other types of data. The observed and videotaped lessons assisted me in understanding the strengths and the challenges faced by Grade 3 Foundation Phase teachers in both the teaching of science and in using an inquiry approach in their classrooms. Thus, using Vygotsky's concepts together with the analytical framework (see Tables 10 & 11 in Chapter 4), in this section I present data from the observed and videotaped lessons. Table 10 explains Vygotsky's socio-cultural concepts adapted in this study. These concepts, together with the analytical framework, helped me see each participant's understanding, strengths and challenges in using an Inquiry-Based Approach to teach basic Scientific Process Skills in their classrooms.

As already explained in Section 4.7, the analytical framework had three sections. Section A is comprised of Zaretskii's six conditions that can be considered when developing learners' Zone of Proximal Development (ZPD) during mediation in the classroom (Zaretskii, 2016). In this study, this refers to how the participants develop learners' ZPDs when using an inquiry approach in their classrooms. Section B, had two sub sections; sub-Section 1, the principles of inquiry approach, helped me to understand the teachers' strengths and/or challenges in using this approach in their classrooms (Pollen, 2009; Tunnicliffe, 2013; Worth, 2010). Sub-Section 2: the actual basic Scientific Process Skills that have to be considered when using scientific inquiry approach (Bosman et al., 2016; Kidman & Casinader, 2017; Lederman et al., 2014). Lastly, Section C: the components for transformation of knowledge. These components assisted in understanding the teachers' Topic Specific Pedagogical Content Knowledge

(TSPCK) in using an inquiry approach in their classrooms (Mavhunga & Rollnick, 2013; Mavhunga & Rollnick, 2017).

To start with, I present data from teacher 1's three observed lessons. Subsequently, I present teacher 2, 3 and 4's observed lessons. For each teacher, the presentation of data is in accordance with the analytical framework used in this study. Then, using the adapted concepts from the socio-cultural theory together with the emerged findings from the analytical framework, I discuss the findings from the four teachers in this chapter.

6.5.1 Data presentation for Section A of the analytical framework

Using the analytical framework, I present and discuss data from the four participants. In these discussions and data presentation, I use the terms teachers and participants interchangeably. To start with, I present data using Section A of the analytical framework, which looks at how the participants mediated learning to develop their leaners' understanding of basic Scientific Process Skills. Section B of the framework looks at the principles of the inquiry-based approach and, lastly, Section C is on the teachers' Topic Specific Pedagogical Content Knowledge. In each section, I start with teacher 1 and then follow with teachers 2, 3 and 4.

6.5.2 Summary of findings for Section A of the analytical framework

As already discussed in Sections 3.1 and 4.7, Section A of the analytical framework assisted me in understanding how the participants through the mediation process, used an inquiry approach to develop learners' basic Scientific Process Skills and were able to develop the learners' ZPDs during the teaching process. The above-mentioned section of the analytical framework identifies the findings on how teachers used the activities and their teaching methods to develop the ZPDs of their learners during the mediation process in the observed lessons. The six conditions are the indicators for developing learners ZPDs during teaching and learning (Zaretskii, 2016). I used the six conditions as a mirror to understand which conditions the participants implemented and how they were utilised, if so, to develop learners' ZPDs during the observed lessons. Additionally, I used these conditions because of their relation to and alignment with the principles of an Inquiry-Based Approach, which is the focus of this study. Other than their relation to the principles of an inquiry-based approach, the six conditions were very important in this study as they speak strongly to the concepts of mediation, social interactions, zone of proximal development and the concept of culture in this research study (Vygotsky, 1978; Zaretskii, 2016).

Through group work (joint activities), at some level, these teachers allowed their learners to share their views and understanding of activities (see Figures 6.11, 6.13, 6.16, 6.20, 6.24 & 6.28). The joint activities, the role played by teachers, the role played by learners and the cooperation between learners and teachers, all promoted and presented the aspects of social interactions in the observed lessons (see T1L1, T1L2 & T1L3) and (T2L1 & T2L3). Again, teacher 3, in her lessons, and in the same manner as T1 and T2, interacted with her learners. T3, in her lessons 2 and 3, promoted joint activities and working in groups. In addition, T3 engaged her learners through a question and answer method to encourage the interaction between herself and her learners (see T3 L2 & T3 L3). However, T3's lesson 1 purely used a question and answer method between the teacher and individual learners, which did not promote the use of joint activities. Throughout her lessons, T4 used joint activities that did not adequately promote, or support inquiry-based learning. According to Zaretskii, condition 1 is the most critical step that teachers need to consider in the learning environment. He stipulates that the adult, the teacher in this case, needs to build trust and comfort with their leaners, in this case to trust him or her in a learning environment. To make sure that learners fully understand the instructions or the activity at hand, is the teacher's responsibility. Failure to do so might result in failure to implement the other five conditions (Zaretskii, 2016, p.155).

The data from the four teachers revealed that they are different when it comes to the implementation of the first condition. For instance, T1, in all her three lessons created a space for both her and the learners to discuss the task before doing it. This resulted in her learners being part of the lesson, engaging in the asking of questions and contributing to design of the investigative questions for the practical investigations across the three observed lessons (see Figures 6.5 & 6.14). On the other hand, T2, T3 and T4 did not implement the same strategy as T1 in their lessons. In all their observed lessons, they were the ones coming up with instructions, and they gave these instructions to the learners without including their perspectives in the design of the activity. Moreover, to introduce their lessons and to make sure learners understood the activities, they often used a question and answer method (see Figures

6.4; 6.18; 6.26 & 6.31). In my view, the question and answer method that they used to introduce their lessons was fair and good; however, there were missed opportunities where their learners could have engaged further in the topic taught with their peers and with the teacher. For example, T4, in her lesson about food groups, could have allowed her learners to present their own understanding of these in groups and give their examples. T3, in her lesson of insects, could have given learners a chance to compare the characteristics of insects and further engage learners about insects. Similarly, they could have picked up some misconceptions that the learners had about those specific topics. Below, in Box 6.1 (see Appendix N for English translation), I present the scenario from lesson 1 in which teacher 1 made sure in each activity that her learners understood the instructions and understood clearly what to do. Before starting the activities, she made sure that the learners clearly understood the activities. Unlike T2, T3 and T4, this strategy helped T1 to understand her leaners' views about the topics to be taught and further assisted her in clarifying any misconceptions her learners had.

Box 6.1: T1 making sure learners understand the instructions of the activity

Teacher:	Sifunu khangela ntoni Luyolo?
Learner:	Sifunu khangela ngeyiphi esebenzayo
Teacher:	ekuthinini kaloku? Lingo?
Learner:	(…) ukwenzela iziqhamo isuke lanto
Teacher:	Isuke? Sizafaka esinayo? Sithini Sbaj
Learner:	sifunu kwazi Miss bana ngeyiphi eyona eyenza iApile lijike libebrown
Teacher:	Uthi uSbaj sifunu khangela yeyiphi ebangela uba iApile lijike libeBrown, uthini wena Lelo?
Learner:	Ndifunu yazi ngeyiphi eyenza isiqhamo sijike Miss
Teacher:	Okay, uthini wena Nqgiz
Learner:	Ndifunu yazi Miss ngeyiphi enceda iApile lingajiki libe Brown
Teacher:	Sifunauyazi ngeyiphi ebangela ukuba iApile lethu lingajiki libe njani?
Learners:	Libe brown
Teacher:	Ngoba mna xandijonge lonto ndibawela uyitya?
Learner:	Hayi
Teacher:	So ndifuna ligcineke lingajiki libe?
Learner:	Brown
Teacher:	Libe brown, Kodwa umbuzo wethu yeyiphi kwezi? Okanye ngowuphi umxube onqanda isiqhamo singabi njani?
Learner:	Brown
Learner:	Hayi
Teacher:	Jonga ke uright xa uyibiza nge English kodwa ke siyifuna ngesiXhosa ngoku, ngoba siyibhale ngesixhosa, singabi njani?
Learner:	Mdaka
Teacher:	Isiqhamo singabi mdaka, singajiki sibe mdaka
Learners:	Mdaka…
Teacher:	Mamela ke khanithetheni kulo group yenu ngubani ozakubhala, ngubani ozaku jonga ixesha, ngubani egruphini yenu ozaku thini kanene… ozawunqunqa
Learner:	Ndim
Teacher:	Suveluthi ndim xoxani ngoba abanye kaloku nabo bafunu kwenza
Learner:	(Abantwana bayaxoxa)
Teacher:	Ngobani abaphethe iAvacado?
Learner:	Nabaya Miss
Teacher:	Inani Banana, inani Apile ~ ozakubhala uzawubhala ngebanana nhe
Learner:	ewe

Condition 2, conversely, is that for development to occur, teachers need to allow learners to take full responsibility for their work. This implies that the learner should be the legitimate agent of overcoming difficulties and reflecting on the activity (Zaretskii, 2016). Again, as highlighted in Section A of the analytical framework above, the four participants did not present the same understanding of this condition. T1, across her lessons, encouraged her learners to be fully responsible for the practical activities performed in class. In doing this, the teacher employed shared roles and responsibilities among learners. T1 allowed and encouraged her learners to take full responsibility in conducting the activities – see Box 6.2 (see Appendix

N for English translation). For instance, they asked questions when necessary and their teacher asked them to present their findings. Consequently, the participant worked collaboratively with her learners (see Figures 6.10-6.14).

Box 6.2: Teacher 1 below, sharing roles for the activity among her learners

Teacher: "*Nibengamaqela, and iqela ngalinye lizakuba nomntu ozakujonga xesha libe nomntu ozakubhala phantsi nzakuninika iphepha lokubhala nzanicacisela elaphepha ngelothini, igruphu yokuqala nguLuyolo nguLingomso nguLuphumlo noAnothando khanindixelele nifuna ukusebenza ngantoni nina? Dibanani niyixoxe ke dibanani niyixoxe. Sinalo Mihlali K no Asonwabisi ningu gruphu2 nina, Mihlali Nqginzi Lithemba LinamandlanoSibabalwe niyenye igruphu, khawuleza nixoxe uba nifuna usebenza ngantoni*" (TIL1).

In Box 6.2 above, the teacher instructed her learners to work in groups and divided them to share the responsibilities of the given task. Learners responded positively to this sharing of work; they also assisted each other and willingly shared the responsibilities among themselves. Teacher 2, in Box 6.3, introduced her lesson and made sure learners understood the topic. As explained above, she used the question and answer method approach (teacher-centered approach). While introducing the lesson, she directly asked learners about their understanding of the topic. In doing so, she asked them to draw from their everyday understandings or experiences. The disadvantage of the above-mentioned method is that it does not accommodate all learners; only the individual learners that participated.

T2, because of the nature of her lessons 1 and 2, was not able to implement Zaretskii's conditions, which also align with the principles of inquiry approach. The question and answer method she employed (Box 6.3 – see Appendix N for English translation) when teaching the content did not allow her to share responsibilities with her learners. In lesson 1, for instance, she asked learners to read a *story* of an ant, and only one learner read for the group (see Figure 6.17). In identifying the characteristics of insects, the teacher only gave one model per group. In my view, a missed opportunity in this lesson was the fact that this participant could have allowed her learners to share their ideas about the characteristics about insects. This knowledge could have been drawn from the leaners' prior-knowledge as well as their experiences. The groups could have used the models to compare the insects, allowing all learners to be involved in her lesson.

Box 6.3: Teacher 2 using a question an answer method to introduce and to teach the content

Teacher:	Likhona eli gama elithi umjikelo wakhe waliva pha ekhaya kuthethwa ngomjikelo okanye nadlalisa nalithetha eligama elithetha ngomjikelo? ukhona umntu onokulizama othi ha a Mam ingathi ndkiyaliqonda kancinci mna.
Learner:	Zizinto ezifanayo, zizinto ezingafaniyo,
Teacher:	uthi zizinto ezifanayo nezingangafaniyo omnye uthini? Ndixelele ngoluhlobo ucinga ngalo uba inoba umjikelo yintoni? Okanye ubom inoba yintoni une chance kengoku undixelele Amyoli ingathi uyadlalisa wena ukhona umntu ofuna ukuzama?
Learner:	(…) zizilwanyana ezifanayo
Teacher:	Uthi zizilwanyana ezifanayo ebesithini uOyama yena? Uthi zizinto ezifanayo nezingafaniyo omnye uthini?
Learner:	Yinto ekhulayo
Teacher:	Uthi yinto ekhulayo, iyakhula makhe sisuke kulanto ikhulayo inoba mhlawumbi kwenzeka ntoni apho sixelele kaloku lento uyicingayo inoba mhlawumbi kwenzeka ntoni apho.

Likewise, in her lesson one (L1), T3 did not provide a space and opportunity for her learners to take full responsibility for the activity at hand. The lesson was more about the teacher explaining the life cycle of a butterfly to her learners (see L1 of T3). In this lesson, learners had minimal responsibility and roles to play. Inquiry-based approach, in the same line with the theory used in this study, promotes shared roles between the teacher and the learner. It is argued that teachers need to create a space for learners to take full responsibility for their work. Similarly, T4, throughout her lessons, took the leading role where she was more explanatory in her lessons, and this minimised the opportunities for her learners to be engaged in the activities. In addition, T3, in her L1, and T4, in all her three lessons, missed opportunities to effectively use an inquiry-based approach.

However, in her lessons 2 and 3, T3 used a different method (see L2 & L3). Her learners were engaged in her lessons, working in groups with each other, with her guidance as the teacher. In these two lessons, there was a clear distinction between the role of a teacher and the role of leaners. She made her learners understand the instructions and made them to take full responsibility for their work, T3 guided learners through questions and gave them clear instructions on what to do and how to present their findings or results back in class.

Condition 3 states that the child-adult interaction throughout the activity is collaborative, with an adult acting as an assistant to the main protagonist (Zaretskii, 2016; Vygotsky, 1978). In the case of this study, the child or the protagonist is the learner and the adult is the teacher. All four participants individually presented different understandings of a collaborative activity. For T1, collaborative activities were presented through investigation activities. She helped learners to understand the activity and worked with each group to make sure all were at the same level (see Figures 6.13 & 6.14). With T2, the collaborative aspect only came through lesson 3, where the lesson was on plants. She created a space for her learners to work collaboratively with her and shared responsibility among learners (see Figure 6.20). Instead, as already stated in condition 2, T3 only allowed her learners to work collaboratively in her L2 and L3 (see Figure 6.28 and L3). T4 had many opportunities that she could have used to allow her learners collaborate; the aspect of collaborative work teaches the learners about how scientists work together. For this participant, in my view, neglect of collaborative work amongst her learners was one of the missed opportunities in her lessons. Again, instead of guiding her learners and probing her learners to develop basic Scientific Process Skills, T4 focused on individual learners and missed the opportunity for them to assist each other.

The fourth condition is that development results from the child's autonomous activity and his or her reflection of it, carried out with the adult's help and support. In this regard, as already specified in the third condition, the collaborative aspect of the activity between the teacher and the learner should be of assistance to the learner. The independent activities that a learner does, with the guidance and support of a teacher, result in development (see T1L1, T1L2, T1L3, T2L3, T3L2 and T3 L3). In the highlighted lessons, for instance, learners gained knowledge and understanding of some basic Scientific Process Skills. This was through the support of a teacher, the method or the approach the participants used and the materials that learners had to engage with in the participants' lessons.

Through the above stated activities (condition 4), a learner can make a step in development through "owning" modes of action implanted in cooperation with the teacher and through reflecting on his or her own shared modes of actions (condition 5) (Zaretskii,2016). The lessons observed for T1 clearly gave evidence of how she, through cooperating and engaging with her learners, developed their understanding of basic Scientific Process Skills and, through her questioning skills, 'pruned' them to be creative thinkers. This took patience and planning on the teacher's part, as well as an understanding of the topics to be taught in each lesson. T1 also took advantage of her space and the environment of her school and turned it into an inquiry space for her learners (T1L2).

Similarly, in her lesson 3, T2 used the same opportunity in her school. Teaching about the different types of leaves and their characteristics afforded T2 to use the school ground and environment for her learners to explore. These strategies implemented by these teachers gave their learners the opportunity to understand that learning is relevant to everyday life, and science is about everyday life. Equally, T3 and T4, in their lessons, brought materials that were mostly familiar to their learners. In contrast, unlike the other three participants, T4 did not use an inquiry approach as much as she could have. Yet, to develop her learners' basic Scientific Process Skills, the materials and the resources T4 had were perfect tools to do so.

Lastly, the sixth condition indicates that in the course of joint activities aimed at overcoming challenging situations, development may emerge in several areas simultaneously (p. 155). T1, in her activities with learners, has evidently showed how she allowed learners to work together and with her during activities. According to Zaretskii (2016), if teachers or adults implement the six conditions effectively, they afford learners an opportunity to take a step in learning which in turn leads to a hundred steps in development. Zaretskii used a flower model or metaphor to represent the effect of learning in development; the buds in a plant do not flower at the same time and therefore teachers need to understand that learners are not the same and not in the same ZPDs. This suggests that how teachers nurture the buds of learners for development in learning in vital. In addition, comparing and contrasting the four participants' ways of mediating learning of the basic Scientific Process Skills, T1, because of her contextual and professional background using the six conditions of mediating learning, was able to actively work with her learners throughout her lessons. After watching T1's videotaped lessons, however, T2 and T3 did try to make an effort to follow a similar strategy. In my view, this was evidence of how important the teacher's role is when using an inquiry approach in their lesson.

6.5.3 Data presentation for Section B1 of the Analytical Framework

Next, I present data for Section B of the analytical framework. Section B is two-fold. Part 1 of this section represents the principles of an inquiry approach and Part 2 represents the basic Scientific Process Skills that need to be developed when implementing inquiry approach. In identifying the principles in each lesson taught by the four teachers, I thus explain how each teacher used each principle (if any) to develop basic Scientific Process Skills.

6.5.4 Summary of findings for Section B1 of the analytical framework

This section of the analytical framework assisted me in understanding and observing how the participants implemented or used an inquiry approach in their science lessons. I used the principles of an inquiry approach as lenses to identify and to understand the strengths and the challenges faced by teachers in implementing this approach in their classrooms. As alluded to in Section 6.1, Kidman and Casinader (2017) identify an inquiry-based education as a method that requires an intensive knowledge of pedagogy. This implies that teachers' knowledge, the understanding of their learners and their understanding of science pedagogy are critical (Halverson, 2007). The principles of an inquiry approach assist teachers in dealing with the expectations of how to implement this approach. The principles of an inquiry-based approach further set out the stages that teachers need to consider when using this approach (Kidman & Casinader, 2017; Worth, 2010).

Principle 1 looked at the starting point of the lesson. It indicates that the starting point should be what learners already know, suggesting that teachers need to draw from learners' prior knowledge (Kuhlane & Ngcoza, 2015). In Zaretskii's conditions, the above part of the framework condition 1 and this principle both look at how the teacher sets the scene for learners. Again, the last part of the framework looked at how teachers taught each lesson in relation to the five components of the topic specific pedagogical content knowledge (Mavhunga & Rollnick, 2013) and in this research, this talked to the use of an inquiry-based approach by these participants. Consequently, the sections of the framework complemented and supplemented each other.

All four participants, from their observed lessons, to introduce them and to apply the understanding of the topic taught, drew examples from learners' experiences. T1 introduced her lessons using a story telling method. She additionally used resources that were familiar to her learners; in lesson one, she used fruits, vinegar, lemon, water, sugar and salt. In her lesson 2, she used the school environment, soil, stones, sticks and leaves. In the third lesson, she used eggs, water, sugar and salt. This made learners feel comfortable, relaxed, and free throughout her lessons. She created a relaxed atmosphere and a calm environment for her learners (Worth, 2010).While utilising these kinds of resources and drew from the learners' everyday socio-cultural context (Mavuru & Ramnarain, 2017; Vygotsky, 1978); this strategy enabled her to teach the basic Scientific Process Skills in a non-threatening manner.

Similarly, T2, T3 and T4 started their lessons by asking learners to explain their understanding of the topic to be taught, or by asking questions that drew from the learners' context. Even though these participants mostly used a question and answer method, their questions drew from the everyday knowledge of learners. The resources used for teaching in their observed lessons were also familiar to the learners, and in this way, learners were able to relate, as well as when they were given an opportunity to bring examples from their homes. For example, T2 used models of familiar insects and the school surroundings, focusing on trees and leaves in the schoolyard. T3 did the same in her lessons; she brought fruits, pictures of insects and, in her last lesson, used calibrated jars, a scale, water and glasses as teaching resources. Lastly, T3 also used familiar resources to the learners and these assisted in engaging learners in a relaxed environment. However, the depth of how each participant used the resources and learners' prior knowledge in their classrooms varied from each participant. Below, in Boxes 6.4 and 6.5 (see Appendix N for the English translation).

Box 6.4: Lesson introduction for T1L1

Teacher:	Ndifunutyi apile lam
Leaner:	Hayi alikho Mam
Teacher:	Uthi wena alikho nhe, inoba liphi?
Leaner:	Lityiwe nguMakhulu
Teacher:	(uyahleka) haha okay! wena?
Learner:	Lityiwe ngu ~Taka hlehle.
Teacher:	Uthi lityiwe ngutaka hlehle heeee yhooo abantu basendlinam nibenza njani, uthini wena Mihlali?
Learner:	Lityiwe zimpuku Mam
Teacher:	Lityiwe zimpuku and ezampuku zikhona nangoku bonanje azikahambi, uthini wena Lingo?
Learner:	Ndithi ba umhlambi ela apile lithathwe ~ ligrunywe ziimpukane.
Teacher:	Ucimba nawe ligrunywe… jonga nzakuxelela akhomntu uthathe iApile lam ke ndikuxelele, because abantu ndiyabaxelela ukuthatha into yomntu kuthini ^?
Learners:	Bubusela (Abanye: Kukuba)
Teacher:	Bubusela so akhomntu uthathe into zam! Kodwa khawujonge into eyenzekileyo
Learners:	Hayi (bekhuza) (Abanye: libolile
Teacher:	Libolile?
Learners:	Ha a Mam
Teacher:	Litheni?
Learner:	Lijike icolour
Teacher:	Lijike umbala,linjani bendilisike linjena dan?
Learners:	Ha a Mam
Teacher:	Lijike umbala, nicingi ntoba inokuba kutheni lijike umbala^?
Learners:	Kuba kudala lihleli Mam

Box 6.5: Lesson introduction for T2L3

Teacher:	kodwa khandixelele yintoni isityalo? Ungathi yintoni wena isityalo ^ kaloku umntu uyathetha lento ayicingayo ukuba yiyo Christina ucinga ukuthi yintoni isityalo?
Learner:	Yintyatyambo
Teacher:	Suyibiza sichazele yintoni isityalo? Uzathini?
Learner:	Isityalo yinto ekhulayo
Teacher:	So isityalo yinto ekhulayo, very good! Isityalo yinto ekhulayo noba iyintonini igama layo?
learners:	Isityalo yinto ekhulayo

Principle 2 of an inquiry approach looks at how teachers encourage learners to fully own or understand the question or the problem they need to solve. As already explained in the framework, T1 made sure that learners worked in small groups and shared responsibilities among themselves (Vygotsky, 1978). Figures 6.10 to 6.14 give a clear view of how the teacher encouraged her learners to take ownership of their work. T2, as highlighted above, gave clear instructions on activities. However, in her lessons 1 and 2, there were no practical investigations; only in lesson 3, where learners had to fully observe and compare the phenomena they were studying. Similarly to T2, group work activities in her lesson 1 were oriented only on the use of a picture (see Figure 6.24) where learners had to choose insects. Referring to an Inquiry-Based Approach and basic Scientific Process Skills, this teacher could have extended this activity by asking learners to compare the insects and to look at the characteristics of insects by themselves. As the researcher, I see this as a missed opportunity from the teachers' side to use an inquiry approach in developing her learners' basic Scientific Process Skills. T4, as already highlighted in other sections of this chapter, in all her three lessons did not fully or adequately used or implemented an inquiry approach, nor adequately developed her learners' basic Scientific Process Skills. Due to the nature of her lessons (see Figures 6.30; 6.31; 6.32 & 6.33), she had opportunities to use an inquiry approach and to develop basic Scientific Process Skills in her learners.

Principle 3 encourages direct hands-on experience with the phenomena to be taught. In this case, principle 3 stipulates the importance of drawing content from the learners' environment in which they live and allowing learners to have a direct observation. All four teachers drew from the learners' environment and prior knowledge. Teacher 1's first lesson was on fruits and she did an investigation. In lesson 2, she used the materials and the resources from the school environment. Lesson 3 was in the same vein as the other two lessons. Teacher 2 did the same; she used materials that were familiar to her learners, and so did teacher 3 and 4. In this principle, the four teachers differed on how practical activities or hands-on activities were used, with regard to an inquiry approach and development of basic Scientific Process Skills.

Principle 4 encourages the use of secondary resources to supplement or to support the practical or direct hands-on activities of learners. When it comes to principle 4, all four teachers used secondary resources to support their teaching activities. It was clear that they planned the lessons taught. How they explained the content, how they planned and used the materials in their lessons were evident in their planning and understanding of the topics and content taught. Again, in this principle, the participants varied on how they used secondary resources to supplement the teaching and learning, with regards to development of basic Scientific Process Skills and the use of an inquiry approach. The other five principles do give an overview of how each teacher taught the science components and developed these skills.

Principle 5 puts an emphasis on the need for language argumentation to be developed in the context of science. Thus, discussions during the lessons should develop scientific debates and discussions. T1, T2, and T3 at some point implemented discussions in their lessons. T4, alternatively, used a question and answer method in her lessons. What was different for the three participants was the method or the pedagogy used to encourage scientific discussions. T1, for instance, encouraged discussions through group activities, through investigations or practical activities and through the question and answer method. In contrast, T2 encouraged or promoted science related discussions through question and answer method, where she drew from learners' understanding. It is only in lesson 3, the last observed lesson, where she extended the discussions to be among learners themselves.

Again, T3, like T2, mostly used a question and answer method in her first lesson, while in her second and third lessons she extended the language argumentation through hands-on practical activities. Principle 6 encourages learners to work in small groups, as science is a cooperative endeavor. When it came to the implementation of this principle, the four teachers were at different levels. For instance, T1, throughout her lessons, planned and taught scientific investigation or practical activities. T2 did not constantly teach and plan her lessons using group activities nor even scientific investigations. Her lessons varied in implementing the principles of inquiry approach. However, in her third lesson, this principle was explicitly explored and engaged with (see Figure 6.23).

T3, in her lessons 2 and 3, engaged with and implemented this principle, while in her lesson 1 she did not. T4, as explained and discussed in the above sections; she limited herself for not utilizing group activities and yet her lessons had a space and opportunity to do so. Principle 7, the last principle demands the importance of developing and teaching basic Scientific Process

Skills. Inquiry skills in this research are referred to as the Scientific Process Skills that Foundation Phase learners should acquire when taught from the Beginning Knowledge Study in the Life Skills subject. Below in Table 6.5, I thus present how each participant developed or taught basic Science Process Skills in the observed lessons.

Box 6.6: T4's Lesson on food groups

Teacher:	To recall, what are we going to do?
Learners:	Recall.
Teacher:	Recall about the different fruit groups that we have learnt in the previous lesson, okay?
Learners:	Yes, Miss.
Teacher:	Now, I have got all these different food types here. Can you tell me what kind of food groups that you remember? ^ Okay! Can you remind/can you recall these are the kinds of food groups that we are having in front of me different kinds of food groups in different kinds of foods, can you give me one food group that you know? Lune?
Learners:	Vitamins
Teacher:	Lune is saying we've got vitamins
Learners:	/ Learners greet someone who entered their class room.
Teacher:	And then give a second type of food group that you know, don't call me I'll call you, Kosi?
Learner:	Dairy fruit
Teacher:	Kosi is saying dairy fruit, somebody please help us, and somebody please help us.
Learner:	Dairy food
Teacher:	Somebody please help us, they are trying guys uhm there are people who are (…) Someleze?

6.5.6 Summary of findings for Section B2 of the analytical framework

In Section 2.7, I highlighted the Department of Basic Education's expectations towards teaching of science in the Foundation Phase (DBE, 2011). In the Life Skills curriculum, the following basic Scientific Process Skills are highlighted: *observation*, *comparing*, *classifying*, *measuring*, *experimenting* and *communication* (DBE, 2011). It is for this reason that my study explored the development of basic Scientific Process Skills. However, in my analytical tool in Table 6. 5, two more skills are included which are *inference* and *prediction*. These skills are a foundation for learners to understand the nature of science at an early stage of schooling, and these skills are building blocks for the upper skills (Kidman & Casinader, 2017; Pollen, 2009).

In developing and teaching basic Scientific Process Skills, the teachers' role is critical (Halverson, 2007; Kidman & Casinader, 2017). During the process of scientific inquiry learning, it is important for teachers to guide their learners, hence the importance of their role (Worth, 2010) (see Section 2.5). In the analytical framework, I thus present data on the basic Scientific Process Skills taught from the four participants observed lessons. T1, throughout her three observed lessons, demonstrated the understanding of doing experiments or practical activities when using an inquiry approach. Through her teaching, she showed evidence of an understanding of focusing on the cognitive, the conative and as effective domains when teaching science (Johnson, 2005). The skills of observation, comparing, measuring, inference and communication using practical investigations, were taught at various levels in her lessons. Figures 6.11, 6.12, 6.13 and 6.14 give a clear indication of how T1 taught in her lessons (L1, L2 & L3).

In contrast, T2 used a different approach in her L1 and L2. The activities were not fully inquiry orientated. In lesson 2, the observation, comparing, classifying and communication skills were partially developed and taught through activities or tasks. The basic Scientific Process Skills were taught in L3, and the activities were scientifically orientated as she encouraged her learners to compare, observe, and classify leaves according to their group, shape and size. Figures, 6.15, 6.16, 6.17, 6.18 and 6.19 present how T2 taught her learners across her lessons (L1, L2 & L3).

Teacher 3 focused her first lesson on insects; however she also covered the life cycle of a butterfly. In this lesson, she did not teach or develop many basic Scientific Process Skills. Nonetheless, the observation skill came out more clearly when learners were asked to observe the picture of insects that was given to them. The rest of the lesson was done through the question and answer method, and this promoted communication skills in some but not all learners. Lessons 2 and 3 were partially inquiry lessons. It seems the teacher designed these lessons as investigative or practical lessons. In lesson 2, learners worked in small groups, investigating characteristics of fruits (see Figure 6.28). Learners developed the skill of observation, comparing and, through group discussions and during presentations, learners developed the skill of communication. However, lesson 3 was a demonstration lesson where the teacher did all activities by herself and engaged learners through questions (see L3).

Lastly, T4 in her 3 lessons the skill of observation and comparing were clear (see Figures 6.30, 6.31, 6.32 & 6.33). By not allowing her learners to engage in group discussions or setting tasks in groups, her learners were deprived, I believe, of an opportunity to learn basic Scientific Process Skills. It is thus recognised that the level at which each teacher used the inquiry skills in their lessons spoke to their understanding of the method.

With regards to the use of an inquiry approach and development of basic Scientific Process Skills, below I discuss how the four participants transformed knowledge of skills and content in their learners.

Box 6.7: T3's Lesson on the topic of insects

Teacher:	Right! Yabonake bantwana bam asizobe siphinde sithethe ngokutya kengoku siyagqitha kenamhlanje, **sizothetha ngezinambuzane**. Ukhona umntu onondixhelela yintoni isinambuzane?
Learner:	Yimbovane
Teacher:	Suyibiza kaloku ndixelele ba yintoni kuzakufika umakhulu abuze yintoni isinambuzane? Ukhona umntu onondixelela? Allright ndifuna ke nimamele today, Isinambuzane yinto okanye sisilo esincinci kakhulu esihambayo kodwa asinamathambo sinemilenze, nina ke bantu bathanda unyathela kuthi krum krum amathambo xaninyathela impukane nembovane?
Learners:	No Miss
Teacher:	So isinambuzane sisilo esincinci Mingaphi imilenze?
Learner:	Mibini.
Teacher:	Nazi izandla uthini omnye?
Learner:	Mine.
Teacher:	Isinambuzane sinemilenze emine okanye emibini?

6.5.7 Data presentation for Section C of the analytical framework

As already discussed in Chapter 3, Section 3.3 and Chapter Four, Section 4.7 pedagogical content knowledge (PCK) of teachers for the teaching profession across disciplines, including science, has become a popular hallmark (Juttner & Neuhaus, 2012). With regards to teaching of the curriculum, disciplines have a different and a specific nature of the teaching methods or strategies, hence the importance of not generalising the topic specific nature of PCK. In this research, PCK is related to the participants' understanding and the use of an inquiry approach in their classrooms. Again, their understanding and development of basic Scientific Process Skills in their learners. I observed the four participants teaching science topics (see Table 6.1), and the main goal of this study was to explore how Foundation Phase teachers mediate learning using an inquiry approach in developing basic Scientific Process Skills in their grade 3 classrooms. It was within the goal of the study that, as espoused by Shulman (1986), transformation of knowledge in each topic taught was crucial.

How each teacher implemented the inquiry approach, understood her learners' contexts, understood the school context, and understood each topic and the materials or resources used in the observed lessons, was crucial in the effectiveness of knowledge transformation. Section C of the analytical framework assisted me in identifying and discussing how T1, T2, T3 and T4 drew from learners' prior knowledge (LPK) if so and how they used it to clarify misconceptions or to strengthen their teaching of the concepts taught. Curricular Saliency (CS) was the other component; how teachers made clarity of challenging concepts or drew from the previously expected and taught content to make sense of the current topic, was important. In addition, how they dealt with what was difficult to understand (WDU), the use of representations (RP) in making the topic clear to the learners and conceptual teaching strategies (CTS), were crucial components of the framework.

Table 6.3: Section C of the analytical framework

T1 & T2' s components for transformation of knowledge in their lessons

(Adapted from Mavhunga & Rollnick , 2013 and Mavhunga & Rollnick, 2017)			
CATEGORY	CRITERIA	COMMENTS (T1 & T2)	
Learner Prior Knowledge (LPK)	What learners already know; includes common misconceptions known in a topic.	**Lesson 1, 2 & 3:** • Used fruits • Anthills • Used eggs • Used houses as examples • Asked learners' experiences about the topic (L1, 2, 3)	**Lesson 1, 2, & 3** • Used models of insects • Used plants • Asked learners' experiences
Curricular Saliency (CS)	Refers to the identification of the most important meaning of the major concepts in a topic, without which understanding of the topic would be difficult for learners. It also includes the knowledge to logically sequence the learning and the knowledge of pre-concepts needed prior to teaching a topic.	**Lesson 1, 2, 3** • Understanding what can be used to prevent colour change • Understanding how the house is built • Understanding how to test cooked and uncooked eggs	**Lesson 1, 2, 3** • The content was taught through giving explanations and descriptions
What is difficult to understand (WDU)	Refers to gate keeping concepts which are difficult to understand often because they cause conflict with previously established understanding.	**Lesson 1, 2, 3** • Explained all instructions clearly, the use of discussions (Teacher and the Learners), stories clarified misconceptions • Question and answer method used to clarify misconceptions. • Following up with questions and drawing other learners in discussion helped with clarification of misunderstanding	**Lesson 1, 2, 3** • The teacher explained all instructions and defined concepts where necessary.
Representations (RP)	Refers to a combination of representations at *macro*, *symbol* and *sub-microscopic* levels that may be employed to support an explanation.	**Lesson 1, 2, 3** • The use of a representation of an apple, to show how an apple has changed colour • Use of diagrams and drawings to make sense of the task	**Lesson 1, 2, 3** • To make her learners to understand, models, diagrams and pictures were used by this teacher.

Conceptual Teaching Strategies (CTS)	Refers to teaching strategies derived from the considerations made from the other components and excludes general teaching methodologies.	**Lesson 1, 2, 3** • Learners explained their work/diagrams to the teacher • Teacher and learner interactions to clarify concepts • Learners to explain their thoughts and give reasons for their conclusions	**Lesson 1, 2, 3** • Allowed learners to reflect on their findings
T3 & T4' s components for transformation of knowledge in their lessons			
CATEGORY	CRITERIA	COMMENTS (T3 & T4)	
Learner Prior Knowledge (LPK)	What learners already know; includes common misconceptions known in a topic.	**Lesson 1, 2 & 3:** • Used pictures of insects • Used fruits • Used water, blocks and stones • Asked learners' experiences about the topic (L1, 2, 3)	**Lesson 1, 2, & 3** • Used models of insects • Used Pictures of insects • Used boxes and containers of cereals • Asked learners' experiences
Curricular Saliency (CS)	Refers to the identification of the most important meaning of the major concepts in a topic, without which understanding of the topic would be difficult for learners. It also includes the knowledge to logically sequence the learning and the knowledge of pre-concepts needed prior to teaching a topic.	**Lesson 1, 2, 3** • Understanding what can be used to explain density, floating and sinking concepts • Understanding how to explain various differences in fruits	**Lesson 1, 2, 3** • The content was taught through giving explanations and descriptions, she mostly used question and answer method.
What is difficult to understand (WDU)	Refers to gate keeping concepts which are difficult to understand often because they cause conflict with previously established understanding.	**Lesson 1, 2, 3** • Explained all instructions clearly, the use of discussions (Teacher and the Learners), actual fruits, resources clarified misconceptions • Question and answer method used to clarify misconceptions. • The use of a diagram in lesson 1, helped learners to understand the life cycle of a butterfly.	**Lesson 1, 2, 3** • The teacher explained all instructions and defined concepts where necessary. However, the learners were not adequately engaged.

Representations (RP)	Refers to a combination of representations at *macro*, *symbol* and *sub-microscopic* levels that may be employed to support an explanation.	**Lesson 2 and 3** • The use of a of actual fruits, to show differences in fruits, • Use of diagrams and drawings to make sense of the task (butterfly-life cycle)	**Lesson 1, 2, 3** • To make her learners to understand, models, and pictures were used by this teacher.
Conceptual Teaching Strategies (CTS)	Refers to teaching strategies derived from the considerations made from the other components and excludes general teaching methodologies.	**Lesson 2 and 3** • Learners explained their work/diagrams to the teacher • Learners to explain their thoughts and give reasons for their conclusions	**Lesson 1, 2, 3** • The use of question and answer method was clearer and did not use other strategies that could have enhanced her teaching.

6.5.8 Summary of findings for Section C of the analytical framework

The framework above, illustrates how the participants used the topic specific pedagogical content knowledge (TSPCK) components. In the case of this study, TSPCK was used as a component of the analytical framework and it assisted in understanding the teachers' methods in using an inquiry approach. For all participants (T1, T2, T3 & T4), learners' prior knowledge seemed critical (Kuhlane & Ngcoza, 2015). That is, all four teachers, when starting their lessons and when making inferences, drew from learners' prior knowledge. T1 and T2 (LI, L2 & L3), to introduce lessons, always asked learners to refer to their experiences from home. Explaining and discussing the terminology, the two teachers drew from daily experiences of learners. For example, T2, in her second lesson, asked learners to explain the term 'cycle' and encouraged them to think of their homes.

> *Likhona eli gama elithi umjikelo wakhe waliva pha ekhaya kuthethwa ngomjikelo okanye nadlalisa nalithetha eligama eligama elithetha ngomjikelo? ukhona umntu onokulizama othi ha a Mam ingathi ndkiyaliqonda kancinci mna (T2L2)***.**

Similarly, T3 and T4, also drew on learners' prior knowledge. The resources that they used in their lessons were familiar to their learners (see the above section of the analytical framework). However, regarding the use of prior knowledge of learners, all four participants differed in their level of engagement with it and with their learners. Drawing from learners' everyday knowledge when teaching encourages learners to see the link between what is taught at school and what takes place in their surroundings (Asheela, 2017). Again, prior knowledge of learners can help teachers to identify and correct the misconceptions that they might have about the concept being taught (Roschelle, 1998).

In the components of curriculum saliency, what is difficult to understand, use of representations and conceptual teaching strategies, the four teachers were at different levels or ZPDs. For instance, when mediating learning of concepts, T2 and T4 used mostly the teacher centred approach, which does not align with the principles of scientific inquiry approach, nor the socio-cultural theory that informed this study. To explain the content and the concepts, they used the question and answer method. However, both teachers used the tasks for learners to strengthen the understanding of the content. It was only in the last lesson that T2 presented most of the components of TSPCK, the principles of an inquiry approach and the components of socio-cultural theory.

On the other hand, T1 presented her lessons showing the understanding of her learners' contexts, the curriculum content and learners' level of thinking. She used *stories* to draw learners' attention and to make them critically think about what was taught. She further used representations, engaging her learners to think and engage in a discussion that promoted science language in learners (T1L1). The methods and the strategies she used spoke to the components of TSPCK. Teacher 3, in her lessons 2 and 3, partially used the TSPCK components as she tried to accommodate all learners through group activities and through the question and answer method. Using demonstration in L3 and practical activities in L2 assisted her to touch on each component (see T3L2 and T3L3). The next section discusses and summarises the overall findings using the socio-cultural theory as it informed the study.

6.6 Discussions and Findings

Vygotsky's socio-cultural concepts were adapted for this study. The overall actions by each teacher in mediating the development of basic Scientific Process Skills when using an Inquiry-Based Approach in their classrooms were observed and aligned according to Vygotsky's theory that underpinned this research (Vygotsky, 1978). That is, I presented the data in relation to the concepts adapted from socio-cultural theory in this study. As already explained and discussed in the preceding chapters (Chapters 1 and 3), Vygotsky's socio-cultural theory concepts align well with the adapted analytical framework and resonate with the aim of this study; hence, the discussion of the findings in relation to literature on inquiry-based approach, literature on TSPCK and socio-cultural theory.

In phases 1 and 2 of this study, I collected data using questionnaires and semi-structured interviews. The data from these methodological instruments were used as a foundation to understand the participants' perspectives and understanding about the use of an inquiry approach and the development of basic Scientific Process Skills in their classrooms. Phase 3, lesson observations the discussions in this chapter were used to understand the participants' mediation processes to use an inquiry approach in developing basic Scientific Process Skills. In presenting and interpreting the data, I used the analytical framework (see Appendix O). Moreover, the summary of findings from each section of the analytical framework is discussed in the above various sections.

All four participants taught their lessons using different methods or pedagogical strategies and were at various levels of understanding. In her questionnaire and interviews, T1 highlighted that she does not prefer to use the term *science* at this phase (FP) as it makes her think of laboratory equipment and science experiments.

> *It is difficult to say, because once you use the word "science" I think of the laboratory and experiments. Unless it does fit with ... when you say science my mind thinks of high school. So, as the FP teacher I would you to use the word "theme". My classroom is set around Life Skills themes. I use these themes to teach language as it needs to be taught around the life skills' theme or context (T1Q & SI).*

However, I noticed that her view of the term science contradicted her approach in teaching. During her observed lessons, for instance, all T1 lessons were scientific investigations and scientific inquiry orientated (L1, L2 & L3). In her lessons, as she claimed in her questionnaire, she engaged learners in groups and encouraged interactions between learners themselves and between learners and herself. Also, her lessons were learner-orientated. For instance, she focused on developing learners' critical thinking and knowledge (Vygotsky, 1978; Zaretskii, 2016). To mediate learning, T1 used both the classroom and the outside environment.

'*From a story to a chemistry lesson'*; that is my view of lesson 1 from T1. Her understanding of scientific reactions and chemical change was evident on how she introduced this lesson to her learners (T1L1). "*Technology and Science',* lesson 2 for teacher 2, took a different turn and yet was another inquiry-based lesson. The integration of technology and science was evident in this teacher's knowledge and understanding of the relationship between the two subjects (T1L2). '*From a potato salad to a scientific investigation lesson*' (T1L3). Her creativity in introducing lessons or topics to her learners was manifested in all three lessons. In general, this teacher, through her methods of teaching and doing things in her class, gave evidence of her general pedagogical knowledge, knowledge of learners, knowledge of educational contents, curriculum knowledge and pedagogical content knowledge (Shulman, 1987). Lastly, T1's ways of doing things in her class gave clarity on the Vygotskian concepts adapted in this study.

T2, instead, used a different approach in her lessons 1 and 2. She did not fully attend to the principles of an inquiry approach, conditions for developing learners' ZPDs, and the basic Scientific Process Skills, and I highlighted how in her lessons she incorporated principles of the socio-cultural theory. In lesson 3, however, this teacher took a different turn compared to the other first two lessons, as she did a scientific investigation lesson. This gave her learners an opportunity to utilise their senses. In her questionnaire and semi-structured interviews, she noted the importance of learners using their senses when doing science.

> *Scientific Process Skills are able to expose learners to the various experiences (discussing issues describe objects and explain). Learners experience what is taught, they observe and touch things. Each learner is able to use his or her senses (T2SI & T2Q).*

From the above excerpt from T2, it seems it contradicts with what took place in her lessons 1 and 2. In lesson 1, to identify properties of insects, learners used models of insects and the activity was not centred on the principles of inquiry. The activity on the characteristics of insects could have been more 'hands-on', 'minds-on' and 'words-on' (Maselwa & Ngcoza, 2003). Lesson 2 on the life cycles of animals, could have been a practical task as well. However, the teacher focused on the question and answer method, which was more of a teacher centred approach rather than balancing learner and teacher centeredness. An Inquiry- Based Approach in a lesson, identifies roles of both the learner and the teacher, which assists in avoiding the lesson being either teacher or learner centred (Bosman et al., 2016).

Similarly to T2, T3 also took a different turn. In her first lesson, she missed an opportunity to develop her learners' basic Scientific Process Skills. With the picture of insects, she had as an introductory approach for her lesson, in my view, she could have allowed learners to interpret their understanding and to promote discussions amongst learners. In her L2 and L3, she practically engaged learners, used some level the socio-cultural approach and worked interactively with her learners. T4, again as highlighted in the above discussions, did not actually engage her learners and therefore missed opportunities in all three of her lessons.

The four participants in this study give a clear picture of different levels of where teachers are with regards to Foundation Phase teaching and the use of an inquiry approach in their classrooms, as well as developing basic Scientific Process Skills in their learners. Through the analytical framework used in this study, the need for teachers to be further engaged and developed in the use of an inquiry approach and in developing basic Scientific Process Skills in their learners is revealed.

This is further evident in how these teachers planned and taught their observed lessons. For instance, in all four cases, the observed lessons were on science related topics and had a greater opportunity to be taught with a scientific inquiry approach and to develop learners' scientific skills. However, through observations and the use of the analytical framework on IBSA and the development of SPS, it was found that these teachers were at different levels in terms of explicitly or implicitly planning lessons that enabled them to implement an inquiry approach and develop basic scientific skills in their learners.

Looking at T1, all her lessons were explicitly planned to promote IBA in her classroom and to develop SPS in her learners. Her lessons were designed to promote an investigative approach, which is aligned with the principles of the inquiry approach. Surprisingly, this participant refused to use the term 'science' in her interview. She highlighted that, in the Foundation Phase, they do not use the term ‘science.’ Despite this, all her lessons were appropriately aligned with IBA and SPS. However, in some instances of her actual teaching, there were missed opportunities to strengthen scientific thoughts and skills in her learners (T1, 6.4.1).

On the other hand, T2’s first two lessons were not explicitly planned to promote IBA and the teaching and development of SPS. This was evident in how she taught her lesson about insects and the lesson on life cycles of animals. These two lessons were more focused on understanding the content: the naming of insects, understanding their characteristics and understanding the life cycles of the presented animals. However, a change in focus for this participant was evident in her third lesson after being in the group’s reflective space where they watched each other’s videotaped lessons. That is, this teacher significantly improved her approach in her last observed lesson. This gives credence to the importance and role of professional development or professional learning communities (see Section 2.5.3). While teaching the content about leaves, her focus was on implementing IBA and developing the SPS in her learners. This meant that her planning was explicit in promoting IBA and developing SPS in learners, which aligned well with the teaching practice of this lesson. Furthermore, learners were investigators, comparing and investigating leaves in class and outside the classroom (T2, 6.4.2).

Similar to T2, T3’s first lesson was a great science topic that could have been potentially used to promote IBA and SPS. However, her lesson on insects was taught to develop learners’ content knowledge about the cycle of a butterfly. That is, the teacher was more focussed on the content knowledge rather than developing scientific skills and using IBA. In her second and third lessons, however, her focus was explicitly on IBA and the development of SPS. As a result, in these lessons, learners were engaged, both in groups and individually. They were given an opportunity to explore fruits and at the same time to engage with each other. Regarding the concept of density, learners in this class had to investigate objects that could float or sink, and they were afforded an opportunity to act as scientists when doing experiments (T3, 6.4.3).

Lastly, T 4, as highlighted and discussed in Section 6.4, in all her three lessons there were missed opportunities regarding the use of IBA and implementation of SPS. Across her teaching of the topics of food groups, insects and volcanoes, the teacher did not design her lessons to follow IBA and to implement SPS. Yet, she had the necessary resources to teach using IBA and to allow her learners to engage in a scientific approach. In my view, this additionally speaks to the need for further collaborative spaces for using IBA and in the development of SPS. It is, however, evident that there are opportunities for Foundation Phase teachers to strengthen the development of basic Scientific Process Skills in their classrooms. Figure 6.21 below shows the relationship between theories and literature used to analyse and discuss data from lesson observations.

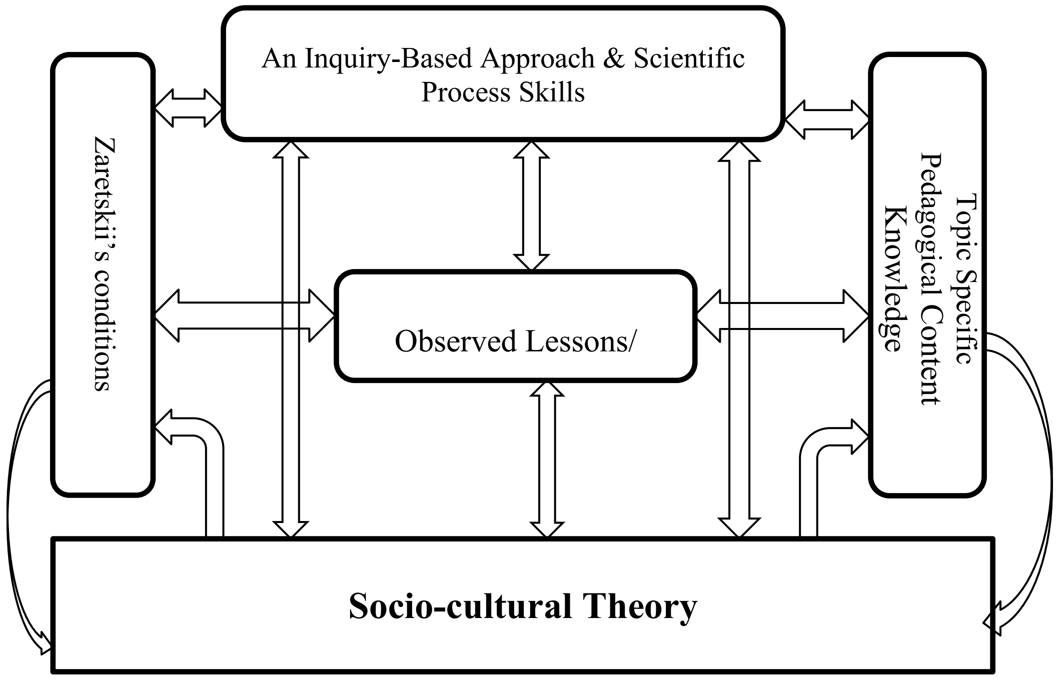


Figure 6.35: The relationship between theory and literature used for lesson observations

6.7 Chapter Summary

This chapter takes the reader on a journey into the classrooms of the participants I observed in this study. To understand the classroom observations, I intended to take the reader systematically through the scenes of capturing the lessons observed, into the analysis process and finally to the findings of this study. The chapter sought to give thick descriptions of data analysis, data interpretation and discussions of findings of the four participants from quintile 3 and 4 schools. The participants in this chapter represent the teacher components of the public schooling system in the South African context. With this in mind, through using the analytical framework and theory, I thus presented data highlighting the strengths and challenges faced by the teachers in this study. The aspects of strengths presented in this chapter highlight the opportunities and challenges that the Foundation Phase teachers have in using an inquiry-based approach to teach science successfully and to build science foundation knowledge and skills in their learners. These challenges give an opportunity for professional development spaces for inquiry–based lessons or approaches, development of basic Scientific Process Skills and science teaching in the Foundation Phase set-up, as reflected in the next chapter.

CHAPTER SEVEN: DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSION: ABSENTING THE ABSENCES IN PARTICIPANTS' VOICES (PHASE 4)

> *Reflection, following the observation of a lesson, is an intellectual activity undertaken in a group setting by means of discussion among participants and observers to explore ways of improving the quality of future student learning, with particular reference to design of the lesson, the materials used, and the mode of delivery. (Chikamori et al., 2013, p. 155)*

7.1 Introduction

This chapter presents, interprets and discusses data from the reflective space[12], which constituted phase 4 of this study. Essentially, this phase describes the data from the group reflections and the stimulated recall-interviews with the four research participants (T1-T4) in this study, in order to address the following research question:

How do discussions and group reflections influence (or not) Grade 3 Foundation Phase teachers' understanding of basic Scientific Process Skills and Inquiry-Based Approach?

In doing this, I start by giving a short background as to how and why the reflections in this interpretive study evolved. Secondly, I present short narratives of reflections from each participant, giving a scenario as to what took place during the reflective space in this study. In addition, I present scenarios on how the reflective space influenced or not the participants' use of an Inquiry-Based Approach in developing basic Scientific Process Skills. The reflective space in this study was due to the participants' experiences and their questions about the focus of this study (Chikamori, Ono, & Rogan, 2013). The four participants in this study deemed it

[12] The reflective space emerged as a result of the request made by the four participants (see Section, 4.6).

appropriate to come together as a group in a professional learning community to reflect and view each other's lessons and to learn from each other (Brodie, 2016; Chauraya & Brodie, 2018; Ngcoza & Southwood, 2019; Chikamori et al., 2013) (see Section 2.5).

Presenting and discussing data from the stimulated recall interviews of the four teachers discussed in detail in Chapter Six, I thus give narratives of how these teachers reflected on their lessons. Lastly, the summary chapter presents and concludes the overall discussions in this chapter.

7.2 Teacher Reflections

As a researcher, I did not initially plan to do reflections together with the participants. Instead, my interest was to observe how the participants in this study used an Inquiry-Based Approach to develop Scientific Process Skills in their classrooms. However, as the lesson observations progressed, the participants expressed that they would like to meet and reflect as a team, making my research generative in nature. According to the participants, the meeting and the reflections were going to assist them in understanding the research and to learn how others are implementing the scientific Inquiry-Based Approach (Lane, McMaster, Adnum, & Cavanagh, 2014). In their study, Lane et al. (2014) describe a reflective space as a space where teachers are afforded an opportunity to learn from their own teaching experiences and the experiences of others. Brodie (2016) refer to this as a professional learning community whereas Ngcoza and Southwood (2019) call it professional learning networks. Central to these models of professional development is learning.

As already noted above and in Section 7.1, in this reflective space the participants aimed to learn from each other and to improve their teaching of Scientific Process Skills through using an inquiry approach (Chikamori et al., 2013). According to Lane et al. (2014), reflections need to support or to improve teachers' pedagogies of teaching. Earlier on, Chikamori et al. (2013) noted the importance of critical reflections in developing and improving teachers' lessons for ultimately the betterment of their learners' knowledge and learning.

In this space, my role as the researcher was to facilitate the process (Brodie, 2016; Chauraya & Brodie, 2017). In doing the facilitation, I presented questions that assisted the start of the reflection process. The questions gave the participants an opportunity to reflect on the research process and their understanding of the objective of this study. Secondly, using the videotaped lessons, I gave narratives of what took place in each observed lesson. This gave the participants an overview of what took place in each teacher's lessons. The following four questions were used as catalysts to start the process of reflections:

1. How do participants find the research process thus far?
2. How has the research process enabled and/or constrained the participants' teaching of Life Skills as a subject thus far?
3. What do the participants' think the researcher needs to improve on?
4. What are the participants' taking from the research process?

The objectives for the above questions was to understand the following:

- In question 1, I wanted to understand how the participants view the research process;
- In question 2, I wanted to understand if the research has had any effect on their Life Skills' teaching. The focus of this research was on science teaching, however, science as a subject is embedded in Life Skills;
- In question 3, I focused on strengthening the ethics of the study. In my view, to respect the participants, to value their opinions and to adhere to the consent is key in the research process; and
- Lastly, in question 4, I focused on understanding the lessons learnt by the participants thus far.

The lesson narratives gave the participants the opportunity to ask questions and to do in-depth reflections about each other's lessons (Lane et al., 2014). After group reflections, I observed one lesson more from each participant and this gave me three lessons for each teacher in total. The last observed lessons constituted the second cycle of observation in this study. That is, cycle one was before the group reflections and cycle two after the group reflections.

Based on the questions asked, I present and discuss the participants' perspectives about the research process in the reflective space.

7.2.1 The participants' views on the research process and how it influenced their teaching of Life Skills

Teacher 1

In the preceding chapters, I highlighted that T1 was the youngest teacher in this group of participants and the least experienced teacher (see Section 4.6). In her semi-structured interviews, she noted that the term 'science' is not used in the Foundation Phase, but the term 'theme' is used instead. In her reflections, she highlighted that the research process itself has motivated her to look forward to planning her exciting experiments or hands-on practical activities. She continued to state that, the opportunity of sharing her lessons with others gave her an understanding of what other teachers do in their classrooms. This was the most important thing for her and she thought that it would be a great opportunity for teachers to continue to share their work across schools. When commenting on the importance of sharing with other teachers this teacher highlighted the following:

> *Sis' Zu, if there could be an opportunity for Foundation Phase teachers to share how they teach Life Skills themes or topics in their schools that would be great because in that way we can assist each other and work together as teachers. We do not have an opportunity like that. (T1)*

From this excerpt, it seems T1 is in favour of professional learning communities so that Foundation Phase teachers could support one another (Chikamori et al., 2013) and to share ideas and lessons for the Life Skills subject.

Teacher 2

T2 confessed and highlighted that she has been at some point neglecting Life Skills, focusing on mathematics and languages instead. For instance, she reflected, "*As a teacher, Life Skills as a subject has not been my focus*" (T2).

In the previous chapters, I highlighted that T2 was the most experienced teacher in this group and has been involved in several professional development workshops. However, such professional development workshops were not focusing on Life Skills as a subject, nor the use of an inquiry approach in the classroom. According to this teacher, as a result of being involved in this study, she has been motivated to fully focus on the teaching of Life Skills. Her excitement to be part of this study was evident when for the first time her learners had to write a June (2017) Life Skills externally examined paper – because of this research study she indicated that she was ready for the exams. She further noted that the writing of exams in Life Skills was not for all schools and yet her school was among the selected schools. T2 went on by highlighting that she was thankful to herself and to me as the researcher because she has now been on her toes. For instance, to know that someone would be coming into her class made her plan thoroughly when teaching Life Skills. She further reflected that she is confident enough to say she is now focusing on Life Skills without any hesitation.

Teacher 3

Similarly to T2, T3 highlighted that from her experience that teachers tend to neglect Life Skills as a subject. To this teacher, Life Skills is not being taught as it should and as a result, most teachers do not think it is an important subject. She reflected, "*Promotion criteria in Life Skills has been neglected*" (T3). She even went further by stating that the Department of Education is adding to the challenge. For example, if learners do not do well in Life Skills, they would not have to repeat that specific grade, but instead would be progressed[13] to the next grade regardless of how poorly they had performed. Given her experience from the Senior Phase (SP), she found it very difficult not to intensively teach Life Skills because she understands the importance of this subject. Apparently, most teachers in her school scold her for taking this subject seriously. According to her, the research itself has helped her a lot with planning and influenced her teaching. Additionally, she reflected that as a researcher I had been flexible with them as participants (see Section 4.9). For instance, she noted that allowing the participants to

[13] To allow learners to progress whether or not they have not done well in Life Skills might have a negative effect in the higher grades, in terms of understanding the Life Skills/Natural Sciences concepts (see Figure 2.1)

choose their lessons and their time slots, was an advantage to them as participants. She acknowledged that as the researcher, I fully respected them and gave them independence in this research process (see Section 4.9).

Teacher 4

Unlike T1 and T2, T4 indicated that in her class she valued Life Skills because she knows that it is an important subject for child development and therefore understands its value. This line of thought resonates with Vygotsky's (1978) socio-cultural theory that children's development is critical. To this end, she commented that: "*In my case I am loving Life Skills because it is focusing on the holistic development of a child*" (T4). She continued to highlight that she is one of those teachers who has been complaining about the time allocation for teaching this subject. She believes more attention should be given to Life Skills because it has many other content subjects embedded in it. For instance, she lamented that: *"Life Skills is where even those who are not having some guidance at home, a teacher has an opportunity to address such challenges"* (T4).

Moreover, with reference to the point highlighted above, T3 narrated on the importance of Life Skills as a vehicle for teachers to give guidance to learners and to address challenges that are faced by learners in general. With this in mind, T3 sees Life Skills as not only a content subject but also a subject that can equip leaners for a life-long journey (Bosman et al., 2016). In my assumption, Life Skills in the Foundation Phase is evidence of an integrated subject where teachers are expected to teach about various issues. According to her, the research made her vigilant, because she knew that someone was coming and therefore made sure she focused on all learners in her class. She confessed, however, that at times she tends to neglect the weaker learners, but the research ensured she accommodated them because she wanted to avoid them disrupting the lessons and perhaps question why they were being left out. To her, the research has thus strengthened her teaching methods and pedagogy (Mavhunga & Rollnick, 2013). In her concluding remarks, she stated that due to this research, she thoroughly plans and teaches Life Skills.

7.2.2 Summary of participants' views on the research process and how it influenced their teaching of Life Skills

In their reflections, all four participants noted the importance of Life Skills as a subject. In both their interviews and questionnaires, the four participants raised few issues about the teaching of science in the Foundation Phase. As already highlighted above, the research highlights that in the Foundation Phase, science content is embedded in Life Skills and therefore most teachers tend to neglect teaching it. Koen and Ebrahim (2013) describe the Foundation Phase as a level of education that has the greatest opportunity or risks for both teachers and learners. They see this phase as playing a crucial role in a child's life as it is supposed to develop the child physically and cognitively. Their argument is evident in how Life Skills as a subject is designed in this phase. It is an integrated subject with various important skills and content knowledge (Shulman, 1987) and therefore if subjects like science are embedded in it, the chances of teachers neglecting it are huge and if teachers are not equipped to teach science at this phase it creates more challenges and risks for learners (Plaatjies, 2014).

The four teachers in this study confirmed the challenges faced by teachers in the teaching of science in the Foundation Phase. The following challenges were raised by these four teachers: limited time allocation to focus on each aspect of the Life Skills subject, how Life Skills as a subject is degraded and lack of support on teaching science in this phase (Beni et al., 2012; Plaatjies, 2014). However, as a result of the research, the participants highlighted that they now plan and teach science with confidence. This was as a result of the informal and formal discussions and the reflective space that occurred during the research process. According to these participants, to know that someone was going to come to their classes made them more consistent in the teaching and planning of science lessons observed in their classes. They further noted that, when it comes to Life Skills, teachers need to be aware of the various content in it and therefore prepare learners accordingly (Mavhunga & Rollnick, 2013). From the teachers' reflections, it is evident that they saw value in being part of this research study.

7.2.3 Participants' voices matter

In my view, in research the participants are the most important people. For researchers, it is important to adhere to the agreement of keeping respect and dignity for the participants (Cohen et al., 2018). In this study, I had four participants and all four were female teachers in the Foundation Phase. The question answered in this section was based on their views about the research process. All four participants valued the independence and the freedom they had to choose their own lessons and visiting slots. According to these participants, the research process was fair and as a researcher, I accommodated all four of them. For example, they reflected that:

> *My learners always looked forward to having sis' Zuki and I really enjoyed having her in my class (T1).*
>
> *Yho! I have been excited to work with you Zuki (T2).*
>
> *Zuki has been flexible with us as her participants and I appreciated that because it gave us enough time to plan (T3).*
>
> *The research itself made me to be alert because I know Zuki is there, so I make sure I focus on all learners in my class (T4).*

From the excerpts above, it could be deduced that these participants were happy with how the research took place. As the researcher, I felt humbled and at the same time honoured to work with these four participants, as certainly the journey with them was quite fulfilling and productive.

7.2.4 Lessons learnt from this research study

In this study, the following aspects emerged from the participants' reflections:

- The participants valued the importance of teaching science in the Foundation Phase and therefore saw it as important to strengthen their teaching methods (Mavhunga & Rollnick, 2013);

- For further development in teachers, the participants felt that it was important to develop professional learning communities (Brodie, 2016; Chauraya & Brodie, 2017; Chauraya & Brodie, 2018; Tshiningayamwe, 2016) to strengthen the teaching of Life Skills (science) in this phase;
- The participants raised the importance of sharing lessons and to learn from each other (Chikamori et al., 2013); and
- They highlighted that Life Skills is a foundation for other content subjects in the higher grades (Bosman et al., 2016).

Through formal and informal reflective spaces, I had with the participants, the points above were raised and the participants highlighted the need for Foundation Phase teachers to have professional learning communities that would allow them to strengthen their science teaching.

Regarding the viewing of the videotaped lessons with each one of the participants, they reflected on how an Inquiry-Based Approach was implemented or enacted by each one of them. In addition, the participants commented on how each could improve their lessons using an inquiry approach. To me as a researcher, this was a productive space as it was clear that these participants cast their critical eyes on each lesson. How the participants commented on their lessons during the reflective space was also a sign of commitment to what they do as teachers and in this research project. It was evident that the four participants are committed and keen to improve their teaching of science in this phase.

Next, I present and discuss data from the second cycle of lesson observations. In this cycle of lesson observations, it was important to see how the reflective space had enabled and/or constrained the participants' last observed lessons.

7.3 Second Cycle of Lesson Observations

To present and discuss this section, I draw from Chapter Six where I presented, analysed and discussed data for T1-T4. As already explained in the previous chapters, the four participants are in my view, a significant representation of the types of teachers we have in the South African schools. For instance, we have teachers that are recently trained as Foundation Phase teachers and teachers that were trained in the previous or old system of education. This alone creates a *gap* on how teachers do things in their classrooms.

As already presented in Chapter Six, all T1's three lessons have been scientific investigation lessons compared to the other three participants. For instance, her learners did experimental and investigative activities. In the second cycle of lesson observations, similar to the other two lessons this lesson was about investigating eggs (see Lesson 3 in Section 6.4). Learners had to do an investigation task to identify the cooked or the uncooked egg.

In contrast, both T2's, T3's and T4's lessons seemed to place a lot of emphasis on subject matter knowledge (Shulman, 1987) rather than on an Inquiry-Based Approach as espoused by Bosman et al. (2016). However, after the reflective space, T2 prepared and taught a different lesson from her other two lessons. Unlike her previous two lessons, in this lesson learners were observing and comparing leaves of different plants. It could be surmised that T2 had strengthened her scientific inquiry lesson as proposed by Worth (2010) and had made sure that her learners developed many Scientific Process Skills in their lesson. For T2, the shift in her scientific inquiry approach was evident (see Lesson 3 Section 6.4).

To understand that there was a shift in her approach of teaching I drew from how the process of mediation of learning as espoused by Vygotsky (1978) and Zaretskii' s (2016) six conditions that could assist teachers in developing their learners' ZPD, took place in her third lesson. Unlike the other two lessons also, this lesson on plants started from inside the classroom and moved to the school grounds where there were different types of trees and plants. That is, the teacher made sure that she brought plants into the classroom and used the *school grounds* as a learning space and resource (Mavhunga & Kibirige, 2018).

In her introduction, T2 brought plants to show learners the characteristics of leaves in plants. This is a teaching method using representation as a teaching strategy to elicit her learners' prior knowledge (Mavhunga & Rollnick, 2013). She then proceeded to group her learners and gave each group instructions to use when outside the classroom. Together with each group, the teacher read the activity to be done outside the classroom to ensure that her learners understood exactly what they were supposed to do. In my view, this approach enhanced teacher-learner social interactions (McRobbie & Tobin, 1997; Vygotsky, 1978). It could also be argued that the out-of-class context took catered for the learners' socio-cultural background as reiterated by Mavuru and Ramnarain (2017).

Again, this method speaks to the use of prior knowledge of learners and the teaching of Scientific Process Skills. In addition, each group had to select a group leader. The role of a group leader was to oversee the work and other learners had different roles to play. This teaching strategy and approach to learning promoted the following aspects of learning: Vygotsky's social interactions between learners and between learners and the teacher; learning in groups and doing activities in groups. Through group work, learners had to interact and assist each other. In her last lesson, there were more skills that were scientific, more interaction and engagement between leaners and the teacher and between learners themselves. Observing her lesson 3, it was evident that her understanding of an Inquiry-Based Approach was strengthened after the reflections.

Next, I discuss how the two participants (T1 & T2) reflected on their lessons.

7.4 Stimulated Recall Interviews

To follow-up on participants' observed lessons, the participants were invited to do stimulated recall interviews. Unfortunately, out of the four participants, only two participants (T1 and T2) were available for these (see Section 4.6). As alluded to earlier, by observing and analysing the participants' observed and video-recorded lessons, I wanted to understand their actions, thoughts and views about their lessons that they taught. Similarly, for the stimulated recall interviews I wanted more insights on their views about the use of an Inquiry-Based Approach in their classrooms. These interviews were conducted in an informal and relaxed space. My aim for using an informal space was for the participants to be in a non-threatening environment and not to feel that they were being interrogated about their teaching. Additionally, in conducting these interviews and for the facilitation of this process, I had a few different questions for each of the two participants and these were aligned with how they taught their lessons.

7.4.1 Teacher 1

In the preceding chapters, I explained how uncomfortable T1 was about using the term 'science' in the Foundation Phase (see Section 5.3). However, this in my view, contradicted her pedagogical approach of teaching science lessons in her classroom. For instance, all her observed lessons were about scientific investigations and experimenting. In my understanding, the use of an Inquiry-Based Approach was visible and evident in her lessons (see Chapter Six, Section 6.5). Furthermore, this teacher in her lessons implemented most of the principles for an Inquiry-Based Approach (see Section 6.5). To me as the researcher, this contradicted with her view of science in the Foundation Phase. During the section of the stimulated recall interviews with her, I asked her the following questions:

- What made you design and plan such lessons?
- In your first interview and questionnaire, you did not want to use the term 'science' and yet all your three lessons are scientifically based lessons. Could you please elaborate on your thinking about this?
- Do you think you had some lost opportunities in your lessons, for example do you think that at some stages you could have done something different?
- Do you think you met all your objectives in your lessons?
- Do you always plan lessons like these for all your Life Skills lessons; and
- From the research process itself, what did you learn?

I based the above questions on her initial interview and her questionnaire responses about the term 'science'. I also looked at how she planned and taught her lessons. Her views and thoughts about her own lessons mattered the most, as it was important to understand her own reflective views about her teaching. This would give a true reflection of what informed this teachers' culture of teaching.

Moreover, observing and viewing T2's lessons, I noticed some lost opportunities where she could have further explored her learners 'thinking and answers' when she interacted with them in her three lessons. In consequence, asking this question gave me an opportunity to understand her views or thinking about the importance of reflecting on her work especially the lessons she taught during this research process. Question 5 gave me an understanding of how she generally plans her lessons and whether or not these lessons were only planned for this research study. Lastly, question 6 was about the general conclusion from this participant.

Again, as discussed in the preceding chapters, the three observed lessons for T1 were as follows: lesson 1 was about investigating fruits; and the focus investigative question was: ‘which solution will work best to prevent fruit from colour change?’ As explained in Chapter Six Section 6.4.1, in this lesson learners had to investigate which solution worked best to prevent colour change from fruit that had been cut into small pieces. Learners worked with three types of fruits: an avocado, an apple and a banana. They also used the following solutions: salt, sugar and lemon. Lesson 2 for this teacher was about insects, focusing on ant-holes. In this lesson, using easily accessible resources learners had to build their ant-holes and the focus question for this activity was: ‘Which ant-hole will sustain the overnight weather conditions and stand strong throughout the night without being damaged?’ The next day the structures were assessed using the following criteria: the structure that was still standing without any damage, the design similar to a real ant-hole and the collaboration of the group members. Both learners and the teacher assessed the structures.

Lastly, the third and the last lesson was about identifying cooked and uncooked eggs. In this lesson, learners had to use different scientific methods to find out which eggs are cooked or uncooked. After the investigation task, working in groups learners came up with their concluding results and shared them with the whole class. To come up with the results, the teacher together with the learners reflected on the findings and checked their answers. The reflections on this task assisted the class to see which group had the correct findings. On her stimulated recall-interviews based on the questions and the discussions, T1 narrated the following aspects:

> *All my lessons in my class are based on discovery so that learners are able to broaden their thinking and reasoning skills. I do this because I try to avoid being the provider of information. So, the practice of inquiry happens where possible (T1).*

In question 1, according to this participant, her lessons are informed by discovery learning that allows learners to explore and investigate. In the same vein, discovery learning informs an Inquiry-Based Approach and therefore this explains why this teacher is able to follow and to foster inquiry-based principles (Kidman & Casinader, 2017). She believes that instead of her as teacher giving information to her learners, learners should find information for themselves believing that learners' thinking and skills would be developed. She used the following words to support her use of discovering method:

> *Discovering things for yourself is more meaningful than being to about something. It makes learning more meaningful; it deepens your understanding and encourages a culture of asking questions. It broadens thinking and problem-solving skills" (T1).*

Indeed, asking of questions is central in inquiry-based approaches. T1 further described that, in planning her lessons she chooses Life Skills themes that they are working with in Grade 3 or chooses familiar topics that familiar to learners' immediate environment as proposed by Asheela (2017). According to this teacher, using familiar topics to learners encourages them to be curious about their surroundings. When explaining herself she noted that,

> *I chose simple topics that I knew they were familiar with but could not possibly understand the processes that underlie them (T1).*

In explaining, what she meant by processes that underlie these familiar topics that she uses in her class, she explained that the topics taught by teachers might be familiar to learners but how things happen beneath the surface are hidden to the learners. When she made this statement, she further explained that learners might experience something from home or outside the classroom (Oluruntegbe & Ikpe, 2011); however, it is the responsibility of a teacher to explain and to give learners the real explanations about the matter at hand.

She made the following examples, in her lesson 1, on why apples turn brown. She added that as the teacher, she understands the *oxidation process*, but her learners do not and through practical activities and investigations it is therefore her responsibility to bring such knowledge to her learners. In lesson 2, learners do not understand how insects build their own houses and this process is not clear to learners. Lastly, in lesson 3 she explained that generally learners are familiar with eggs and they are familiar with spinning of objects, however, for learners to do spinning, as a scientific method to identify cooked and raw eggs was unfamiliar to them.

In question 2, about the term 'science', T1 clarified that, from her understanding science seemed to work with specialised elements that she could not possibly understand. On this, her own words were

> *From my understanding science seemed to work with specialised elements that I could not possibly understand. That is why I feel like I don't or can't call it science" (T1).*

From this explanation, it was obvious that she was still uncomfortable about the use of the term 'science' in the Foundation Phase. My assumption is that this could be caused by how Life Skills is generally viewed in this Phase.

Question 3 looked at the lost opportunities when teaching lessons during this research. About some answers from her (T1) learners that could have been further interrogated, her comment was as follows:

> *The opportunity went unnoticed… the main aims of my lessons felt more important than probing one learner. If time was not a factor, they would have been possible taken into consideration. I must say it would be impossible to cover all aspects or to consider all opportunities in every lesson. We deal with them according to the importance you place on each lesson (T1).*

According to T1, dealing with each aspect or probing each learner's reply in a lesson can take time and hence some of opportunities are lost. She noted that one cannot deal with all aspects in one lesson and because of that, she focuses on what she considers important in a lesson. To answer or discuss her questions 4 and 5 regarding meeting her lesson objectives and planning inquiry-based lessons, T1 described her thinking as follows:

> *I felt like my objectives were met because we had an opportunity to engage with the processes of discovery and inquiry. What each learner received from these lessons was again based on their own level of thinking and development. When grouping my learners, I tried to do it according to their levels in order to enable every group to have a certain level of success. I made sure that each person has some role to play according to his or her strengths so that no one feels left out and able to shine in their own area (T1).*

From the above excerpt, T1 described how she felt about meeting her lesson objectives and she presented gratification towards her teaching. She further explained more about how and why she used group activities during her lessons and this to me as the researcher gave evidence of thought towards her planning. In addition, through her explanation she showed an understanding of her learners and their level of thinking. The use of her learners' socio-cultural context when teaching (Mavuru & Ramnarain, 2017), spoke to one of the principles of scientific Inquiry-Based Approach and to Zaretskii's (2016) six conditions of developing learners' zone of proximal development (ZPD) during the mediation process. On this point, she concluded that when she plans inquiry-based lessons she plans them once for every theme and even with themes, she noted that not all lend themselves to an inquiry-approach.

To clarify her explanation, she stated that it is difficult to plan inquiry-based lessons for some themes. She gave the following examples, '*About me*', '*People who left long ago*' and '*Rights and Responsibilities*'. T1 seemed to understand her curriculum and had knowledge of how to plan and what to do for each theme. In question 6 about the research process, she noted that if there was something she learnt is that she needed to be flexible when working with an Inquiry-Based Approach. She added that when working or using this approach, unexpected things that you did not expect as the teacher, crop up. She said that realistically, an Inquiry-Based Approach takes more time than what you as the teacher can anticipate. To emphasise what she meant she highlighted that:

> *Certain children will surprise you in how versatile their thinking is 'outside the box' and of the normal classroom setting and as teacher you try to direct learning towards your aims and objectives (T1).*

The above comment or emphasis relates and supports the reason this teacher did not attend to some children's comments or answers. T1 further narrated that when using an Inquiry-Based Approach the teacher has to be aware of the above factors. Overall, according to T1, this research process taught her to be flexible and to be more vigilant to the learners' thinking.

Next, I discuss T2's stimulated recall-interviews.

7.4.2 Teacher 2

In Chapter Four, I described T2 as the most experienced teacher in this group (see Section 4.6). She has been teaching the Foundation Phase for 37 years. It is my assumption, that with such experience as a teacher, you should be knowledgeable in your specific field. Indeed, during my observations, T2 seemed to love her work and was willing to learn and share from others. This was evident in the reflective space above.

For T2, unlike T1, I requested her to reflect and talk about her overall teaching or observed lessons in research process. In doing this, I wanted to see if she would highlight any differences in her lessons. For this teacher, her lesson 1 was about insects and focusing on the characteristics of insects. Lesson 2 was on the life cycles of different animals. The third and the last lesson was about plants, focusing on the different types of leaves. In reviewing her lessons together with her, the first thing she highlighted was that through this journey she learnt a lot and she has grown in so much that she is never going to stop planning her Life Skills lessons.

> *Zuki, you know I really appreciate this. Doing this research with you has helped me a lot, I now understand why Life Skills should be seriously looked at. You know, I so wish we can continue with this" (T2).*

I must say from the beginning of this research study, this teacher repeatedly commented stating the above. As I already explained about, T2, this was the same sentiment shared by all four participants. This factor strengthened the importance of this research. T2 continued to share that after the reflective space she was rejuvenated as she could see and understand how to improve her science lessons using an Inquiry-Based Approach.

> *In doing inquiry lessons I think as a teacher I need to be patient and allow my leaners to explore their environment. Yho! I have been missing out Zuki. I normally take my learners to the museum, but I never followed up on those lessons (T2).*

From this comment, when teaching Life Skills, it was clear that this teacher had realised the importance of using an Inquiry-Based Approach (Kidman & Casinader, 2017; Sackes et al., 2010) and how important it was to follow up on your lessons as a teacher. Comparing her three lessons, this teacher looked at how different the first two lessons were, compared to her third lesson. In lesson three, she taught more Scientific Process Skills and her learners were a group of young scientists, working together to achieve the intended objectives. In contrast, her first two lessons were more focused on teaching content than developing Scientific Process Skills. The irony is that, however, in her interview and questionnaire she seemed to understand what an Inquiry-Based Approach entails, yet she did not effectively implement it in her first two lessons. When we looked at the above two lessons (1 & 2), she made the following comment:

> *When watching other lessons from the other three teachers, I observed how they do their practical activities. I also noticed how they work with their learners in groups. I took their lessons as examples (T2).*

In her comment, observing other lessons from other participants motivated her to plan a different lesson compared to her first two lessons. She confirmed that during this research process she learnt a lot about an Inquiry-Based Approach and her teaching of Life Skills had improved because of it. In her third lesson, when implementing an inquiry approach in her class this teacher met most of the inquiry principles in this lesson (see Section 6.5).

In summary, observing the four teachers (T1-T4), although they were teaching in the same grade their lessons during this research process were planned and designed differently. Admittedly, teachers are idiosyncratic in their teaching strategies. From the beginning, for instance, T1 demonstrated adequate understanding of the principles of an inquiry approach and she seemed to be knowledgeable about how to teach and develop Scientific Process Skills in her class. As already explained in Section 7.3.1, in her stimulated recall interview she noted that all her lessons are designed with the aim to do discovery learning and this resonates with an Inquiry-Based Approach (Kidman & Casinader, 2017). For T2, in turn, she confirmed when teaching Life Skills, her focus is on integration of language and numeracy while teaching this subject. The narratives in this chapter are evidence of the need to support Foundation Phase teachers in planning and teaching of Scientific Process Skills using an Inquiry-Based approach in lessons.

7.5 Chapter Summary

The participants' *voices* matter. With this term in mind, when the participants advised that they wanted to meet and reflect on each other's lessons and to learn from each other, as part of the ethics of this study, 'respect' for the participants was important at that moment. Agreeing to this reflective space created a magical turn for this research project.

It is through the reflective space that the participants narrated their experiences in this research and most importantly voiced the need for this kind of research in the Foundation Phase. Hence, this chapter sought to understand the teachers' reflections on the research process itself and on their own taught lessons; that is, to understand what took place during the reflective space, what teachers learnt from each other's lessons and from the research process. Why this reflective space came about was explained and I then drew from the informal discussions with the teachers during the first cycle of lesson observations. To continue the discussion, using the guiding questions that assisted to facilitate the reflections (Brodie, 2016), I presented reflection narratives from each participant. To conclude the lesson narratives, I pulled the threads together discussing the outcomes from the group reflections and the stimulated recall interviews.

CHAPTER EIGHT: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

> *Successful teachers resort to a variety of activities to achieve planned classroom outcomes and to enable learners to use these techniques to take control of their own learning. (Bosman et al., 2016, p. 17)*

8.1 Introduction

In the previous chapter, I presented the discussion of findings from the reflective space and stimulated recall interviews. This final chapter presents a summary of findings, recommendations, acknowledgements of limitations, conclusions and reflections on my PhD journey. In assembling the sections that make up this chapter the contents of earlier chapters are examined as a whole (Hacker & Dreifus, 2010). In Chapters Five, Six and Seven, the three objectives, which guided this study, were presented, discussed and supported by the analytical statements or the raw data from the participants. Again, this chapter presents the three research questions in order to support the overview of this study, major findings and their benefits, the limitations of the study, recommendations, new knowledge and conclusions.

8.2 Overview of This Study

As already discussed in the preceding chapters, the main goal of this study was to explore how Grade 3 Foundation Phase teachers mediate the development of basic Scientific Process Skills when using an Inquiry-Based Approach in their classrooms. To achieve this goal, the three research questions were addressed:

1. What is the <u>understanding</u> of basic Scientific Process Skills and Inquiry-Based Approach by Grade 3 Foundation Phase teachers?

2. How do Grade 3 Foundation Phase teachers mediate the <u>development</u> of basic Scientific Process Skills through an Inquiry-Based Approach in their classrooms?

3. How do discussions and group reflections influence (or not) Grade 3 Foundation Phase teachers' <u>understanding</u> of basic Scientific Process Skills and Inquiry-Based Approach?

To answer each research question, I used various data gathering techniques. For research question 1, for instance, questionnaires and semi-structured interviews were used and I found these to be beneficial to me as the researcher, as they afforded me an opportunity to access first-hand information from the four participants involved in this study (see Section 4.5 & 4.6). In addition, the questionnaires and the semi-structured interviews complemented each other and informed Phase 1 of this study.

For research question 2, data were gathered through using the method of lesson observations, which were video-taped. Being present in the participants' classrooms assisted me to understand the extent to which they developed basic Scientific Process Skills using an Inquiry-Based Approach. Essentially, observing how the participants worked and taught basic Scientific Process Skills to their learners was the aim of these lesson observations. Moreover, research question 2 was the core for this research study.

To answer my research question 2, I observed four teachers, and this is presented in Chapter Six of this thesis. In Chapter Four, the methodology chapter of this study I described each participants' context. To recap, for instance, T1 was the least experienced teacher, whereas T2 was the most experienced teacher. Again, T1 was the same as teacher 4, being a quintile 4 teacher and T1 was the same as teacher 3, being a quintile 3 teacher (see Section 4.5.2).

For research question 3, the group reflective space was deemed essential as a data gathering process. This reflective space afforded the teachers involved in this study an opportunity to reflect on each other's lessons. Furthermore, with my guidance using questions, the participants also reflected on the entire research process.

The reflective space subsequently resulted in the second cycle of lesson observations. The second cycle assisted me to see if the reflective space enabled and/or constrained the teachers' instructional practices or pedagogies when mediating basic Scientific Process Skills using an Inquiry-Based Approach in their classrooms.

To summarise, the data for the objectives (see Section 1.4) in this study that answer the aim of this research were gathered using questionnaires, semi-structured interviews, video-taped lessons, stimulated recall-interviews and group reflections. In Chapter Four, the methodology chapter of this study, I discussed each of these data gathering tools (see Section 4.6).

In the next section, I discuss the summary of my findings in relation to my research questions.

8.3 Summary of Findings

For research question 1, data were gathered using questionnaires and semi-structured interviews; for research question 2, I used videotaped lessons; and for research question 3, data were generated through group reflections and discussions, as well as stimulated recall-interviews with T1 and T2. Each data set is unique and important in this study and the research questions served a specific and distinct purpose (see Table 4.1 & Section 4.6).

8.3.1 Research question 1

Research question 1 of this study was the initial step in finding out the participants' perspectives (conceptions and dispositions) in relation to the aim of this research study. To gather data for research question 1, questionnaires and semi-structured interviews were used. In Section 4.1, I discussed how questionnaires and semi-structured interviews assisted me in understanding the participants' perspectives about an Inquiry-Based Approach, basic Scientific Process Skills and the teaching of science in the Foundation Phase. In my view, this research question was important because it gave a picture and understanding of how each teacher understood an Inquiry-Based Approach, basic Scientific Process Skills, and the teaching of science in this phase.

In Chapter Five, I presented, interpreted and discussed data addressing my research question 1 (see Sections 5.4, 5.5 & 5.6). Hence, I draw the discussions for this section from Chapter Five of this thesis. It could be argued that my Chapter Five in this thesis constituted the baseline in this study. In my view, this research into teaching using inquiry skills in the Foundation Phase is important because as alluded to in Section 2.1, the Foundation Phase is a foundational stepping-stone for any South African child that aspires to become a valuable and educated citizen. It is thus important for Foundation Phase teachers to understand their role in achieving what is necessary and what is expected of them to produce valuable citizens. As already explained above, research question 1 of this research was as follows:

What is the understanding of basic Scientific Process Skills, scientific knowledge and an Inquiry-Based Approach by Grade 3 Foundation Phase teachers?

In the previous chapters, it was explicated that research question 1 critically engaged with the teachers' understanding of scientific knowledge, an Inquiry-Based Approach and basic Scientific Process Skills. In addressing the findings of this research question, I first draw on what the literature says about science teaching in the Foundation Phase. In Chapter Two of this thesis, in Section 2.1, I gave an overview of teaching in the Foundation Phase and science in the South African context. Many scholars have deliberated on the issues around science and science teaching in this phase (Beni et al., 2012; Bosman et al., 2016; Green et al., 2011). Again, in Section 2.1, I drew from Beni et al.'s (2012) view, who highlight the recent developments in South Africa "that echo the worldwide transformation trends in science education" (p. 65). These scholars further explain that, in the United Kingdom, Target 1 for science in the National Curriculum has apportioned much precedence to scientific investigation.

The Revised National Curriculum Statement in the Natural Sciences learning area, deals with the promotion of scientific literacy. According to the curriculum, this is achieved by developing and using basic Scientific Process Skills, critical thinking skills and problem-solving skills. From these deliberations, the major and important question that has been argued by researchers both in primary and secondary schools is: What do teachers understand about basic Scientific

Process Skills and an Inquiry-Based Approach? Hence, some challenges have been highlighted about the use of an Inquiry-Based Approach in classrooms (see Sections 2.2; 2.3; 2.6 & 2.7).

Notwithstanding, the highlighted challenges faced by teachers in the use of an Inquiry-Based Approach, the context and the participants in this research are different. In Chapter Four, Section 4.6, for instance, I highlighted that the four participants in this study were four Foundation Phase teachers in the Sarah Baartman district in the Eastern Cape and they were all *isiXhosa* speaking female teachers. Even though these teachers were from the township schools (quintile 3 & 4), their teaching experiences, their social backgrounds and their school contexts varied (see Section 4.6) and this played a role in their understanding of the research objectives. Again, as explained in Chapter Four, throughout the research discussions and the data analysis of this study, I named each teacher T1 to T4.

The findings for my research question 1, revealed that the four teachers in this study had some understanding of what scientific inquiry is and what basic Scientific Process Skills are and the understanding of their roles as teachers when using an Inquiry-Based Approach. The data gathering tools for question 1, both the questionnaires and the semi-structured interviews assisted in developing themes from data that spoke to each of the above (see Table 5.1). Again, findings also presented their understanding of learners' roles when using an Inquiry-Based Approach, the understanding of how to use resources when using an Inquiry-Based Approach and what it means to teach science in the Foundation Phase. In the paragraph above, referring to the participants' socio-cultural contexts (Mavuru & Ramnarain, 2017), their schooling background and their experiences, I highlighted the differences in the participants in this study and from the data and the discussions in Chapter Five of this thesis, this was evident as to how each teacher interpreted their understanding of the questions from both the questionnaires and the semi-structured interviews.

Their interpretation of questions asked reflected the participants' personal PCK about an Inquiry-Based Approach, their prior knowledge as teachers and how they could use prior knowledge in their use of an Inquiry-Based Approach and development of basic Scientific Process Skills. This was highlighted by the data from the questions. Regarding the use of an Inquiry-Based Approach and the development of basic Scientific Process Skills, the participants' understanding of their socio-cultural context and of their learners also emerged from the data. Vygotsky's socio-cultural approach and Shulman's PCK focusing on TSPCK specifically underpinned this study and hence the above explanation about the teachers' interpretation on the data gathered in question 1. Tables 5.10 and 5.11 in Chapter Five compared the teachers' views regarding their thinking about the main goal of this study. As explained and discussed in Chapter Five, the tables were designed to show the participants' perspectives and the influence of what they thought towards each developed theme. Table 5.5, for instance, looked at the teachers' thoughts about an Inquiry-Based Approach and basic Scientific Process Skills. On the other hand, Table 5.6 looked at the roles of a teacher and of a learner when implementing an Inquiry-Based Approach in their teaching.

The relationship between an Inquiry-Based Approach and basic Scientific Process Skills as presented by the participants in Chapter Five highlighted a strong sense of their level of understanding regarding the use of an inquiry approach. Overall, the data interpretation tables in Chapter Five were a summary of the participants' ideas and perceptions about how they viewed an inquiry approach. The teachers' responses showed a relationship between an Inquiry-Based Approach and basic Scientific Process Skills. The correlation between the participants' perspectives and their understanding of an Inquiry-Based Approach gives credence to how they mediated the development of an Inquiry-Based Approach in their classrooms.

The four teachers presented knowledge of what an Inquiry-Based Approach is and how it can be used in the classroom. The participants' data from the questionnaires and semi-structured interviews also spoke to the principles of an Inquiry-Based Approach, the development of the learners' ZPD (Vygotsky, 1978; Stott, 2016) and how these could be dealt with in class. For this question, unlike other studies on the attitudes of Foundation Phase teachers towards teaching science in the Foundation Phase, it was evident that the four participants were positive about teaching science in this Phase and were keen to teach science (see Tables 5.4.1 & 5.4.2).

From the data, the challenges that were raised concerned the teaching time allocation for the Life Skills subject in this phase. The other challenge highlighted was the fact that Life Skills as well as two other subjects (Literacy and Numeracy) in the Foundation Phase, is not externally examined. In consequence, if learners do not do well in Life Skills, they are allowed to progress to the next grade and some teachers do not take Life Skills seriously. The four participants in this study raised the above challenges and most importantly, they highlighted the need for the Department of Basic Education to engage with the subject of Life Skills as it is the foundation for various content subjects and is embedded in them. Next, I discuss the findings that answer my research question 2 of this study.

8.3.2 Research question 2

As explained in the previous chapters and in Section 8.2 above, research question 2 of this study looked at the mediation process that took place in this study. In Chapter Six, I explained that the four teachers involved in this study taught three observed and video-taped lessons each. Hence, the total number of lessons observed was 12.

Research question 2 was as follows:

How do Grade 3 Foundation Phase teachers mediate the development of basic Scientific Process Skills through an Inquiry-Based Approach in their classrooms?

Research question 2, as already stated above, looked at how the participants mediated the development of basic Scientific Process Skills using an Inquiry-Based Approach in their Grade 3 classrooms. To analyse the lessons, the designed analytical tool adapted the principles of an inquiry approach and was used to see which of the principles the participants employed in their lessons. The basic or foundational Scientific Process Skills in the adapted analytical tool were used to observe which of the basic Scientific Process Skills the participants focused on or not during their lessons.

Zaretskii's (2016) six conditions as part of the adapted analytical tool were used to understand how the teachers mediated the development of basic Scientific Process Skills and how teachers developed learners' ZPDs during the mediation process in the classroom. These were further aligned and related to the principles of an Inquiry-Based Approach. Additionally, the components of TSPCK (Mavhunga & Rollnick, 2013) were also adapted as part of the analytical tool and were used to understand the teachers' PCK on the use of an Inquiry-Based Approach.

Using the adapted analytical framework, from the observations and videotaped lessons it was evident that teachers' levels of teaching basic Scientific Process Skills in their classrooms were different. Likewise, their understanding of an Inquiry-Based Approach was understandably in different ZPDs also. The concept of ZPD in this study, the concept of mediation, the concept of culture and the concept of social interactions were adapted and used as the vehicle to discuss how teachers mediated learning in their classrooms. These concepts from Vygotsky's (1978) socio-cultural theory linked well with the analytical framework in this study, as the core concept was mediation of learning.

As already explained and discussed in Chapters One, Three, Four and Six, the adapted analytical framework in this study, assisted me in understanding what took place in each observed lesson. In my view, the framework itself proved to be a tool that could be adapted to assist Foundation Phase teachers in understanding how they could mediate learning in their classrooms specifically using an Inquiry-Based Approach in the Foundation Phase.

In addition to the use of the analytical framework, the lessons taught in this study were in *IsiXhosa*, the mother tongue of both learners and the teachers. T1-T4 as discussed in Chapter Six were from quintile 3 and 4 schools where the language of teaching and learning was IsiXhosa. The use of the mother tongue in teaching science, proved to be a strength in promoting learning (Mavuru & Ramnarain, 2019), in contrast to literature, which highlights that the disadvantage of using a second language to teach science has been identified (Gudula, 2017). Once more, the use of easily accessible resources (Asheela, 2017; Ndevahoma, 2019) in the observed lessons was an advantage for teaching basic Scientific Process Skills in Grade 3 learners. Regarding the resources, learners were familiar with them. As a result, they were comfortable to use and manipulate these during their lessons. Furthermore, the utilisation of the school environment for both teachers and learners were also an advantage as it stimulated a positive learning environment, something reiterated by the constructivists (Vygotsky, 1978; McRobbie & Tobin, 1997; Stott, 2016).

T1, besides the above factors in the observed and videotaped lessons, used a unique approach. For instance, she introduced most of her science lessons using a *storytelling* approach, which catered for both a setting up of a positive environment and a scientific lesson. In my view as a researcher, this approach is appropriate for Foundation Phase learners as it introduces a scientific investigation in an interesting and a comfortable method. From a story to a scientific investigation, this approach worked well for T1. As a result, in all her three observed lessons were actively engaged (Sedláček & Sedova, 2017) and involved in scientific discussions which promoted scientific literacy and the development of basic Scientific Process Skills.

From the observation of lessons in this study, it was evident that in the Foundation Phase, learners love to be actively involved and to be engaged in discussions that stimulate their thinking. In my view, through asking the right questions, setting the correct space for learning, and for teachers to understand what an Inquiry-Based Approach is, teachers can develop basic Scientific Process Skills and promote scientific learning in their learners. It is thus the responsibility of teachers to understand their environment, to understand their learners' level of development and learning, and to create a culture of learning that suits their teaching environment. It could be argued, therefore, that this research question revealed the need for more developmental support for teachers in the Foundation Phase to understand and appropriately use an Inquiry-Based Approach in their classrooms. For instance, all four participants agreed and exposed that the teaching of science in the Foundation Phase was more important and it prepared young learners for science knowledge development in higher grades. Put differently, a solid foundation in Foundation Phase is a cornerstone for education.

The highlight for research question 2 as discussed in Chapter Six and highlighted above, was how the participants used everyday resources and how they used their school surroundings to teach and promote basic Scientific Process Skills through an Inquiry-Based Approach – it was a revelation. A revelation in the sense that Foundation Phase teachers as highlighted by literature are known to have some challenges in the teaching of science, but what this study did was raise the fact that there are teachers who are trying and unknowingly teaching science through the method of an Inquiry-Based Approach. Admittedly, the fact that science is embedded in Life Skills, makes it not explicit enough or makes teachers fear the teaching of science in this phase. As discussed in research question 1 above, how teachers understand the process or the method of an Inquiry-Based Approach and how they value the teaching of science in this phase, impacts on their teaching in their classrooms. The following is the summary of findings for research question 3 of this study.

8.3.3 Research question 3

As explained in the previous chapters and in Section 7.2, research question 3 of this study looked at the reflective space that took place in this research. In Chapter Seven, Section 7.2 I explained how the group reflections came about in this research study. After two lesson observations, the participants suggested meeting together to reflect on the process of the research and reflect on how they understood the research itself. This afforded me an opportunity to do research *with* these teachers rather than *on* them as reiterated by Ngcoza and Southwood (2015). Research question 3, which answered the third objective of this study (see Section 1.4), was as follows:

How do discussions and group reflections influence (or not) Grade 3 Foundation Phase teachers' understanding of basic Scientific Process Skills and Inquiry-Based Approach?

Allowing the participants to meet and agreeing to the request of the participants spoke to the ethics agreement of this study. In Chapter Four, Section 4.9, for instance, I discussed how this research was of mutual benefit to both the participants and me. Hence, agreeing to the participants' request meant that I *respected* them and *valued* the important role they each played in this research study. However, the reflective space as explained earlier on, was not part of the initial plan of this research and even though that was the case, it brought another, yet important dimension to this study. It could be argued that the reflective space resulted in the study being generative in nature.

For instance, the space allowed me to observe how the participants experienced the research process thus far and opened an opportunity for the participants to share their knowledge about the aim of this research with each other, which in turn assisted in strengthening their understanding of an Inquiry-Based Approach. Again, the group reflections supported the individual participants to strengthen their planning of science lessons using an Inquiry-Based Approach and this was evident in the second cycle of lesson observations.

After the reflective space, T2 as discussed in Chapter Six, had improved her last science observed lesson. Using the analytical framework in her lesson, she implemented most of the principles of an Inquiry-Based Approach and taught most of the basic Scientific Process Skills. Learners engaged and fully interacted with each other and with her as the teacher. Comparing the third lesson of this teacher with her first cycle of lesson observation, the third lesson had improved immensely, and such a shift could be attributable to the reflective space that was created.

Regarding the research ethics and the group reflections that took place in this study, for me as the researcher this meant that I allowed the participants' *voices* to be heard and to be part of this interpretive study. This supported the mutual benefit of the research and at the same time strengthened the research process. This for me was evidence of how as the researcher, I did not only ensure the research principles as discussed in Section 4.9, but in doing research *with* my participants, we also invariably adhered to the socio-cultural theory that underpinned this study. In working together, we drew on Vygotsky's socio-cultural theory, following the concept of social interaction where during the group reflections we interacted with each other. In addition, respect for each other and respect for elders is key in our culture (all four participants and myself as the researcher are *IsiXhosa* speaking and follow the same cultural norms) and therefore to respect my participants was key to me as the researcher.

The concept of the ZPD in this research did not only apply to how teachers developed learning in their learners, but in hindsight also applied to professional development of the participants themselves. For example, how the participants themselves assisted each other impacted on their ZPDs of an Inquiry-Based Approach and hence the significance of the reflective space in this research. Lastly, the concept of self-regulation emerged (Harrison & Muthivhi, 2013; Vygotsky, 1978), as the four teachers were motivated to be part of this research and to learn from each other. Moreover, the research itself motivated the participants to learn more about Life Skills as a subject and to give evidence to this they raised the need for professional development workshops to strengthen their teaching methodologies in Life Skills (see Chapter Seven, Section 7.2.1).

The theoretical framework in this study played an important role and next I discus its significance in this research.

8.4 Theoretical Framework in This Study

Vygotsky's (1978) socio-cultural theory underpinned this study. The overall data from each research question in this study (that is, research questions 1-3), were analysed and discussed using Vygotsky's concepts of *mediation*, *ZPD*, *culture* and *social interactions*. Within the socio-cultural theory, Zaretskii's (2016) six conditions for developing learners' ZPD during the mediation process were used as lenses to see how teachers developed basic Scientific Process Skills using an Inquiry-Based Approach with their learners. On the other hand, PCK focusing on TSPCK was used to identify the teachers' strengths in their understanding of the process of an Inquiry-Based Approach and basic Scientific Process Skills within the specific topics taught in each observed lesson.

The figure below describes and gives evidence of the relationship between literature and theory in this study. The literature and theory assisted to analyse the data and that gave evidence to the strengths, the relationship and the alignment of the literature and theory used in this study. Again, as discussed in the preceding chapters, the principles of an Inquiry-Based Approach, the socio-cultural theoretical concepts, Zaretskii's six conditions and the concepts from the TSPCK relate with each other (see Sections 2.6, 3.2 & 3.3). The strength of this research originated from the use of both literature and theory that underpinned this study throughout this thesis. From Chapter One to this last chapter, theory is weaved through as evidence that it underpinned this study.

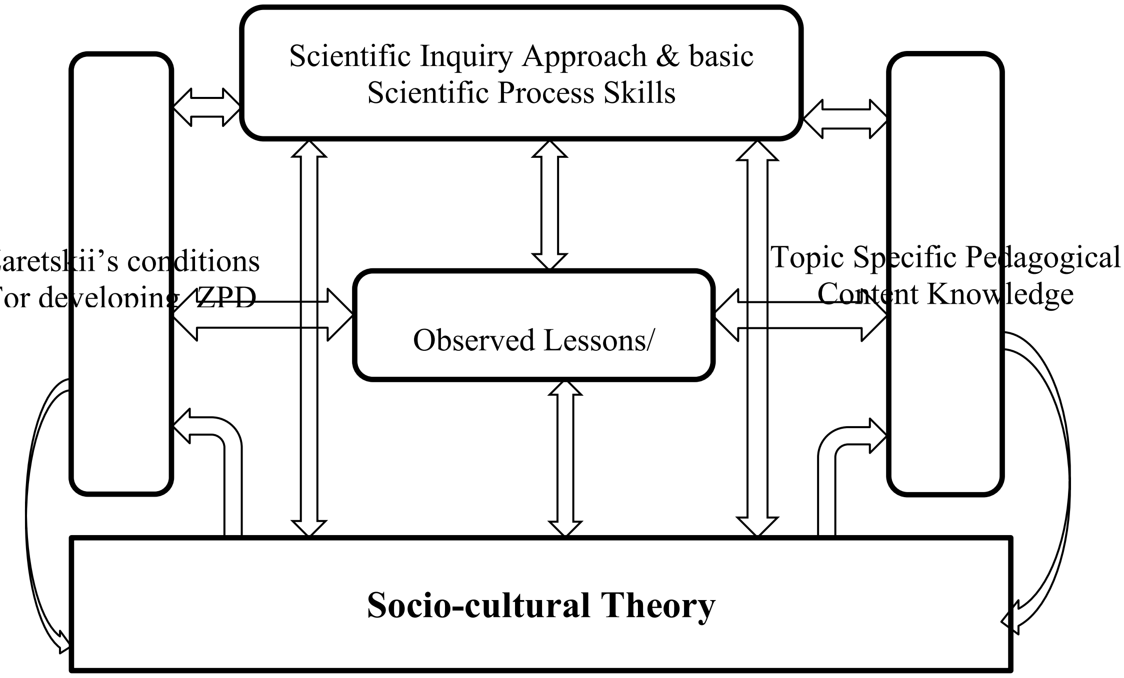


Figure 8.1: Shows relationship between theory and literature used for lesson observations

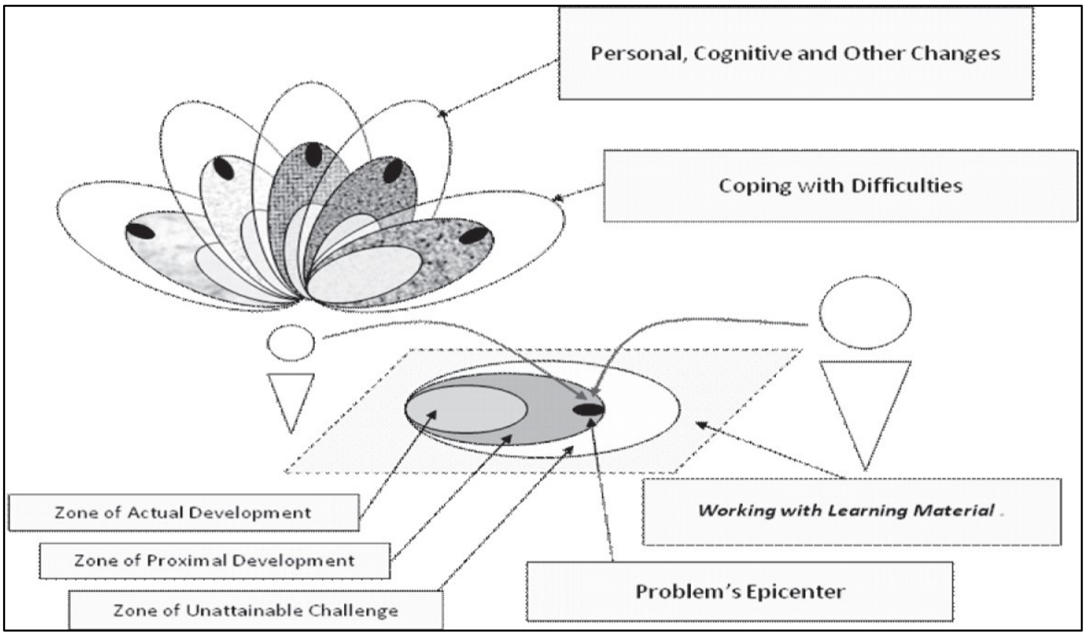


Figure 8.2: ZPD (1) as a generality of dimensions of potential developmental steps (Zaretskii, 2016, p. 155)

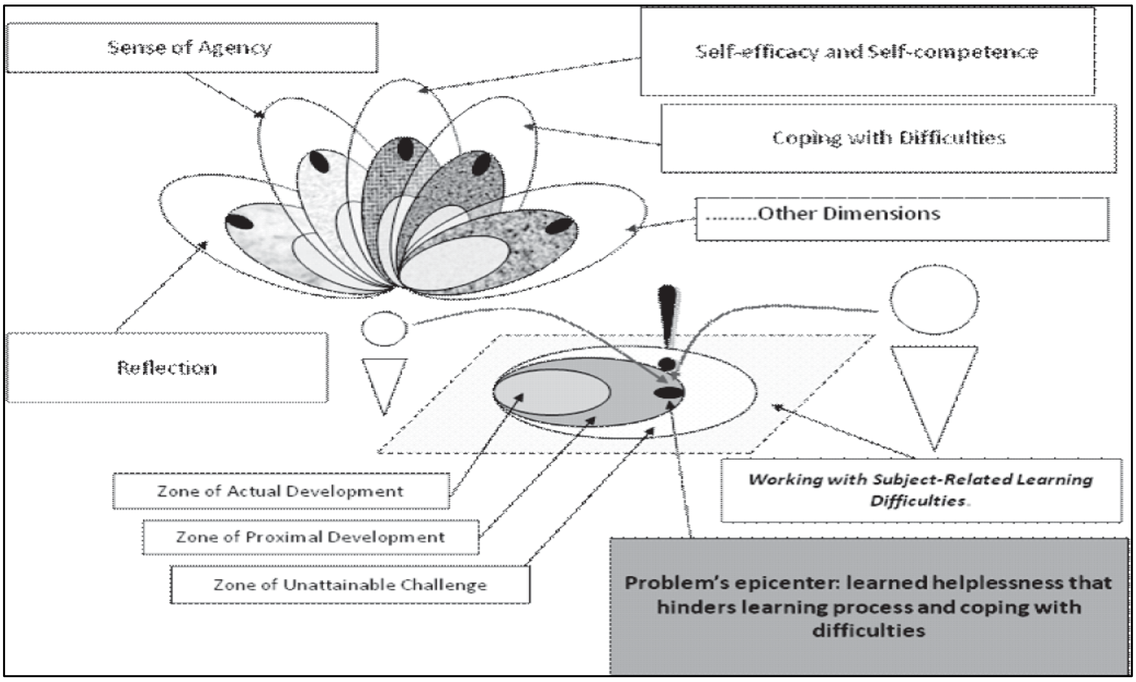


Figure 8.3: The multidimensional model of ZPD (2) (Zaretskii, 2016, p. 157)

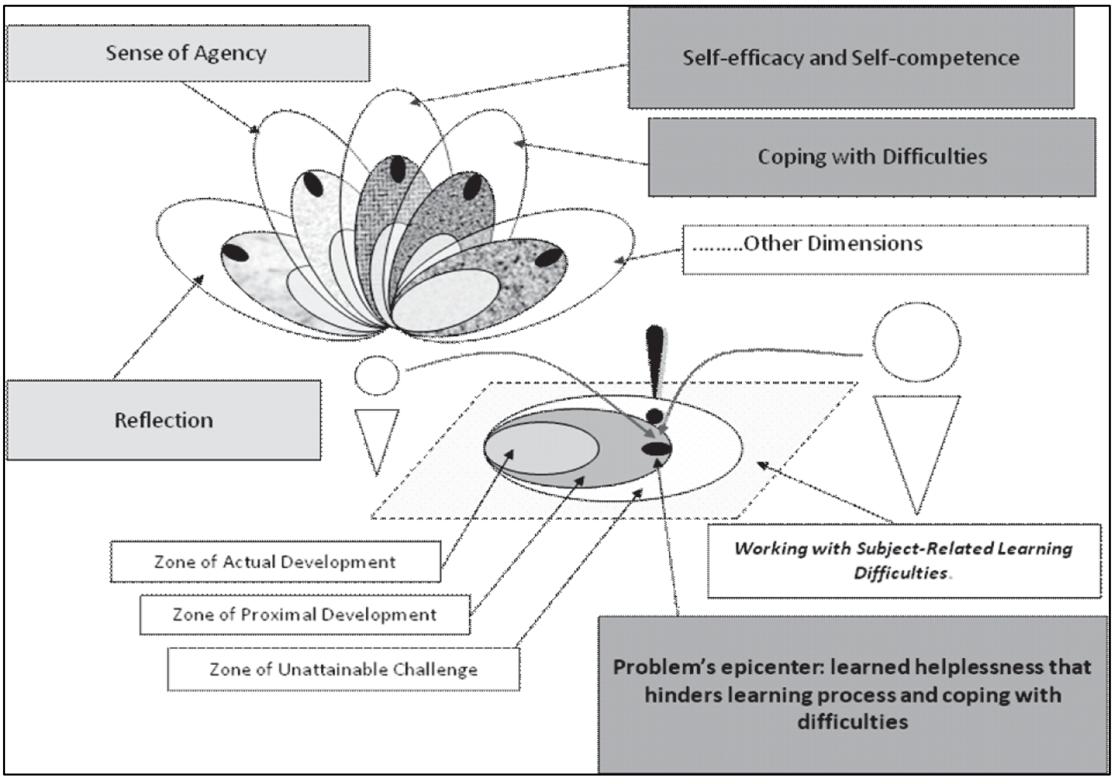


Figure 8.4: The multidimensional model of ZPD (3) (Zaretskii, 2016, p.158)

The three diagrams above, as part of the theory in this study give an overview on how the six conditions could enable a learner to develop through learning. As explained in the theory and methodology chapters, the three figures above illustrate how a learner starts to unfold like a flower through using Zaretskii's six conditions when developing learners' ZPD through the mediation process. In addition, Zaretskii's model shows the levels that represent how learners develop knowledge at various levels. A flower takes time to sprout and to develop; it needs to be looked after. Flowers do not also shoot up at the same time and at the same level. Like flowers, learners need teachers to assist and to work with them.

Notwithstanding, teachers in this study were at different levels of making use of the six conditions and these diagrams together with the six conditions could assist teachers in understanding how they could develop their learners' knowledge in learning. Overall, the concepts or stages in these diagrams speak to the concepts of the socio-cultural theory; hence, Zaretskii (2016, p. 149) drew his understanding of learning from Vygotsky's concept of "*One step in learning leads to a hundred steps in development*".

8.5 Ethical Issues in This Study

As discussed in Section 8.2.3, the participants' *voices* mattered in this study. With this in mind, when the participants advised to meet and reflect on each other's lessons and to learn from each other, as part of the ethics as a researcher, 'respect' for the participants was important at that moment. As the researcher, I adhered to my promise to respect and to maintain the dignity of my participants. Agreeing on this reflective space created a magical turn in this research project. For instance, it is through this reflective space that the participants freely narrated their experiences in this research and voiced the need for this kind of research in the Foundation Phase. Hence, Chapter Seven narrated the teachers' understanding of the research process itself and on their own taught lessons – that is, to understand what took place during the reflective space, and what teachers learnt from each other's lessons and from the research process. It could be surmised that as the researcher I set the scene by giving the background narrative about why this reflective space was necessary.

In doing the above, I drew from the informal discussions from the teachers during the first cycle of lesson observations. To continue the discussion, using the guiding questions that assisted to facilitate the reflections, I presented reflection narratives from each participant. To conclude the lesson narratives, I pulled the threads together discussing the outcomes from the group reflections.

This conversation on ethics in this study continued as together with two participants from this research, we presented at an Eastern Cape SAARMSTE[14] Chapter Colloquium – the title of our collaborative presentation called "Absenting the absences in ethics". In a lovely twist of the standard presentation process, the scientific Inquiry-Based approach formed the basis of our presentation and was drawn from this study.

At this stage of my research, I prioritised an investigation into the power of ethics in observational work. My take-home message was simple: the voices of participants are fundamental. In the spirit of promoting African approaches to ethics, the acknowledgement that I made in this presentation and in my research, project was that anonymising research participants in a study is tantamount to a nullification of their *voices* and *representations*. Thus, it could be argued that my study emphasised the transparent co-creation of knowledge from a grassroots level.

In her reflection T3 lamented that:

> *The focus should be on "teacher development", instead of "teacher training" believing that when teachers' skills and methods are developed, there is a longer lasting impact and follow-through.*

At the time of our presentation, T3 believed that there should be more teacher development programmes instead of teacher training. Again, drawing from the theories in this study, development is the key concept. Teachers too, in the same vein as learners, need to develop

[14] **SAARMSTE**: Southern African Association for Research in Mathematics, Science and Technology Education.

skills and methods of teaching so that the impact on their career as teachers is evident. T2 remarked that;

> *I would like to see more teachers invited into the research presentation process for future colloquiums. Exposure to different ways of thinking and doing – especially in the lesson planning and preparation phase will help more teachers implement creative alternative strategies in their teaching techniques.*

Similarly to T1, T2 highlighted the need to expose teachers to different ways of thinking and in planning of lessons. Again, this teacher spoke of creative ways of teaching techniques that could assist teachers to be better in their practice. It was evident that both these participants saw the need for continuing professional development in Life Skills and their thoughts are evidence of how they benefitted from this research study. Following from this, I present the new knowledge contributed by this study.

8.6 New Knowledge

In this research, my field of focus was the Foundation Phase level. As alluded to in earlier chapters, this research focused on the teaching of basic Scientific Process Skills using an Inquiry-Based Approach. This area of focus constituted a new contribution in research in the field of Science education as it shifted the science focus from the secondary school level to the Foundation Phase or primary, science teaching and learning. In the South African context, there is minimal research in this field as more attention has been given to Numeracy and Languages (literacy). To make the teaching and learning of science more explicit in the Foundation Phase might prevent the fear that is attached to learning science in secondary schools or higher grades. Since there is very little research on this in the South African context in particular, the foundational science knowledge embedded in the Beginning Knowledge of the Life Skills subject has become a hindrance or constraint in fulfilling the curriculum aims that talks to producing citizens who are *creative thinkers*. I vehemently argue that there is a need for a shift in mindsets in terms of teaching science in the Foundation Phase and in particular using an Inquiry-Based Approach to develop basic Scientific Process Skills.

Methodologically, this study made a significant contribution. For instance, the use of various methods in conducting data in this study made an important stance in this research.

Questionnaires were used to profile the participants and to document their understanding of the research objectives (see Section 1.4). To support the data and to strengthen the data from questionnaires, semi-structured interviews were used, and findings were authentic as they were validated through the use of different data gathering tools. Not only was the use of the two techniques qualitative, the data were further validated *with* the participants. In addition, the data from the initial phase of the study, gave a clear route to the second phase, which were classroom observations.

Equally, the use of video-taping and lesson observations gave a true reflection of how the participants understood an Inquiry-Based Approach and the development of basic Scientific Process Skills. The observed lessons lead to a reflective space where the major contribution of this space was on ethical issues in research. As the researcher, the importance of respecting and valuing my participants was the core factor during this research and this assisted in the smooth running of this research project. The participants' request to meet and share their experiences thus far in this research 'turned the tables around' as the aim was only to understand the participants' lessons. However, listening and accepting their request strengthened the research methodology of this study, hence the idea of '*the participants' voices matter'* or '*absenting the absences'* in this research.

The use or the design of the analytical framework that combined theory and literature was another contribution of this study. I believe that the tool may be used to research other contexts or other school phases on the use of an Inquiry-Based Approach. The framework gave a clear view and perspective of the participants' understanding and use of an Inquiry-Based Approach in their classrooms.

For mutual benefit and as a token of appreciation (Ubuntu) to the participants involved in this study, I designed a poster for each school (Appendix P). Both the school principals and the teachers (those involved and not) appreciated this. Additionally, I presented the poster at the SAARMSTE Conference, and it was well received by the delegates at the conference.

In the next section, I discuss and highlight the recommendations from this research study.

8.7 Recommendations

As explained in the previous chapters, this research sought to explore how Grade 3 Foundation Phase teachers mediate the development of basic Scientific Process Skills using an Inquiry-Based Approach in their classrooms. In doing that, four participants were part of this research project and were interviewed, engaged in informal and formal conversations and observed in their classrooms. To answer the questions asked in this study, various findings that complemented each other emerged from these methodological data gathering techniques, and as a result, the following recommendations developed from this study:

- With reference to the research question 1 of this study:, because of the lack of both quantitative and qualitative studies on Inquiry-Based Teaching and Scientific Inquiry in the Foundation Phase in South Africa, I explicitly chose to undertake an in-depth case study research into teachers' practices in this area to understand this phenomenon in more depth more deeply. While the results from this study cannot be generalised, they can be used to inform adaptation of research instruments for wider quantitative research studies across the field of Foundation Phase science teaching. I therefore recommend that the study be used in further research, for example, by adapting the Views About Scientific Inquiry (VASI) questionnaire by Lederman et al. (2014) to the South African context.

- Regarding my research question 2, there is a need to have in-depth lesson observations on the teaching of science related topics in the Foundation Phase and across all quintiles. Additionally, there is a need for research that focuses on the learners' experiences on the use of an Inquiry-Based Approach.

- Pertaining to my research question 3, there is a need for continuing professional development or professional learning communities for Foundation Phase teachers so that they are supported on how to promote basic Scientific Process Skills through an Inquiry-Based Approach. For example, there is a need to promote the use of easily accessible resources when teaching science, especially in under-resourced schools.

- Finally, in research, there is a need to relook at how ethics influences the research process especially in an African context.

8.8 Limitations of the Study

It should be acknowledged that every research study has its own strengths and limitations. This study is no exception. This study was conducted in the Sarah Baartman district in the Eastern Cape Province in South Africa. It was conducted with four teachers from four schools. It was recognised that the culture of the four participants and four schools did not represent the whole population of the Foundation Phase in the Sarah Baartman district of the Eastern Cape Province and South African teachers in general. Consequently, the study cannot be generalised. However, it provided some insights on how Foundation Phase teachers developed basic Scientific Process Skills by means of an Inquiry-Based Approach in their classrooms.

Various factors can have influence on the research process. These factors can affect the results or findings of a study. The four teachers in this study were a small group of Grade 3 teachers, two from a quintile 3 school and two from a quintile 4 school. As explained earlier, quintiles refer to different categories in which South African schools are grouped, according to their contexts. These factors did not allow the research findings from this study to be generalised across all South African schools who have Grade 3 Foundation Phase classes.

In view of the aforementioned limitations, however, if I were to do this study again, I would consider the following:

- To give the questionnaires to at least all Grade 3 Foundation Phase teachers in the Sarah Baartman district. On reflection, this could have strengthened the context of this study especially with regards to the perspectives of the teachers regarding the research aim of this study;
- To interview several teachers, not only the few participants. Again, as explained above, this might have assisted in having a broader view or perspective with regards to the aim of this study, but of course this was beyond the scope of this study;

- To consider all school quintiles (1-5). Once more, this would provide a broader view and a larger scale of findings for the research objectives of this study.

Notwithstanding these limitations, the findings from this research can be used as a yardstick to assist and to strengthen the teaching of science or Life Skills in Foundation Phase classrooms in South African Schools. I now present some potential areas for future research.

8.9 Areas for Future Research

This research on the use of an Inquiry-Based Approach in developing or teaching the basic Scientific Process Skills in Grade 3 Foundation Phase classrooms has raised more opportunities of research in the field of Foundation Phase Life Skills as a subject and as a curriculum. Adding to this, research on teachers' pedagogical content knowledge (PCK) in relation to an Inquiry-Based Approach can be extended to a larger scale of participants. Again, the focus could be shifted from teachers and an investigation done on how learners in the Foundation Phase respond to the use of an Inquiry-Based Approach by their teachers. The focus on various languages or the use of bilingualism in teaching basic Scientific Process Skills in the Foundation Phase can be another angle taken from this research. Given that recently the institutions of higher learnig are also graduating Foundation Phase male teachers, this could be a potential for a gender based research on teaching of science in the Foundation Phase. There is a need for a comparitave study across quintiles (1 to 5), on how schools in these quintiles respond to the teaching of science, development of basic Scientific Process Skills and the use of an inquiry approach in their Foundation Phase classrooms. In conclusion, the use of easily accessible resources in developing an Inquiry-Based Approach or teaching using an Inquiry-Based Approach in the Foundation Phase can be another area of research.

Next, I present the concluding section of this thesis. In doing this, I draw from the previous chapters of this study and draw from this final chapter as well.

8.10 Conclusion

Science teaching has become the most fundamental topic in the curriculum. The use of an Inquiry-Based Approach in developing basic Scientific Process Skills in learners, especially high school learners has been the focus for the science curriculum. Several studies have indicated strengths and gaps that hinder the successful use of this approach. The Foundation Phase Life Skills curriculum advocates the use of an Inquiry-Based Approach in developing the basic Scientific Process Skills in this phase (DoBE, 2011). Hence, this research project is important. This research project sought to understand how the Foundation Phase teachers used an Inquiry-Based Approach to develop basic Scientific Process Skills in their classrooms. To conclude this study, I draw from each chapter of this thesis. In doing this, I weave the threads of each chapter together.

Chapter One positioned the panorama for the study. The chapter introduced the reader to the contextual background of the study, the statement of the problem, significance of the study, research aim and objectives. The research questions were presented to highlight the research objectives and aims of this study. Explanations and descriptions of concepts in this study were discussed. Pertaining to the study, the introduction to an Inquiry-Based Approach and basic Scientific Process Skills was made. The theoretical overview that underpinned this study was introduced together with the theoretical concepts focused on. In Chapter One, I also introduced the data analysis and ethical issues in this study. Overall, Chapter One gave the contextual background of this study.

In **Chapter Two,** I engaged with the literature relevant to the research topic. Literature related to an Inquiry-Based Approach and the development of Scientific Process Skills in relation to this study was examined. Literature on challenges and benefits of using an Inquiry-Based Approach was deliberated upon in this chapter. Relative to this study, I also discussed the literature on practical activities in relation to the development of Scientific Process Skills in learners.

Chapter Three provided the theoretical underpinnings of this study, namely, the socio-cultural theory in particular, focusing on socio-cultural theory in relation to the concept of mediation, the ZPD, culture and social interactions. I discussed the analytical framework of PCK, focusing on TSPCK in relation to the participants' understanding and implementation of an Inquiry-Based Approach. Last, I discussed the process of data analysis relating to the described theories and framework that underpinned this research.

Chapter Four discussed the research design, methodology and the research techniques employed in this study. Questionnaires, semi-structured interviews, observations, stimulated-recall interviews and group reflections were critically discussed with reference to how each data technique was used to gather data and which turn this study took. Additionally, to understand the curriculum expectations and content in the Foundation Phase Life Skills subject I used document analysis. I engaged with data analysis, as well as issues pertaining to ethics and validity in this chapter.

Chapter Five positioned the participants' understanding and views from research question one. Using theory and literature, I presented, analysed and discussed data and findings in this chapter. The participants' understanding of an Inquiry-Based Approach, basic Scientific Process Skills and their views on science teaching in the Foundation Phase were crucial to this chapter. With the aim to present the truthfulness of the participants' *voices*, when presenting the data, the analytical statements were used to keep the data alive.

Chapter Six dealt with how the participants used an Inquiry-Based Approach to develop basic Scientific Process Skills in their classroom and this was the focus for research question two and the focus of this study. Again, I presented the data from the question 2 and the analysis of data using theory and literature was deliberated upon. Thus, the focus of this chapter was the mediation process in the participants' classrooms.

Chapter Seven concluded the process of research by presenting the data for question 3. Essentially, this research question considered the participants' reflections and stimulated recall-interviews with regards to this research. Their thoughts and views of the whole research process were the core of this chapter. How the research process impacted in their practice, is what Chapter Seven was about. Moreover, question 3 magically turned the ethics discussions on this study.

This **last chapter** presented a summary of findings and recommendations from the three questions and objectives of this study. The participants' interpretation and understanding of an Inquiry-Based Approach and their understanding of basic Scientific Process Skills was objective one of this study. Objective two of the study, which aligned with research question 2, looked at the mediation process of the four teachers developing basic Scientific Process Skills in their Grade 3 classrooms, the core question and objective of this study. Research question 3 answered objective three of this study, which looked at how the reflective space affected their teaching of basic Scientific Process Skills using an Inquiry-Based Approach. The recommendations made stem from the data that answered the aim and objectives in this study. This chapter also discussed the key roles played by both theories that underpinned this study and the ethical issues in this study. The chapter highlighted the limitations of this research project.

In conclusion, the findings of this research showed the importance of the instructional language used in teaching or developing an Inquiry-Based Approach in the Foundation Phase. For teachers' lessons (T1-T4), I narrated and highlighted the engagement of learners in Chapter Six, especially where learners were given the opportunity to engage. As a result of using the learners' Home Language (isiXhosa in this study), learners found it easy to engage with the teacher and to ask relevant questions. Questions are a socio-cultural practice in early learning amongst isiXhosa children in their home environments, and the use of an inquiry-based approach connects with this sociocultural practice, as does the use of familiar artefacts. This allows learners to participate with ease in Inquiry-Based Teaching practices. Furthermore, the use of isiXhosa Home Language afforded learners access to a wider vocabulary, which is essential for participating in argumentation and predictions, which are foundational to scientific inquiry (Mavuru & Ramnarain, 2019; Ngcoza, 2019).

Consequently, learners at the Foundation Phase level (Grades R-3) are known to be active and energetic. Their curiosity affords teachers an opportunity to fully engage and allow them to explore materials and resources. Hence, the use of an Inquiry-Based Approach in this phase has been demonstrated to be a good method of teaching in developing both basic Scientific Process Skills and scientific literacy. In addition, the use of easily accessible resources or everyday materials during the use of an Inquiry-Based Approach ensured learners were relaxed and indirectly the learners were taught basic Scientific Process Skills. The use of Zaretskii's six conditions, the principles of an Inquiry-Based Approach, the components or categories of TSPCK together with adapted concepts from the socio-cultural theory in this study, was a new knowledge of how literature and theory could be used to equip and support teachers in using an Inquiry-Based Approach effectively in their classrooms. The findings from this research as discussed in Section 8.9 also presented new areas of potential research. I now turn to the implications for this study.

The findings motivate the need for Foundation Phase teachers to be supported and to be equipped through professional development spaces on how to use or to strengthen the use of an Inquiry-Based Approach in their classrooms. The critical engagement with the Life Skills Curriculum with regards to how it was designed and how it is perceived in the Foundation Phase, is crucial in order to achieve its aims and objectives. Higher institutions of learning need to engage with Life Skills education and Life Skills as a subject in a manner that equips pre-service teachers so that they are able to teach all the required and the expected knowledge embedded in Life Skills.

In conclusion, drawing from Vygotsky's sentiment of "*one step in learning leads to hundred steps in development*", supports the importance of this research study as it is crucial for young learners to be *cognitively*, *emotionally* and *physically* developed. As revealed in this study, this sentiment, also speaks to how teachers should work together in professional learning communities to strengthen their knowledge and teaching skills (Brodie, 2016; Chauraya, 2016; Chauraya & Brodie, 2017; Ngcoza & Southwood, 2019).

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APPENDICES

APPENDIX A: Ethical Clearance

RHODES UNIVERSITY
Grahamstown • 6140 • South Africa

EDUCATION FACULTY • PO Box 94, Grahamstown, 6140
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PROPOSAL AND ETHICAL CLEARANCE APPROVAL

Ethical clearance number 2017.04.1.01

The minute of the EHDC meeting of 26 April 2017 reflect the following:

2017.04.1 CLASS A RESTRICTED MATTERS
DOCTOR OF PHILOSOPHY RESEARCH PROPOSALS

To consider the following research proposal for the degree of PhD (Education) in the Faculty of Education:

Kuhlane, Zukiswa (08K5463)

Topic: Exploring the foundation phase education teachers' pedagogical content knowledge on the development of scientific process skills and the implementation of assessment for learning in their classrooms.

Supervisor: Professor K Ngcoza
Co-Supervisors: Ms S Murray and Professor H Lotz-Sisitka

Decision: *Approved*

This letter confirms the approval of the above proposal at a meeting of the Faculty of Education Higher Degrees' Committee on the 26 April 2017.

The proposal demonstrates an awareness of ethical responsibilities and a commitment to ethical research processes. The approval of the proposal by the committee thus constitutes ethical clearance.

Sincerely

Prof Marc Schäfer
Chair of the EHDC, Rhodes University
17th May 2017

APPENDIX B: Letter to participants

17 April 2017

Dear research participant

Re: Participation in research on *Exploring Grade 3 Foundation Phase teachers' pedagogical content knowledge on the development of scientific process skills and the implementation of assessment for learning in their classrooms.*

Thank you for agreeing to be a research participant on my study. As per our discussions, my research area is on 'how Grade 3 teachers develop scientific process skills when teaching science topics during life skills lessons and how they implement formative assessment during these lessons'.

As discussed, the study will be conducted in four phases. The first phase requires the participants to complete the questionnaire and the second phase will be individual interviews with the participants. These interviews will help to clarify any misunderstandings that might have occurred when completing the questionnaires. The third phase of the study will be classroom observations and video recording of chosen science lessons by the participants (two lesson per term over three terms). Lastly, individual interviews and group reflections on the lessons taught per term will take place with the participants.

Your participation in this research study is completely voluntary and you can withdraw at any time you wish to do so. The data collected in this study will published as Rhodes University PhD thesis and in academic articles. The identity of each participant, their views and contributions will be treated with high degree of confidentiality and anonymity.

Yours sincerely

Zukiswa Kuhlane

Rhodes University

PhD in Science Education

Prof K. M. Ngcoza (Supervisor)

Rhodes University

………

I agree to participate in the research on condition that I can withdraw at any time.
Name: ……………………………………………………

Signature: ……………………………………………….

Contact number: …………………………………………

Date: ……………………………………………………..

APPENDIX C: Letter to school principals

The School Principal

[redacted]

Grahamstown

6139

Dear [redacted]

Subject: Request for permission and access to conduct educational research at [redacted] Primary School

I am Zukiswa Kuhlane, a part-time registered PhD Science Education student at Rhodes University (student number: 08k5463), a Bachelor Education in Foundation Phase Coordinator and a lecturer here at Rhodes University Department of Education. I am specifically responsible for the Life Skills course and science education. I hereby humbly request for permission to conduct a research study at Tantyi Lower Primary School for the next three terms in 2017.

My research topic of study is: *Exploring Grade 3 Foundation Phase teachers' pedagogical content knowledge on the development of scientific process skills and the implementation of assessment for learning in their classrooms.*

The Foundation Phase Life Skills curriculum in South Africa promotes the development of scientific process skills through inquiry-based learning. In the same manner, it promotes assessment for learning or formative assessment. The purpose of this learning strategy is to develop citizens who can take care of their environment and to make provision for the development of high quality scientists. This study aims to explore how Grade 3 Foundation Phase teachers understand the nature of *scientific process skills* in Natural Sciences, and in addition, how they develop the scientific process skills in their learners as part of the Beginning Knowledge study area of Life Skills Curriculum. Additionally, the study seeks to gain insights into how the selected teachers (participants) implement assessment for learning in their classrooms. This research study will comprise of four phases;

- ✓ **Phase 1**: I am hoping to send questionnaires to as many grade 3 foundation phase teachers these will help me to understand their thinking on the teaching of science in Foundation Phase. I would also use supporting materials and documents to see how these guide teachers in teaching of science or life skills in grade 3.
- ✓ **Phase 2:** In this part of the research I would like to interview the four teachers who will be the main participants for this research.
- ✓ **Phase 3:** The four teachers will be observed in their classrooms (two lessons per term) and this will continue for three terms.

- ✓ **Phase 4:** Lastly, after each term the four teachers will be individually interviewed and afterwards come together as a group to reflect on the process and on each other's lessons.

I would like to assure your office that, should I be granted permission, the research ethics will be applied at all times when carrying out my research. The identity of each participant, their views and contributions, the school, will be treated with a high degree of confidentiality and anonymity.

Your humble understanding in this regard will be highly appreciated and I look forward to hearing from you through completion of the template at the bottom of this page.

Yours' sincerely

Zukiswa Kuhlane

Rhodes University

PhD in Science Education

…………………………………………………………………………………………………….

I the Principal of [redacted] Lower Primary School hereby grant permission to the researcher to conduct her research in my school.

Name…………………………………..

Signature………………………………

Date……………………………………

APPENDIX D: Letter to Director of Education

The District Director of Education

Grahamstown

6139

To the District Director,

Subject: Request for permission and access to conduct educational research in the Sarah Baartman District

I am Zukiswa Kuhlane, a part-time registered Phd Science Education student at Rhodes University (student number: 08k5463), a Bachelor Education in Foundation Phase Coordinator and a lecturer here at Rhodes University Department of Education. I am specifically responsible for the Life Skills course and science education. I hereby humbly request for permission to conduct a research study in the following schools [redacted] primary schools for the next three terms in 2017.

My research topic of study is: *Exploring Grade 3 Foundation Phase teachers' pedagogical content knowledge on the development of scientific process skills and the implementation of assessment for learning in their classrooms.*

The Foundation Phase Life Skills curriculum in South Africa promotes the development of scientific process skills through inquiry-based learning. In the same manner, it promotes assessment for learning or formative assessment. The purpose of this learning strategy is to develop citizens who can take care of their environment and to make provision for the development of high-quality scientists. This study aims to explore how Grade 3 Foundation Phase teachers understand the nature of *scientific process skills* in Natural Sciences, and in addition, how they develop the scientific process skills in their learners as part of the Beginning Knowledge study area of Life Skills Curriculum. Additionally, the study seeks to gain insights into how the selected teachers (participants) implement assessment for learning in their classrooms. This research study will comprise of four phases;

- ✓ **Phase 1**: I am hoping to send questionnaires to as many grade 3 foundation phase teachers these will help me to understand their thinking on the teaching of science in Foundation Phase. I would also use supporting materials and documents to see how these guide teachers in teaching of science or life skills in grade 3.
- ✓ **Phase 2:** In this part of the research I would like to interview the four teachers who will be the main participants for this research.
- ✓ **Phase 3:** The four teachers will be observed in their classrooms (two lessons per term) and this will continue for three terms.
- ✓ **Phase 4:** Lastly, after each term the four teachers will be individually interviewed and afterwards come together as a group to reflect on the process and on each other's lessons.

I would like to assure your office that, should I be granted permission, the research ethics will be applied at all times when carrying out my research. The identity of each participant, their

views and contributions, the school, will be treated with a high degree of confidentiality and anonymity. I also promise to share outcomes of this research with the district.

Your humble understanding in this regard will be highly appreciated and I look forward to hearing from you through completion of the template at the bottom of this page.

Yours' sincerely

Zukiswa Kuhlane

Rhodes University

PhD in Science Education

I the Sarah Baartman District Director hereby grant permission to the researcher to conduct her research in the schools that are mentioned in the letter.

Name…………………………………..

Signature………………………………

Date……………………………………

APPENDIX E: Letter from Director of Education

Province of the
EASTERN CAPE
EDUCATION

SARAH BAARTMAN DISTRICT

DISTRICT DIRECTOR'S OFFICE
Graaff-Reinet Education District, Corner of Murray & Kruger Street, Private Bag X726, GRAAFF-REINET, 6280, REPUBLIC OF SOUTH AFRICA, E-mail: grtdistrictoffice@gmail.com
Tel: 049-8072200 (Switchboard) **Fax:** 049-8072254 **Enquiries:**

TO : Ms. Zukiswa Kuhlane

FROM : DISTRICT DIRECTOR: Sarah Baartman Education District
Graaff Reinet
6280

DATE : 09 JUNE 2017

SUBJECT : Permission to conduct educational research in schools in the Sarah Baartman Education District

The above mentioned has reference.

After careful consideration I have come the following conclusion;
Permission is hereby granted to your good selves to conduct your educational research in schools in the Sarah Baartman Education District, provided you adhere to the following:

- To conduct your research in [illegible] and [illegible] Primary Schools for 2017-2018 as per your request.
- That you will share the outcome of your research with the Department of Education.

I wish you all the best with your research project in our schools.

Thank you.

Yours in Education

....
NRW De Bruyn
District Director

APPENDIX F: Participants' profile

Dear Participant,

I am really honoured to work with you in this research. In order for me to understand your teaching context better, I would like you to help me with the following information.

Name & Surname	
Teaching Experience in grade 3 or FP.	
Qualification/s	
Your favourite teaching subject and why?	
Do you encourage the development of scientific process skills in your teaching?	

Do you plan science lessons for your teaching?	
What kind of resources do you use when teaching science?	
What is your school Ethos?	
How would you rate your school in terms of work ethics?	
How would you rate yourself in terms of work ethics	

APPENDIX G: Data from Phase 1

DATA FROM QUESTIONNAIRES: PHASE 1 OF THIS STUDY (T1-T4)				
	T1	**T2**	**T3**	**T4**
PERSPECTIVES ON	• In FP we do not use the word science, we use themes. These or some themes have a scientific angle. • It about observation, analysing, and exploration of what is around us. Meaning, our bodies and their functions, the environment, plants and electricity, etc. • Science opens eyes for learners to the fact that science is all around us. It speaks to their curiosity and encourages them to ask questions to think critically and logically.	• Science lessons need to allow learners to experiment and observe things. • Science should really start at this phase as learners are curious and still young • Lessons need to allow the leaners to explore	• Science in FP should be done practically, and it needs to start from Grade R. It is embedded in Life Skills curriculum. • Science is important in this phase because it can help learners to understand it better in higher grades. • It forms a foundation where more abstract and complicated scientific processes will be built on.	• A very important subject • Must be taught in early ages • FP teachers need to give foundation knowledge for higher Grades • It develops learners' thinking and knowledge • It assists leaners to think critically

METHOD OF INQUIRY APPROACH	• It is all about finding out about specific objects. • It is about observing, analyzing etc.	• Learners are asked to find out about the given topic for example growing a bean • Visiting museum to explore and to observe those things that we do not have in my school	• Tasks based process and prepared and develops science knowledge step by step • The teacher explains instructions and activities as learners are working • Teacher sets questions to be answered.	• It is about asking questions • Solving a problem • Discovery learning • Practical activities or being hands-on.
SCIENTIFIC PROCESS SKILLS	• It is about finding out • Working with real life experiences	• The process of experimenting • To explore, and find out, observe, • To answer questions	• The kind of thinking that is required to acquire scientific knowledge through tasks and practical activities set and questions asked. • They form a foundation for the necessary skills for acquisition of science knowledge	• Process of inquiring • It involves observing, comparing, classifying, measuring, experiments and communication • These skills widen learners' thinking • Expose leaners to do practical activities

ROLE OF A TEACHER IN SCIENCE INQUIRY APPROACH	• Assist learners in activities • Plan materials and lessons • Understand the topic to that I am going to teach	• To guide learners • To assess leaners • To assist during the activity • To understand my learners as a teacher	• Plans lessons • Ask and explain questions • Explains instructions • Sets tasks and activities	• Need to plan lessons and investigate the topic • Provide materials • Create comfortable space for learning
ROLE OF LEARNERS	• To work as a team when necessary • To answer questions and to ask questions • To record findings • To give feedback • To ask for help during activities	• Learners at this level like to be hands on and curious to know more. • Learners like to touch and smell at this stage • Lessons need to allow the leaners to explore	• Answer questions	• Giving feedback • Being active in a lesson • Collaborate with others
RESOURCES/MATERIALS DURING	• Use materials from home and around the environment	• To use everyday resources • Recycling materials • From home materials • posters	• Everyday materials, like soil, baking powder, coke, glycerine, vinegar, bread and beans, etc.	• Posters • Actual substances/ materials • Samples of what is taught • School surrounding • Use models

APPENDIX H: Data from Phase 2 (Examplar)

DATA FROM SEMI-STRUCTURED INTERVIEWS: PHASE 2 OF THIS STUDY(T1-T4)				
	T1	T2	T3	T4
PERSPECTIVES ON TEACHING SCIENCE IN FP	• "Science" when I hear this word I think of laboratory and experiment. • Instead I prefer the word themes in this Phase • The themes have a scientific element • Themes are used to further interrogate numeracy and language (integration).	• science is important • it helps learners to understand their world	• It is a subject that needs to be taken seriously and taught in FP • It prepares learners for high school subjects • From my experience, FP teachers do not take science seriously and learners find it difficult in higher grades "*We do not"*	• Science sets foundation for higher learning • In FP we teach the basic knowledge and sets them for difficult knowledge at higher grades • Science is important for FP learners
METHOD OF INQUIRY APPROACH	• It is when learners are given the opportunity to make sense of what they are learning • Through engaging in physical activities and real experiences. • To work with different materials that are making sense to what is taught.	• It assists leaners to see and find their own their own answers without a teacher leading them • But as a teacher I need to assist them • To make the invisible visible to learners	• It promotes practical activities • Learners get to observe, answer questions, building scientific knowledge and • Allowing learners to be involved in a task	• As a teacher you draw from what they know and from everyday experience • Learners need to be actively involved • Make learning visible • Everyone must be part of the lesson

	• Engages as many senses as possible so that learning is tangible and caters for many learning styles	• Use of senses is important		
SCIENTIFIC PROCESS SKILLS	• To experiment • Practical activities • Discuss, observe, ask questions, compare, • To be actively involved	• Exposing learners to various experiences • Leaners to use their senses • Learners touch, explain, describe, discuss, observe • Make sure there are real objects for my learners to use during activities.	• Task based way • Teaching step by step • Develop skills through activity • Ask questions, experimenting, observation, inferring, reasoning • Promote curiosity in learners • Do practical activities with leaners	• Use activity to ask questions • Develop learning skills • Observe and analyse objects
ROLE OF A TEACHER IN SCIENCE INQUIRY APPROACH	• Tom raise questions • To plan ideas for teaching • To give examples • To promote language and numeracy • To assess • Freedom of planning • To be creative in your teaching and planning	• Provide correct materials • Plan and research before I teach • Resources must be familiar to learners and at their level • Ask questions • Use pictures and models • Promote language and maths	• Ask thought provoking questions • Guide learners • Research work before teaching • Draw from leaners ‘ experiences • Find materials’ • Plan practical activities • Promote outside activities	• Bring the materials • Part of the lesson • Plan the lesson and • Arrange supporting material

ROLE OF LEARNERS IN SCIENCE INQUIRY	• To be part of the lesson • To answer and to ask questions • To engage in a lesson • To report back • To work together as learners	• They bring resources from home at times • Active in a lesson • Answer questions	• Ask and answer questions • Being active in a lesson • Bring materials • Work together in groups	• Answer questions • Part of the lesson • Actively involved in a lesson
RESOURCES/ MATERIALS DURING INQUIRY	• Everyday material from home • Things like food from home, water, kettle etc. • Recycling materials, magazines, news papers	• The school surroundings, magazines, models, posters and newspapers etc.	• Posters • Pictures, models, recycling materials etc.	• Resources from home, computers, fruits, vegetables, magazines, posters etc.

APPENDIX I: T1-T4 combined analysis

Questionnaires & Semi-structured Interviews Analysis Combined (T1 – T4)				
(Q)- questionnaires *(SI)- semi-structured interviews* ***Blue- T1***	T1	T2	T3	T4
	PERSPECTIVES ABOUT SCIENCE AND SCIENCE TEACHING IN FOUNDATION PHASE			
	• In Foundation Phase we do not use the word science, we use themes. These or some themes have a scientific angle. (T1Q) (T1SI) • It about observation, analysing, and exploration of what is around us. Meaning, our bodies and their functions, the environment, plants and electricity, etc. (T1Q) (T2Q) • Science opens eyes for learners to the fact that science is all around us. It speaks to their curiosity and encourages them to ask questions to think critically and logically. (T1Q) (T4Q) (T2Q)	• Science should really start at this phase as learners are curious and still young (T2Q) (T4Q) (T1Q) • Lessons need to allow the leaners to explore (T2Q)	• Science in FP should be done practically, and it needs to start from Grade R. It is embedded in Life Skills curriculum. (T3Q) (T4Q) (T2Q) • Science is important in this phase because it can help learners to understand it better in higher grades. (T3Q) (T4Q) • It forms a foundation where more abstract and complicated scientific processes will be built on. (T3Q) (T4Q)	• A very important subject(T4Q) (T3Q) • Must be taught in early ages(T4Q) (T2Q) • FP teachers need to give foundation knowledge for higher Grades(T4Q) T3Q) • It develops learners' thinking and knowledge(T4Q) (T1Q • It assists leaners to think critically(T4Q) (T1Q

Green-T2 ***Dark blue-T3*** ***Red-T4***	**UNDERSTANDING AN INQUIRY-BASED APPROACH**			
	• To experiment(T1Q) • Practical activities (T1Q) (T3Q) • Discuss, observe, ask questions, compare, (T1Q) (T3Q) (T2Q) • To be actively involved(T1Q) (T3Q) (T2Q) (T4Q)	• It assists leaners to see and find their own their own answers without a teacher leading them(T2Q) • But as a teacher I need to assist them(T2Q) • To make the invisible visible to learners(T2Q) (T4Q) • Use of senses is important (T2Q) (T3Q) (T1Q)	• It promotes practical activities (T3Q) (T1Q) • Learners get to observe, answer questions, building scientific knowledge and (T3Q) (T1Q) • Allowing learners to be involved in a task (T3Q) (T4Q) (T2Q) (T1Q)	• As a teacher you draw from what they know and from everyday experience(T4Q) • Learners need to be actively involved(T4Q) (T2Q) (T1Q) (T3Q) • Make learning visible • Everyone must be part of the lesson(T4Q) (T2Q)
	UNDERSTANDING ABOUT TEACHERS' ROLE			
	• To raise questions(T1Q) (T2Q) (T3Q) • To plan ideas for teaching (T1Q) (T2Q) (T4Q) (T3Q) • To give examples (T1Q) • To promote language and numeracy (T1Q) • To assess(T1Q) • To be creative in your teaching and planning (T1Q)	• Provide correct materials(T2Q) (T3Q) (T1Q) • Plan and research before I teach(T2Q) (T1Q) (T4Q) (T3Q) • Resources must be familiar to learners and at their level(T2Q) • Ask questions(T2Q) (T3Q) (T1Q) • Use pictures and models(T2Q) • Promote language and maths (T2Q)	• Ask thought provoking questions (T3Q) (T1Q) (T2Q) • Guide learners (T3Q) • Research work before teaching (T3Q) (T1Q) (T2Q) (T4Q) • Draw from leaners ' experiences (T3Q) • Find materials' (T3Q) • Plan practical activities (T3Q) • Promote outside activities (T3Q)	• Bring the materials (T4Q) • Part of the lesson (T4Q) • Plan the lesson and (T4Q) (T1Q) (T3Q) (T2Q) • Arrange supporting material (T4Q)

	UNDERSTANDING ABOUT LEARNERS' ROLE			
	• To be part of the lesson(T1Q) (T2Q)(T3Q) (T4Q) • To answer and to ask questions(T1Q) (T2Q)(T4Q) (T3Q) • To engage in a lesson(T1Q) (T2Q) (T4Q) (T3Q) • To report back (T1Q) • To work together as learners (T1Q) (T3Q)	• They bring resources from home at times(T2Q)(T3Q) • Active in a lesson (T2Q) (T1Q))(T3Q) (T4Q) • Answer questions (T2Q) (T1Q) (T4Q) (T3Q)	• Ask and answer questions (T3Q) (T2Q) (T4Q) (T1Q) • Being active in a lesson(T3Q) (T1Q) (T4Q) (T2Q) • Bring materials (T3Q)(T2Q) • Work together in groups (T3Q) (T1Q)	• Answer questions(T4Q) (T2Q)(T3Q) (T1Q) • Part of the lesson(T4Q) (T1Q) (T2Q)(T3Q) • Actively involved in a lesson(T4Q) (T1Q) (T3Q) (T2Q)
	VIEWS ABOUT THE MATERIALS TO BE USED WHEN USING INQUIRY APPROACH			
	• Everyday material from home (T1Q). (T4Q) • Things like food from home, water, kettle etc. (T1Q) (T4Q) • Recycling materials, magazines, newspapers (T1Q) (T2Q)(T3Q)	• The school surroundings, magazines, models, posters and newspapers etc. (T2Q) (T3Q) (T1Q)	• Posters(T3Q) • Pictures, models, recycling materials etc. (T3Q) (T1Q)	• Resources from home, computers, fruits, vegetables, magazines, posters etc. (T4Q) (T1Q)

	T1	T2	T3	T4
PERSPECTIVES ON TEACHING SCIENCE IN FP	• "Science" when I hear this word I think of laboratory and experiment. T1SI • Instead I prefer the word themes in this Phase T1SI • The themes have a scientific element T1SI • Themes are used to further interrogate numeracy and language (integration). T1SI	• science is important T2SI T4SI • it helps learners to understand their world T2SI	• It is a subject that needs to be taken seriously and taught in FP T3SI • It prepares learners for high school subjects T3SI T4SI • From my experience, FP teachers do not take science seriously and learners find it difficult in higher grades "*We do not*" T3SI	• Science sets foundation for higher learning T4SI T3SI • In FP we teach the basic knowledge and sets them for difficult knowledge at higher grades T4SI T3SI • Science is important for FP learners T4SI T2SI

APPENDIX J: Semi-structured interview questions

Teacher Semi- Structured Interview Questions

NOTE: This interview followed a questionnaire after the four participants in this study had answered it.

Purpose:

To determine how Grade 3 Foundation Phase teachers understand basic Scientific Process Skills, their view of teaching science in Foundation Phase and their understanding of an Inquiry-based Approach.

1. Generally, how do you feel about teaching of science in Foundation Phase in the Life Skills Curriculum?
2. To your understanding, what are basic Scientific Process Skills?
3. What do you understand about inquiry-based approach?
4. How do you develop basic Scientific Process Skills in your class?
5. What do you think is a Role of a teacher when developing basic Scientific Process Skills in learners?
6. What do you think is a Role of a teacher when planning for an Inquiry-Based Approach lessons?

APPENDIX K: Interview schedule

Teacher Interview Schedule 1: Example of responses

NOTE: This interview followed after a questionnaire has been answered by the four participants (Their biography, Teaching background and experience, general questions on Life Skills curriculum and science teaching on Foundation Phase).

Purpose:

To determine how grade 3 Foundation Phase teachers understand basic Scientific Process Skills, their view of teaching science in Foundation Phase and their understanding of Inquiry-based Approach.

1. Generally, how do you feel about teaching of science in Foundation Phase in the Life Skills Curriculum?

Science is important in this phase. It helps learners to understand their world.

2. To your understanding, what are basic Scientific Process Skills?

Scientific Process Skills are able to exposed learners to the various experiences (discussing issues, describe objects and explain). Learners experience what is taught, they observe and touch things. Each learner is able to use his or her senses.

Follow up Q: So, do you believe learners have to experience these skills themselves?

Yes Zuki, learners need to be exposed to these skills during class activities. As a teacher I need to create a space for my learners to see real objects when I am teaching.

3. What do you understand about inquiry-based approach?

Learners need to see and find their own answers without a teacher leading them but assisting them. To inquire is to find out on their own. For example, I do take my learners to the museum at times especially when I am teaching about space. To make the invisible visible to my learners. Use of their senses is also important.

4. How do you develop the basic Scientific Process Skills in your class?

By providing the correct material, collecting information before I teach, resources must be at the level of learners and familiar to them. My learners are from a poor community so as a teacher I need to help them and assist in collecting resources for them. Sometimes they amaze me and bring the resources themselves even when I have completed the theme I was doing with them. Learners keep on bringing the material. Also, when I am teaching science, I do not use the word science in my class, the vocab is in their level.

Follow up Q: How do you then develop these skills?

I use the garden at school – observe how we plant, and how plants grow. So, I promote outside classroom experience.

5. What do you think is a Role of a teacher when planning for an Inquiry-Based Approach lessons?

As said inquiry helps to develop these science skills. Asking questions, using pictures and models. Use of different materials.

In conclusion:

Since my learners come from a poor community. They do not get some materials and they are not familiar with some of the things I used when teaching in class. It really difficult for them at times to even bring magazines.

In grade 3 I try to use both English and IsiXhosa to prepare my learners for grade 4. I also integrate life skills themes to promote language and maths. By asking questions that can promote maths and language.

APPENDIX L: Example of transcript

Transcript of School 1

(...) = inaudible

/ = speaker interrupted

~ = pause

^ = teacher cueing in learners for an answer.

Teacher: Ndifunutyi apile lam

Leaner: Hayi alikho Mam

Teacher: Uthi wena alikho nhe, inoba liphi?

Leaner: Lityiwe nguMakhulu

Teacher: (uyahleka) haha okay! wena?

Learner: Lityiwe ngu ~Taka hlehle.

Teacher: Uthi lityiwe ngutaka hlehle heeee yhooo abantu basendlinam nibenza njani, uthini wena Mihlali?

Learner: Lityiwe zimpuku Mam

Teacher: Lityiwe zimpuku and ezampuku zikhona nangoku bonanje azikahambi, uthini wena Lingo?

Learner: Ndithi ba umhlambi ela apile lithathwe ~ ligrunywe ziimpukane.

Teacher: Ucimba nawe ligrunywe... jonga nzakuxelela akhomntu uthathe iApile lam ke ndikuxelele, because abantu ndiyabaxelela ukuthatha into yomntu kuthini ^?

Learners: Bubusela (Abanye: Kukuba)

Teacher: Bubusela so akhomntu uthathe into zam! Kodwa khawujonge into eyenzekileyo

Learners: Hayi (bekhuza) (Abanye: libolile

Teacher: Libolile?

Learners: Ha a Mam

Teacher: Litheni?

Learner: Lijike icolour

Teacher: Lijike umbala,linjani bendilisike linjena dan?

Learners: Ha a Mam

Teacher: Lijike umbala, nicingi ntoba inokuba kutheni lijike umbala^?

Learners: Kuba kudala lihleli Mam

Teacher: Kuba kudala lihleli, ngubani umntu owake wajikelwa liApile?

Learners: (Baphakamise izandla)

Teacher: Nani, Walithini walithini ukujikakwalo?

Learner: Ndalilahla (Omnye: Ndalisika

Teacher: Ngobani abalilahlayo? Phakamisa isandla ukuba walilahlayo

Learners: (Baphakamisi izandla)

Teacher: Ulilahlelani? Khandixelele ulilahlelani walilahlelani wena Mihlali?

Learner: Ndandicinga libolile ndalilahla

Learner: (Bayahleka)

Teacher: (Uyahleka) Wawucinga libolile, ngobani abalityayo lalinjani elakho ngokuya walityayo Luxolo?

Learner: Lalimnandi Miss

Teacher: Lalisemnandi waligcina ixesha elingakanani?

Learner: Elifutshane Miss

Teacher: Elifutshane khandixelele mhlawumbi walishiya I hour, walishiya ihours ezimbini okanye walitya ngengomso?

Learner: I hour

Teacher: Inoba walishiya I hour wafika linjeyana. So nithini mandilitye^?

Learners: Ha ana Miss

Teacher: Jonga uba umntu uthi mandilitye masilitye sobabini

Learners: Ewe Miss (abanye: bayahleka)

Teacher: (laughs) Yimani ke khandixelele ikhona enye into eqhelu tshintsha xa uyishiyile mhlambiphandle kowenu uyishiye uyisikile xa ufika uqonduba haa itheni ngoku yatshintsha umbala?

Learner: Ewe Miss

Teacher: Yintoni mntana?

Learner: Lipere Miss

Teacher: Lipere nhe, Lipere qha

Learner: Nebanana

Teacher: Nyani?

Learners: Abanye: Hayi

Teacher: Yimani, yimani ndicelubuza uthi uSinalo nebanana, Leaners: (Bayahleka)

Teacher: Yimani uSinalo uthi nebanana nina nathi hayi niyazelaphi nina nake nashiya ibanana?

Learners: Hayi

Teacher: Njani niphikise uSinalo owaye shiye ibanana nithi zange yenzeke lonto kwi banana.

Learners: (Bayahleka)

Teacher: Yimani ke ndibuze yenzeka lonto kwi fruit qha^?

Leaners: Ha a Miss

Teacher: Yenzeka nakwi ntoni?

Learners: Nase kutyeni…

Teacher: Okunjani ukutya?

Learner: Kwi rice Miss

Teacher: Irice xa uyishiyile ibuya i brown?

Learner: Mna Miss xandiyishiye fridge

Teacher: Eheeee Mihlali amdikuqondi, kodwa mna mdiye ndaba nomdla bantwini ndaqonda hey andiyaz ba kutheni ifruit yam ijike yanje ngubani oyaziyo kutheni ijike yanje kuthi ngubani oyaziyo, ngubani oyaziyo^?

Learner: Kuba Miss uyishiye ithuba elide

Teacher: kuba ndiyishiye ithuba elide okay uthu u… wayeyi shiye ihour eyakhe, kutheni ekaa nayo yajika? Sthandwa sam

Learner: Ibethwe lilanga qgitha

Teacher: Uthi wena inoba ibethwe lilanga qgithi, okay uthini omnye

Learner: Ibethwe bubushushu

Teacher: Inoba ibethwe bubushushu okay nicinguba ikhona indlela ngendiyinqande ngayo lento ayenzeka, because keiApile lam bendilifuna ngoku ndibuya and kengoku iyandi warisha intoba kuthwe eli apile kufuneka ndililahlile, uthi wena ngendilifake efridge omnye uthi ngendilitheni?

Learner: Livase Miss

Teacher: Ngendilitheni?

Learners: Livase Miss

Teacher: Ndilivase ngoku?

Learners: Haaaa

Teacher: Ndibuza ukuze ingenzeki lento kwa ukwenzeka, ngendiyenze ntoni? Ngendilivasile before ndilishiye?

Learner: Ha a Miss ulifake efridge

Teacher: Ngendilifake efridge, uthini wena Lingomso?

Learner: Okanye Miss uliqgume ngento

Teacher: Okanye ngendiliqgume ngento? Mamela ke uLingo uthi okanye ndiliqgume ngento yazi bendingakhange ndiyicinge yazi mhlawumbi ngendilithathile ndayenza into ngaphandle kukolifaka efridge mhlalwumbi ndiqabe into okanye ndiyifake emanzini mhlawumbi ke ndiyifake emanzini anantoni?

Learner: a clean

Teacher: Ngendilifake emanzini aclean, mhlawumbi ndilifake emanzini ashushu

Learner: Emanzini ane tyiwa (ehleka)

Teacher: Mhlawumbi emanzini anetyuwa

Learner: Amanzi aneswekile

Teacher: Mhlawumbi emanzini ane swekile

Learner: Emanzini abandayo

Teacher: Okanye ndilifake emanzini abandayo yazi, and akhange ndibenaxesha lakuyenza uyayazi moss thina izinto sifuna ukuzibonela ngokwethu, ndaqonduba jonga ndizakuza apha esikolweni and apha esikolweni sizakufika sizame zonke ezizinto nizithethayo, sizakuzama amanzi anhe?

Learner: Tyuwa

Teacher: Amanzi ane tyiwa ngubani ebethe amanzi anhe swekile?

Learner: Ndim

Teacher: Sizame amanzi ane swekile okanye sizame amanzi ane ncidi yeLemon, niyayinobona iLemon? Imuncu moss iLemon, Isweet ilemon?

Learners: Ha a Miss, Abanye: uyigalela iswekile, Abanye: Imuncu

Teacher: Uthini Anothando

Learner: Uyisele Miss uyigalele iswekile

Teacher: Isele uligalele iswekile?

Learner: Hayi Miss

Learners: Uthi uyisele

Teacher: Oh okay mamela ke sithandandwa sam into esizakuyenza ngoku sizake sisike iApile lethu and sifunu jonga uba nyan nyan na lamanzi ayasebenza nha and ngawaphi amanzi asebenza bhetele ukwenza ifruit yethu ingatshitshi ibenjani?

Learner: Yityuwa Miss

Teacher: yima kaloku asikafiki apho and sifuna uzibonela ungaqashela uthi yityuwa, sizakufika apho uqashele egruphini yakho uba nina apho egruphini nicinguba ngawaphi amanzi azakwenza ifruit yakho ingajiki ibe?

Learner: ibe brown

Teacher: ingajiki ibe brown, and kengoku asisebenzi nga Apile qha ukhona omnye umntu othe nantoni yakhe yatshintsha yabrown?

Learner: lipere Miss

Teacher: uthe lipere but ngoku siphethe intoni?

Learner: iApile

Teacher: Siphethe iApile nantoni?

Learner: Nebanana

Teacher: Nhe Banana nenye into endingayaziyo nokuba niyayazi na?

Learners: Siyayazi Miss

Teacher: Siphethe ne Avocado ngoba sifunu bona ingaba olutshintsho into ibe brown wenzeka kwi fruits ezininzi nha okanye wenzeka kwi Apile, ngoba mna ndazi iApile uthi ke uSinalo nebanana so sifuna ujonga nebanana uba ingaba unyanisile na uSinalo, nantoni enye

Learner: Avocado

Teacher: NeAvocado, mamela ke into masiyijonge okokuqala masiyibhale intoba kwezizintozethu, kwezi container zethu sizakuba necontainer eziyi4 igruphu nganye izakuba necontainer eziyi4, izitya eziyi 4, kwisitya sokuqala akuzubakho manzi, kuzabe kukho lento uzabe usebenza ngayo, uba usebenza nge apile kuzabakho I slice se apile,uba uzabe usebenza ngantoni?

Learner: ngebanana

Teacher: ngebanana kuzabe kukho islice sebanana, uba uzabe usebenza ngantoni?

Learner: i Avacado Miss

Teacher: kuzabe kukho Avacado anhe, asinanto ke esi sinesiqhamo qha, zisinika ntoni kanene iziqhamo?

Learners: Iivitamins

Teacher: Nantoni enye?

Learners: Minerals

Teacher: Neminerals nantoni?

Learner: Nefibre Miss

Teacher: Niyakhumsha kanjani yintoni ifibre?

Learner: (...)

Teacher: Inceda ntoni ifibre?

Learners: Ukutya kuhambe kakuhle emathunjeni

Teacher: Ukutya kwakho kuhambe kakuhle emathunjeni(...) kweyesibini saba namanzi anantoni sifuna ukuba ibe namanzi anantoni?

Learner: Neswekile

Teacher: Amanzi ane... mamela ke sifuna usebenzisa itisipuni yeswekile okanye icephe leswekile?

Learners: Icephe leswekile

Teacher: Ane cephe leswekile

Learner: Amabini

Teacher: Hayi izakuphela iswekile yethu Anothando (laughs) eyesithathu sifuna ibe nantoni?

Learners: Ityuwa

Teacher: Xasisebenzise icephe leswekile sifuna usebenzisa ityuwa engakanani?

Learner: Itisipuni, Abanye: icephe Abanye: ihafu yecephe

Teacher: Kutheni sisithi ihafu yecephe? Ngubani lo uthi ihafu yecephe? Sthandwa sam

Learner: Kuba Miss ungayididiyeli Miss

Teacher: Kuba wena ufuna siyididiyele betere sisebenzi ihafu yecephe, uthini omnye? Uthini wena Ningo

Learner: Umhlawumbi Miss izaba sweet kakhulu

Learners: Hayi

Teacher: Yima ke Ningo uthuNingo mhlawumbi izaba sweet kakhulu ngoku sithetha ngeswekile kanye sith?i kulaManzi

Learner: Siii… sofaka iii…

Teacher: Sofaka esosiqhamo sisebenza ngaso, kodwa xasithe icephe leswekile funeka senze sure ukuba neletyuwa ngumlinganiselo ofanayo neleswekile, Klaas ndicela kulandawo ubuhleli kuyo mntanan ngaphandle uthi Miss indixakile lento ndifuna uyithetha ngoku yintoni le ufuna uyithetha ngoku yintoni le ufuna uyithetha ngoku? Myeke uLuphumlo akekho nase gruphin yakho (…) myeke mntanam avha okay, so amanzi alandelayo azaba nantoni?

Learner: (…) necephe letyuwa

Teacher: Amanzi anecephe letyuwa

Learner: leswekile

Teacher: okay besithe kengoku leye sine izakuba inantoni?

Learner: Amanzi ashushu, Abanye: Amanzi abandayo…

Teacher: besiyithethile wathi uOnothando sofaka iswekile..yhuu imnandi kakhulu xaidibene neswekile

Learner: iLemon

Teacher: sizakuyigalela kangakanani ke ilemon? Yimani ke mantombazana make ndibuze apha emakhwenkweni, sizakuyigalela kangakanani Luphumlo iLemon juice leyethu

Learner: Kaninzi Miss

Teacher: Kaninzi nhe kaloku kufuneka sibenawo umlinganiselo wawo asinawukwazi ukuthi kaninzi because ukanintsi wakho akafani nokaninzi kaLuyolo

Learner: Kayi 2 Miss

Teacher: Kayi 2 njani uthetha njani kay2

Learner: Sogalela amacephe amayi2

Teacher: Sigalele amacephe amangaphi apha?

Learners: 2 abanye: 1 Miss

Teacher: Sigalelele icepe leswekile, Apha sigalele amacephe angakanani?

Learner: 1 Miss

Teacher: ane cephe letyuwa, apha sogalela kangakanani

Learner: 2 Miss

Teacher: Ngoba kutheni apha kufuneka sigalele 2

Learner: Ngoba...

Teacher: Ngoba? Imilinganiselo besithe kufuneka ithini Mihlali? Apha besithe imilinganiselo kufuneka ithini?

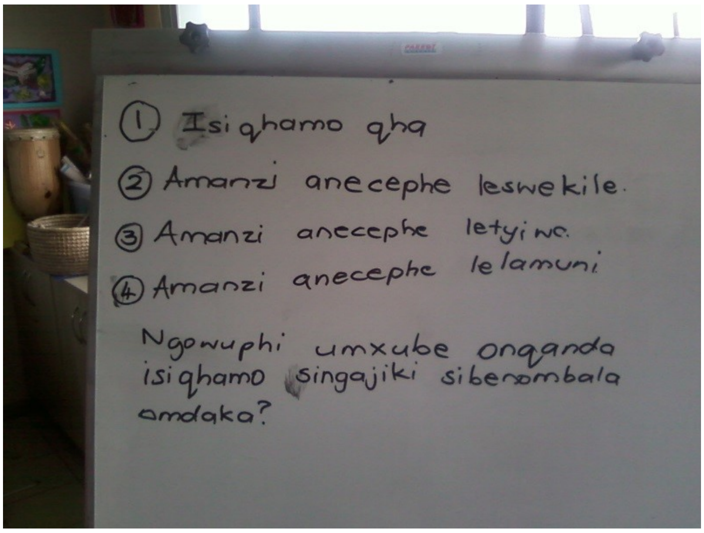
Learner: Ilingane Miss

Teacher: So uba apha besigalelele icephe leswekile, apha sagalela icephe letyuwa, apha kufuneke sigalele icephe le

Learner: Le Lemon

Teacher: Good, Ndifuna ukuthi ilemon engakakanani, ey ndinixelele impendulo amanzi anecephe le

Learners: le Lemon



Teacher: Le lemon, Ngoku into esizayenza ndizakunahlula nibe ngamantoni

Learners: Ngamaqela Miss

Teacher: Nibengamaqela, and iqela ngalinye lizakuba nomntu ozakujonga xesha libe nomntu ozakubhala phantsi nzakuninika iphepha lokubhala nzanicacisela elaphepha ngelothini, igruphu yokuqala nguLuyolo nguLingomso nguLuphumlo noAnothando khanindixelele nifuna ukusebenza ngantoni nina? Dibanani niyixoxe ke dibanani niyixoxe. Sinalo Mihlali K no Asonwabisi ningu gruphu2 nina, Mihlali Nqginzi Lithemba LinamandlanoSibabalwe niyenye igruphu, khawuleza nixoxe uba nifuna usebenza ngantoni.

Learners: (benza ingxolo) Avocado, Banana, Apile

Teacher: Hayi batsho aba kuqala, bathe Avocado, okay ndicela nibhekele ke because asizokwazi ukuzixutha sizakuzifumana sonke, Ina Anothando

Learner: Thina Apile

Teacher: Nifuna usebenza ngeApile, hay batsho iApile kuqala besenithethe ngeBanana khake nizijongeleni iBanana, ningalityi okwangoku ningalityi, Jongani khethani apha egruphini yenu ngubani umntu ozasijongela ixesha ngoba kaloku sifuna ukhangela ngeyiphi ezakusinceda, yima lentika awuyiva lento siyithethayo uyancokola, mamela lingomso Yima sthandwa sam yima ke ndizakuxelela kuqala into esizabe siyijonga, kuqala simane emveni kwexesha siyojonga uba ingaba seyitshintshile ngoku into yethu yanombala obrown, kuqala umbuzo wethu sikhangela ntoni? Sifunu khangela ntoni?

Learner: uba Miss ezizinto…

Teacher: Sifunu khangela ntoni Luyolo?

Learner: Sifunu khangela ngeyiphi esebenzayo

Teacher: ekuthinini kaloku? Lingo?

Learner: (…) ukwenzela iziqhamo isuke lanto

Teacher: Isuke? Sizafaka esinayo? Sithini Sbaj

Learner: sifunu kwazi Miss bana ngeyiphi eyona eyenza iApile lijike libebrown

Teacher: Uthi uSbaj sifunu khangela yeyiphi ebangela uba iApile lijike libeBrown, uthini wena Lelo?

Learner: Ndifunu yazi ngeyiphi eyenza isiqhamo sijike Miss

Teacher: Okay, uthini wena Nqgiz

Learner: Ndifunu yazi Miss ngeyiphi enceda iApile lingajiki libe Brown

Teacher: Sifunauyazi ngeyiphi ebangela ukuba iApile lethu lingajiki libe njani?

Learners: Libe brown

Teacher: Ngoba mna xandijonge lonto ndibawela uyitya?

Learner: Hayi

Teacher: So ndifuna ligcineke lingajiki libe?

Learner: Brown

Teacher: Libe brown, Kodwa umbuzo wethu yeyiphi kwezi? Okanye ngowuphi umxube onqanda isiqhamo singabi njani?

Learner: Brown

Learner: Hayi

Teacher: Jonga ke uright xa uyibiza nge English kodwa ke siyifuna ngesiXhosa ngoku, ngoba siyibhale ngesixhosa, singabi njani?

Learner: Mdaka

Teacher: Isiqhamo singabi mdaka, singajiki sibe mdaka

Learners: Mdaka…

Teacher: Mamela ke khanithetheni kulo group yenu ngubani ozakubhala, ngubani ozaku jonga ixesha, ngubani egruphini yenu ozaku thini kanene… ozawunqunqa

Learner: Ndim

Teacher: Suveluthi ndim xoxani ngoba abanye kaloku nabo bafunu kwenza

Learner: (Abantwana bayaxoxa)

Teacher: Ngobani abaphethe iAvacado?

Learner: Nabaya Miss

Teacher: Inani Banana, inani Apile ~ ozakubhala uzawubhala ngebanana nhe

Learner: ewe

Teacher: uzawubhala ngebanana (…) abazawubhala mabayothatha ipencil zabo eclassin. (…) ngubani ozaku sika apha kuni? Nguwe nhe thatha ke imela pha, thathi mela pha uzenayo aphe tafuleni ungasiki kwangoku thathi mela uye nayo etafuleni yakho (…) ~. Ndicela ke nithume umntu apho kuni ozakuzo kwenza umlinganiselo apha and umlinganiselo and umlinganiselo esi zakuba nawo sizakuba ne hafu yekopu, ihafu ibhalwa njani kuqala?

Learners: 1 umgca no 2

Teacher: Nenze sure ukuba lomntu uzazoni Mejarishela uyayazi ba ihafu ibhalwa njani because apha ikhona ihafu and amanzi ayo funeke awagalele afike kwi?

Learners: Kwi hafu

Teacher: Esi zakuqala siyi mejarishe saqala senze le inetyuwa, nithume umntu wenu nithume umntu wenu, licephe nelentika, iza nesitya sakho cause ndizakugalela icephe apha esityeni sakho, mejarisha amanzi kaloku wena…

Learner: zugalelele ihafu ke… Lingomso izapha (…)

Learner: Lirongo elixesha

Teacher: Ha a asikalijongi ixesha okwa ngoku, silinde wena Lingomso siyayifuna lekopi yintohi akusayithembanga uba uyayazi hafuningakanani, yibeke phantsi kaloku lekopi ungayiwisi, iphi ihafu ikweliphi icala ihafu? Okay beka phantsi ke ugalele ujonge apho nimncedisi nimxelele uba makapheze phi Luphumlo. Natsoke kuphela mntanam enkosi siyabulela (ehleka) he he he uAnothando… yhuu ndicela uthathe lento mntanam uyibeke phaya singekayi galeli ngamanzi, mamela ke ubhala amanzi akho apha ubhale uba ngamanzi anantoni ndiwancamathelise apha enantsikeni yenu

Teacher: Umejarishe kakuhle nimbonile? Iphi igruphu yakho? Umejarishe kakuhle nina nimjongile, iphi ihafu khababonise uhafu Mihlali,

Learner: Nantsi Miss

Teacher: Okay niyavuma ukuba yihafu na nina

Learner: Hayi Abanye: cwaka

Teacher: Yibeke phantsi Mihlali because uyayi jika jika ngoku, niyavuma uba yihafu nale?

Learner: Hayi asoyi hafu le

Teacher: So mangakanani lamanzi kaMihlali? Matheni?

Learner: Mancinci Miss

Teacher: Mancinci ndicela abantu begruphu kaMihlali, ngobani abantu begruphu kaMihlali

Learners: Naba Miss (Bephakamise ezandla)

Teacher: Okay ndicela ibe nini abathethayo because yi experiment yenu le, nithi lamanzi ayihafu na okanye akayo hafu? Lingomso sisitya esinamanzi anetyuwa eso?

Learner: Ayihafu Miss

Teacher: Eliphepha sisitya esinamanzi anetyuwa? He?

Learner: Ha a Hayi

Teacher: Imeluba niyincamathelaphi na lonto

Learner: Apha Miss

Teacher: Okay, yimani bethuna nitheni, Sinalo nithe iright ngoku?

Learner: Ewe Miss

Teacher: Khame ndiyibone ndicela ukuyibona nam, Mihlali yibeke phantsi uyijike because xa uyibambe olohlobo… nisathi iright iphi ihafu khanindilathiseleni ihafu nina.

Learner: Nantsi Miss

Teacher: Lamanzi ase hafini okanye angaphezulu okanye angaphantsi kwehafu?

Learner: Aphezulu

Teacher: Kay ke bantwini besithe sicela ihafu, sithe sicela ihafu bantase, yibeke phantsi kuqala Mihlali asoze ukwazi ukiyibona kuqala imeasurements ungakhange uyibeke phantsi kwindawo enga muviyo isandla sakho siya muva, ingaphantsi? Sinalo Asonwabise ingaphantsi kwi hafu ingaphezuli kwihafu okanye isehafini?

Learners: Isehafini

Teacher: Isehafini? Khame ndiyijonge, isehafini good! Nincamathele ke apho kwesositya

Learner: Iphityuwa?

Teahcer: inoba iphi Mihlali, inoba ityuwa iphi Mihlali? Hambani hambani hambani, uqgibakwenu leyo olandelayo/abalandelayo nize sizokwenzxa amanzi eswekile, iphi igroup yakho yibeke phantsi Nqginzi yibeke phantsi siyibone, okay well done! Ngubani obhalayo kuni?

Learner: NguLina Miss

Teacher: Ina Lina… Okay sigalele ntoni ngoku sigalele ntoni?

Learners: Sigalele iswekile Miss

Teacher: Okay namanzi angakanani? (…) Okay, yibeke phantsi mama suyibamba itafile izayibamba yona yibeke phansti wena, ngubani obhalayo wenze sure uba ubhalela esositya.

Learners: (Abantwana bayasebenze ngokwa maqela abo)

<u>Umboniso weApile</u>

Teacher: So abanye ke sebese manzini aneswekile ngoku, ba niready for amanzi aneswekile yizani kum emanzini aneswekile… isenguwe omejarishyo Allright yizani ke ndicela nizomjonga ke bethuna because yihafu le siyifunayo.

Learner: ILemon Miss, kushoti Lemon kuthi

Teacher: Kushota ilemon kuni nhe okay, ngubani umbhali apha ngubani ababhali?

Ngubani umbhali?

Learner: Ndim Miss

Teacher: Uzoyenza sure for amanzi akho aneswekile, Learner: Miss Ndicela into yosula

Teacher: Ucela into sula yeyiphi le uyichithileyo ke ngoku, yeyiphi le niyichithileyo?

Learner: Yile Miss

Teacher: Niyayazi ke ngoku le niyichithileyo izawulingana na nezinye? Ayizulingana nezinye ngoku because kufuneka ube carefull ngento yakho, ngoku asiyayaz noba mangakanani lamanzi niwachithileyo, niyayazi mangakani lamanzi niwachithileto?

Learner: Ha a Miss

Teacher: Ngoku lonto ithethu kuthi iexperiment yenu kengoku ayizukuthi gca amanye amanzi enu achithakele amboythatha eclassin andinanto zosula, sigalela ntoni ngoku?

Learner: iLemon

Teacher: engakanani?

Learner: Icephe

Teacher: Mihlali ufuna ntoni apha sthandwa sam?

Learner: Amanzi Miss

Teacher: Amanzi angaphaya… Hayi subonisa mna uba nivumile nina negruphu nisithi yihafu niyayazi ihafu nizithembile

Learner: (Abantwana bayathetha)Nge Lemonade

Teacher: yiLemonade? (Ehleka)

Learners: (Abavisisani abantwana ngomlingani wamanzi) hay maan khawugalele encinci, Abanye bathi: yihafu le

Teacher: Khawutsho kutheni Sibaj usithi incinci silathise siyibone

Learner: Kham kham… ihafu iphela apha

Teacher: Uthi yihafu okanye usayibona isencinci nangoku?

Learner: Ihafu iphela apha

Teacher: Phi Sibaj ukhona umgca apha othi yihafu, uphi umgca othi yihafu khasilathele hayi susiqhatha apha. Okay yeyobani leLemon?

Learners: Yeyethu Miss.

Teacher: Ungandigili

Learner: Nzakugila ngokwam,

Teacher: Niqginelane nenze sure niyanqginelana,

Learner: Kushota isiqhamokuthi

Teacher: Yimani ke bantwini ndicela ubuza kutheni abanye beney1 e empty

Learner: Kuba Miss asiwagalelanga amanzi eswekile

Teacher: Ezinye asizufaka fruit kuzo? So lei empty izakuba nantoni yona? Le i empty izakuba natoni?

Learner: Izakuba namanzi abandayo Miss.

Teacher: Izakubanamanzi abandayo? Izakuba namanzi ashushu bantwini thethani ndive le I empty izakuthini yona?

Learners: Amanzi ane Lemon Abanye: Amanzi ashushu*

Teacher: Amanzi ashushu sinawo amanzi ashushu besithethile ngamanzi ashushu ukuba sizakufaka emanzini ashushu?

Learner: Ewe Miss'

Teacher: Nyani?

Learner: Hayi Miss

Teacher: Sizibhale phi izinto esizakuzifaka ithini lento ithi kutheni?

Learner: Eyi 1 yeyezi qhamo Miss

Teacher: Yeyentoni?

Learner: Yeyesiqhamo Miss

Teacher: Moss wena usebenza ngesinye uyambona eyi 1 yakho izakuba nantoni?

Learner: Nesiqhamo Miss

Teacher: Qha! Uyambona uqha

Learner: Ewe Miss

Teacher: So izakuba nenye into ngaphandle kwesiqhamo Isiqhamo senu nina yintoni?

Learner: Yi Avacado

Teacher: Yabona ke nayo kufuneka niyifake ukuba izakubanantoni

Learner: Nasi Miss

Teacher: Okay nizakubhala ntoni apha ninayo into yokubhala apha, okay.

Ha a, Ha a ndifuna ubhale apha le iEmpty izakuba nantoni yona?

Learner: Nebanana

Teacher: Yimani eliBanana kengoku nizakulifaka apha lonke ngoluhlobo?

Learners: Ha a Miss

Teacher: Kuzakufuneka nenze ntoni?

Learners: Sizakulinqunqa Miss

Teacher: Kufuneka nilinqunqe kaloku ngoba nayo lena kufuneka ibengamanzi anantoni? Anantoni lamanzi ithini into yenu?

Learner: Ane Lemon

Teacher: Amanzi aneLemon kunye nantoni?

Learner: Nebanana

Teacher: Le kufuneka ibena ntoni

Learner: Amanzi ane swekile

Teacher: kunye nantoni

Learner: Nebanana

Teacher: Le ngamanzi anantoni

Learner: Ane tyuwa

Teacher: Kunye nantoni?

Learner: Nebanana

Umboniso webanana

Teacher: Okay, heee ukula gruphu kutheni ingath ukude nje, ukuba.... Khandithethe ngokusika khandithethe ngokusika, ukuba kuqala amanzi akho asenetyuwa engeka nyibiliki yenza sure ukuba iyanyibilika kuqala, andikathethi ngokusika andikathethi ngokusika. Yenza sure ityuwa yakho neswekile yakho inyibilikile yenza sure inyibilikile yenza sure inyibilikile (...) ayikanyibiliki izakunyibikia ngoske kuthini?

Learner: Ngoske izanyiswa Mam

Teacher: Ewe Izakuzanyiswa ngubani?

Learner: NguLuphumlo Mam

Teacher: Ewe mayizanyiswe mayizanyiswe. (...) Ndifun'ubona ke ndizakujikeleza ndifunu bona sonki sitya esisetafuleni yakho sinento ebhaliweyo ukwenzsela singathi ngoku yhuuu ngamanzi anantoni la oh nkosi yam masijongeni, aneswekile okay ndiwabonile, la? hahaha (utitshala uyahleka) okay ndiyayibona kodwa, le? aneLemon Okay leithini?

Learners: Avacado

Teacher: Okay. Ndicelu bona. Yhuuu ndiboninto apha yintoni le yenzekayo apha?

Learner: Ayizanyiswanga Miss

Teacher: Ewe izakuzanyiswa ngubani bantwini

Learners: Abantwana bayazixoxela egruphini: ewe yiLemon kaloku lena

Omnye: Ayikanyibiliki lena

Teacher: Heeeee ilinde bani? Izakunyibilikiswa ngubani lento?

Learners: Sithi

Teacher: Nizakuyi nyibilikisa njani?

Learner: Sizakuyizamisa Miss

Teacher: Heee kuthwa ayikanyibiliki kodwa benithe mayinyibilikiswe, leswekile seyinyibilikile?

Learner: Ewe Miss

Teacher: Yhuuu hayi anenzinto nindincamile, mamelani ke Mihlali ndicela sitshintshe iimela yazi kutheni ndisithi masitshintsheni iimela?

Learner: Hayi

Teacher: Sazitshintsha iimela nababantu banamapere kutheni nicimba sizakutsintsha iimela?

Learner: Kuba ibukhali

Teacher: Kuba ibukhali le and then ibanana lidinga imela ebukhali?

Learner: Ha a

Teacher: Okay! ~ Niqgibile? (...) qgiba ke qgiba masiqgibeni uzamisa kengoku ngoba sifunutya, masiqgiben uzamisa because sifuna utya. Khanike nifundeni lento yenu, lento yenu aphek'qaleni ikhona imibuzo eyibuzayo nhe, khame make sijonge ithini lemibuzo iyibuzayo, (...) Hayi iqalaphi? khanindixelele into xasiqala ufunda siyiqala ndawoni, Okay very good. Ndicela nindixelele ithini?

Tescher: Yhuuuu hay bantwini siyafunda okanye siyadlala?

Learener: Siyafunda

Teacher: Khanifundeni ndinive

Learner: Inkangeleko yeAvacado yakho emva kokuba uyi(...)

Teacher: Ithetha ntoni lanto inkangeleko yeAvacado emven kokuyisebenzisa? Inkangeleko yintoni?

Learner: (...) yhoo inuka isele Miss, omnye: inuka njani

Teacher: inuka njani? (...) Thank you so into xaniqgiba kuyisika kufuneka niyijonge lepiece niyijonga ngayo ikhangeleka njani ne, elandelayo ithini?

Learner: Inuka kanjani

Teahcer: Nizakusebenzisa ntoni ukuxe niyojonge uba inuka njani?

Learner: Ngempumlo

Teacher: ngempumlo, ithini elandelayo

<u>Umboniso weAvacado</u>

Presentation (Yegruphu)

Learner1: Thina besifuna ukubona oba ngowuphu umxube onga yenza

iAvacado ingatshintshimbala wayo abemdaka

Learner2: Siqikelele ukuba yityiwa engayenza umbala weAvacado angajiki abemdala

Learner1: Sathatha isitya sagalela icephe leswekile sathatha isiqingathana sekopi samanzi

(...) necephe leswekile

Learner2: qgiba sathatha isitya sagalela icephe letyiwa sathatha isiqingatha sekopi

Samanzi sasigalela sasigalela esityeni necephe letyiwa

Learner3: Siphinde sathatha isitya sagalela icephe leLemon sagalela ii~ sathatha

Isiqingatha sekopi samanzi saxuba necephe leLemon sasika iAvacado yaba

ngamaceba amahlanu enye sayifaka emanzini anetyuwa, enye sayifaka emanzini

aneswekile, enye sayifakia emanzini aneLemon, enye sayifaka esityeni sodwa,

enye sayinukisa sayitya

Learner4: Xasiyiva siyi… ngoku besiyinukisa siyinukisile sabona ukuba inuka ipopo, ngoku

besiyiva ibingathi liqanda elibilisiweyo, emva kosuku siye sabona ukuba ityuwa

yeyona itshintshileyo yaba nombala omdaka

Teacher: Kutshintshe ityiwa?

Learner4: Kutshintshe iAvacado le ifakwe esityeni esinetyuwa

Teacher: Mm

Learner2: Safumaniseka ukuba amanzi aneswekile ngawona ayenza iAvacado yethu ingajiki

umbala wayo

Teacher: Cool nina nifumaniseke ukuba ngamanzi eswekile la ayigcina ingatshintshi

umbala?

Group1: Ewe Miss

Teacher: Abenjani wona amanzi aneLemon?

Group1: Abemdaka Miss

Teacher: Iye yatshintsha umbala?

Group1: Ewe Miss (benqwala iintloko)

Teacher: Yamdaka

Group1: Ewe Miss

Teacher: Mmm

Learner2: Siqgibile (esebezela omnye)

Learner1: Imibuzo (emphendula)

Teacher: oh okay! Nina niye nayitya nayiva emveni kosuku uba incasa yazo?

Group1: Yes Ms.

Teacher: Yeyiphi eyona ibene ncasa ukoqgitha zona zonke?

Learners: Yile yeswekile Mis

Teacher: Yile yeswekile (ekhuza), zange ndiyive iAvacado eneswekile nzake ndiyizama

(ehleka), nantsi eminye imibuzo Lithemba ufuna ubuza umbuzo?

Learner: Hayi Miss

Teacher: Oh

APPENDIX M: Colour coded story

Teacher 1: Lesson 1 (1hr)

Research Question:
How do grade 3 FP teachers mediate the development of basic Scientific Process Skills through an Inquiry-Based Approach in their classrooms?

This lesson was on healthy eating focusing on fruits.

To start off the lesson, the teacher used an interesting method, even though her focus was on fruits, she started her lesson on the carpet where she narrated a story of what happened to her the previous night. She narrated a story on how she got home hungry the previous day, and while she was busy cooking she had to eat an apple. Unfortunately for her after cutting it into two halves, she had to attend to something else. On her return, she could not eat her apple. At this point, she kept quiet for few seconds asking her learners to say what they think happened to the apple?

This was a fun part for her learners as they came up with various answers about what happened to her apple. The learners thought it was eaten by one of her family members but eventually to their surprise the teacher showed them the apple. The apple had turned into a brown colour and was "not sure" whether to eat it or not. She brought it to her class to be advised by her learners on how she could have prevented the colour change.After narrating the whole story, she asked the following questions:

What do you think made the apple to turn brown?

What can be done to prevent the apple from not changing colour?

Do other fruits when cut change colour or not?

Using their knowledge and understanding learners gave various answers; according to the learners, *the sun changed the colour of an apple, the heat changed the colour of an apple and the air changed the colour of an apple.*

Learners were given an opportunity to come up with their own prior knowledge at this stage. Afterwards learners also highlighted that other fruits like bananas do change colour as well. They also mentioned some fruits and vegetables that change colour if cut into pieces and left exposed to air and light. At this stage they were showing their thinking across other fruits in their everyday life and their experiences of other fruits.

The teacher followed with another question of whether or not she could have prevented the colour change from an apple, if so how?

Learners mentioned that the teacher could use clean water, salt water, cover an apple with a plastic and sugar water and some even said that there is nothing wrong with it she could have eaten the apple.. These were various answers from the learners. The teacher then suggested that they test which solution will work better to prevent fruit from changing colour. Before starting the actual experiment the teacher asked learners to assist her in coming up with the question for the experiment to be done. Also, to assist her in writing instructions on board with her.

The teacher had an apple, an avocado and a banana which were familiar to the learners. To be part of making instructions assisted learners to be part of coming up with instructions of how to do this experiment. In this way all learners were involved in making the decisions in this lesson and it also helped learners to internalised and understand what to do.

After instructions, to prepare for the experiment; learners were asked to be groups of four and amongst the three types of fruits that were brought by the teacher in class learners had to choose the fruit they were going to work with as a group.

Instructions and the question:

Investigation

Which solution will work best to prevent the fruits from colour change when cut into pieces?

Instructions/process

- ✓ Four dishes
- ✓ One without any solution (A spoon was used as a measurement in each)
- ✓ One with salt solution
- ✓ One with Sugar solution
- ✓ One with lemon solution

In conducting this experiment, the teacher divided the class into three groups with four dishes with each having a different solution of salt, sugar, lemon and an emptydish without any solution. Each group worked with a different type of fruit. The learners had to predict which solution would work better, in doing this they started by measuring solutions for each dish and made sure there were equal quantities of salt, sugar and lemon. Dishes were the same size across all groups and the solutions were the same, only fruits were different.

Learners were given an opportunity to choose amongst themselves the person that will be responsible for each role during this activity/experiment. A leaner to measure the quantity of water for the group, a leaner to cut fruit, a scriber for the group and a learner in charge of their group is following instructions. In this process the teacher was assisting each group to follow instructions and making sure learners understood the process of doing this experiment.

Each group labelled their dishes to make sure that the observations were properly correct and conducted. The first step was to measure the quantity of water by the groups for their experiments.

As this was taking place, you could clearly see students that they understood how to use a measuring jar. They were looking at the "meniscus" and really trying to observe the correct measurement. Also they were working as a team in each group making sure they follow instructions. Within this specific period learners had to observe and record their findings. For every 20 minutes, each group had to write their observations concluding the task in the next day. After a day, each group had to report their findings to the whole class with the assistance and guidance of the teacher. In reporting each group presented their findings and their concluding observations. The lemon solution worked better than salt and sugar solution. Where the teacher did not follow up on learners' questions and comments, I saw those as lost opportunities that could have made the lesson richer in science knowledge and content.

The teacher:

- Provided resources for her learners – easily accessible resources from home (familiar fruit, sugar, salt and water)
- Created a pleasant atmosphere, - through story telling
- Asked questions- for understanding, probing knowledge, for engagement, for instructional purpose, for ensuring learning, prior knowledge of learners.
- Promoted group work: sharing responsibilities, for joint activities, promoting social interactions, assisting with guidance and learning
- Knew her responsibility: instructions, guidance, facilitator, assisting learners, providing resources
- Understood her learners- story telling draw their attention; sitting arrangement made learners comfortable; how she asked questions across the class, engaged her learners
- Understood her topic- curriculum; how the experiment was planned, the type of questions asked,
- Promoted basic Scientific Process Skills – experimental investigation.

APPENDIX N: Transcripts of boxes

English Translations

BOX 6.1: T1

Teacher:	What are we going to be testing, Luyolo?
Learner:	We'll be testing which one works, Miss?
Teacher:	Works in doing what exactly? Yes, Lingo?
Leaners:	To remove that thing from fruit.
Teachers:	Remove it? And replace it with what that we have? What are we really saying here, Sbaj?
Learner:	We want to know, Miss, is what it is that causes an apple to turn yuck.
	What do you think, Lelo?
Learner:	I want to know what causes fruit to change, colour Miss.
Teacher:	and you, Ngqiz?
Learner:	I want to know what can stop an apple turning yuck.
Teacher:	We want to know what does stop an apple **from** turning what?
Learners:	Yuck.
Teacher:	Because that makes an apple too appetizing, night?
Learner:	No!
Teacher:	So, I need to prevent it from turning what?
Learners:	Yuck!
Teacher:	Yes yuck. But, what exactly, is the question we want answered here? We want to find the right mixture or solution that prevents fruit from discolouring, right?

	And turning what?
Learner:	Yuck. No!
Teacher:	Ok. Look, it's fine to refer to the discolouration as"yuck". But, because this is a formal task or assignment, we want to keep things formal. So, we want to prevent an apple from turning what colour?
Learners:	Brown.
Teacher:	So, that fruit doesn't discolouring. It doesn't turn brown.
Learners:	Oh! Browny, yhoo! Brown dash! Brown dash! More brown dash! Yhoh! Yhoh!
Teacher:	Whoa! Listen now. Pay attention! Who in that group is going to be the scribe? And who the timekeeper? And then who to what, again? Jo! PRESENT!
Learner:	It's me, miss.
Teacher:	You can't just say, "It's me, miss". That should be a product of group discussion.
Learners:	(Noisily discussion).
Teacher:	Which group is the Avocado group?
Learners:	Over there, miss.
Teachers:	Banana group, come fetch. Come on, one person!
	Applepreneurs, here. Each group should ONLY discuss their own fruit. Do we ALL understand?
Learners:	Yees!

Box 6.2

Teacher:	Got ready to work in groups. Each group will have a timekeeper and a scribe. I'll provide you with a blank paper. I'll explain what you should do with the paper. Group one members are Luyolo, Lingomso, Luphumlo and-Anothando. Tell me what you will be working on. Get together and discuss. Sinalo, Mihlali K and Asonwabise, you will be Group Two. Mihlali, Ngqizi, Lithemba, Linamandla and Sibabalwe, form another group. Hurry up and decide what you want you to work on.

Box 6.3

Teacher:	There is this term "evolution". You may have heard this term used at home or at play. Some of you may even have used the term jokingly. Could someone, anyone, please try to explain this term? Even if you don't fully understand it.
Learner:	It's how similar things are, how different things are.
Teacher:	How's similar things are and how different things are. Any other answers? I want your personal understanding of the term "evolution"; or the cycle of life. Now, there's a hint for you. Amyoli, you seem distracted. Who wants to try?
Learner:	It's similarities between animals.
Teacher:	Similarities between animals. What was Oyama's answer? He said, it's how similar and how different things are. Let's get other opinions.
Learner:	It's when things grow.
Teacher:	You say, it is something growing, its growing, let us move away from something growing; what is really happening, tell us what you think. What is really happening?

Box 6.4

Teacher:	I want to cat my apple
Learner:	No it is not there Ma'am.
Teacher:	So you say it is not there, where is it?
Learner:	Granny has eaten it
Teacher:	(Laughing) okay, and you
Learner:	TakaHlehle has eaten it
Teacher:	You say Taka-Hlehle has eaten it, Oh what are you doing to the people of my house hold, what are you saying Mihlali?
Learner:	Rats have eaten it Ma'am
Teacher:	Have rats eaten it and those rats are still around, you see, what are you saying Lingo?
Learner:	I am saying maybe that apple has been taken or eaten by the flies.
Teacher:	Do you also think it has been eaten...look I'm going to tell you, no one has taken my apple, because I tell people what it means to take someone else's things.
Learners:	That is theft (others: that is stealing)
Teacher:	That is theft so there's no one who has taken my things! But look at what has happened.
Learners:	No (Exclaiming) others: It is rotten
Teacher:	Rotten!
Learners:	No Ma'am
Teacher:	What is wrong with it?
Learner:	It has change the colour

Teacher:	Has it changed the colour, how is it. Was it like this when I cut it?
Learners.	No Ma'am
Teacher:	It has changed the colour, what do you think is the reason for it to change colour?
Learners:	Because it has been there for a long time

Box 6.5

Teacher:	But, can you tell me what a plant is? What can you say the plant is? Because one says what one thinks it is Christina what do you think a plant is?
Learner:	It is a flower
Teacher:	Do not name it, explain what a plant is? What are you going to say?
Learner:	A plant is something that is growing
Teacher:	So a plant is something that is growing, very good! A plant is something that is growing, no matter what its name is.
Learner:	A plant is something that is growing.

Box 6.7

Teacher:	Right! Can you see my children we are not going to talk about food again now, we are proceeding today, **We are going to talk about insects.** Is there someone who can tell me what an insect is?
Learner:	It is an ant
Teachers:	Do not name it tell me what it is, Grandmother is going to arrive and ask what is an insect? Is the anyone who can tell me? Alright I want you to listen today, An insect is something or a small animal a very small animal that is moving but it does not have bones, but has legs, you people who like to trample the bones will crush crush when you trample on flies and ants.
Learner:	No Miss
Teacher:	So an insect is a small animal How many legs that it have?
Learner:	Two
Teacher:	Here are the hands what does someone else say?
Learner:	Four
Teacher:	Does an insect have four legs or two

APPENDIX O: Example of analysis for lessons taught

How T1 developed learners' ZPDs when using inquiry approach in her teaching (Zaretskii, 2016)

Six Conditions	Lesson 1	Lesson 2	Lesson 3
Condition 1			
How do participants **make their learner to understand and be clear** about the activity and instructions?	**Lesson 1**: Before starting the experiment in this lesson, the teacher asked learners to assist her in coming up with the aim or the main question for the experiment. Also, to assist her in writing the instructions to be followed on board **(see figures 6.5 & 6.6).**		
	Lesson 2: Starting the lesson, the teacher revised the previous days' lesson and this lesson was a follow up lesson. To continue, she asked the following questions, What do we call ants' babies? What did you do yesterday with your plastic bags? What do you think you should consider when building your anthills? The actual lesson was on building anthills, and the teacher explained the task sequentially. Previous day learners went out to observe anthills. Firstly, she revised with them the previous lesson. Secondly, learners		

	had to draw the structure of their anthill and then went outside with the material they collected the previous day to build the anthills. **(see figures 6.7, 6.8 & 6.9)**
	Lesson 3: The teacher narrated a story of what happened to her eggs the previous night (see lesson narrative summary). **S**he told her learners that as she was practicing to make a salad potato to prepare for the cam, the previous day she boiled eggs and after they were cooked she left them on the table. On her coming back she realized that her eggs were put back inside the refrigerator and mixed with other eggs. She raised an important concern to her learners, asking for some assistance on how she could identify the cooked one from the raw ones. Both instructions and the guidelines of the experiment to investigate which eggs were cooked and which eggs were not were discussed **(see figures 6.10 to 6.14).**
Condition 2	

How do participants encourage learners to take **full responsibility** of the activities at hand?	This teacher, in all three observed lessons she made sure that her learners are involved in drawing up of instructions and in taking individual roles in a group task. In lesson one, for their experiment on fruits the learners worked in groups and assisted each other. In overall, in a group learners had shared roles to play during the activity **(See figure 6.5 & 6.6**).
	In lesson 2, through planning and advising each other learners drew the plan of the anthill and built their anthills as a group. Again, learners had shared roles where in a group others assisted with the required materials and others were building the planned structure **(See figure 6.11).**
	Again, in this lesson learners worked in groups where they were doing an investigation about eggs. They assisted each other following the instructions that were discussed beforehand (**See figure 6.11 & 6.12**).
Condition 3	

How do **joint activities (if any) assist learners** in achieving challenging activities?	In the case of this teacher, in all her lessons, she had investigation or practical activities and her learners worked in groups to assist each other. In lesson one, learners had to decide on which solution prevents the fruit from colour change when cut **(see section 6.3.1, Lesson 1**). In lesson two, learners in this class had to choose the materials they will use in building their anthills. Afterwards, learners had to draw the plan of their anthill and then build the anthill **(see section 6.3.1, Lesson 2)**. Lesson 3, the last observed lesson, learners in this lesson were part of the investigation or practical activity on eggs. These learners worked in groups and same as the other lessons the activity was a group work activity **(see section 6.3.1, Lesson 3). I**n all her lessons, in deciding and in working together learners had to make decisions that were presented in front of the whole class. Therefore, the joint activities in the case of these learners assisted them to make informed decisions about each experiment.
	Condition 4

The **roles** of both the **participant** and the **learner** during the activity.	**The teacher**: In her lessons, the teacher provided the resources for teaching and learning. She created a conducive space for learning, from the carpet that was used as a space to introduce and to start the lesson. Because of her teaching style, learners were comfortable and relaxed throughout her lessons. The teacher facilitated the lessons and assisted her learners during activities. For her learners to understand the lessons, the content, the tasks she drew from her learners' prior knowledge, she used easily accessible resources or familiar materials to the learners. **(See figures 6.5 to 6.14).** **Learners** also played several roles in these lessons. Learners had to answer questions, reflect on their activities, engage with each other and engage with the teacher. They had to ask questions from the teacher as well. These learners also drew from their prior knowledge. During activities, learners had to observe, discuss, interpret, reflect and present their findings. **(See figures 6.5 to 6.14).**
Condition 5	
How do participants **create a space for learners to**	As already stated in condition 4, learners were given an opportunity to present and to reflect on their findings on the experiments (Lesson 1 & 3). In lesson 2, learners had to reflect on why other houses

reflect on their own work?	(anthills) were had stronger structures than others. For this, they had to compare each other's structures. **(T1, lesson 1, 2 & 3)**
Condition 6	
How does working or **cooperating with a teacher assist learners** to achieve the intended objective?	In this aspect, whenever learners worked or cooperated with the teacher it was the opportunity for the teacher to explain the question asked by learners in ach group, to give an explanation about the activity and to make sure each group was on track with their activity. This teacher made sure she accommodates all her learners. Whenever, she noticed a reserved learner she asked that learners' opinion. **(Figures 6.13 & 6.14**)

How T2 developed learners' ZPDs when using inquiry approach in her teaching (Zaretskii, 2016)

Six Conditions	Lesson 1	Lesson 2	Lesson 3
Condition 1			
How do participants **make their learner to understand and be clear** about the activity and instructions?	**Lessons 1, 2 & 3**: In these lessons, because of the class arrangement **(see figure 6.4.1 & 6.4.2)** learners w***ere into groups and the teacher had the opportunity to use this arrangement into her advantage***. In the first activity, the teacher gave learners models of insects ***(see figure 6.15)*** to observe their characteristics. However, the teacher did not encouraged her learners about the importance of working together as the team. In all three lessons, she ***orally gave the instructions*** to the learners. She however did repeatedly confirmed in all three lessons if all learners understood the activities. She made sure that there were both individually and group activities. I must highlight that in the activities she gave her learners it was clear what to do. When learners were working the teacher made sure		

	that she assisted each group or each learner and explained the task while standing in front of the class **(see figures 6.15 to 6.20).**
Condition 2	

How do participants encourage learners to take **full responsibility** of the activities at hand?	For her lessons and activities, she randomly asked questions to those learners that had their hands up and willing to participate. Through my observation, she did not consider those learners that some learners might have been unclear about the content of the lessons. During the activities, she gave learners individual tasks **(see figure 6.16**) matching insects with their names. Again, giving group activities (**see figures 6.16, 6.18 & figure 6.20).** In this way, she made sure that learners are taking responsibility individually and in groups with the help of others. Again, she discussed the instructions with learners to make sure they fully understand the activity.
Condition 3	

How do **joint activities (if any) assist learners** in achieving challenging activities?	**In lesson 1**, there was a group reading activity where a learner read an ant story for the whole group. In this activity, other learners were just listening and no shared roles, which made this activity to be lacking some aspects of a joint activity **(see figure 6.7)**. However, through reading the story learners learnt about how insects live as ants. Secondly, using insect models as a group learners had to discuss characteristics of insects and the teacher chose each group to share their findings to the class about their insects. In this way, learners learnt more about characteristics of insects **(see figure 6.15)**. **In lesson 2**, there were no joint activities. **In lesson 3**, there were several joint activities. Learners had to work in groups to discuss various properties of different leaves **(see figure 6.20)**. Learners had to observe

	and discuss the characteristics of the leaves. In addition, an outside activity allowed learners to observe, compare, discuss and present their findings on different leaves of trees.
	Condition 4

The **roles** of both the **participant** and the **learner** during the activity.	**The teacher:** In all three lessons, this teacher planned her lessons. She prepared and brought the resources/materials for teaching and learning. She guided the learners and asked questions to check her learners' understanding in each lesson **(see figures 6.15, 6.18 & 6.19).** **Learners**: During activities, learners worked in groups and individually. In lesson 1, they read a story of an ant as a group but other activities were individually. Lesson 2, the most part of her lesson was through question and answer method. Learners did not work in groups; they only did individual tasks/activities. In lesson 3, through the guidance of the participant learners worked in groups and individual thinking was a contributing factor **(See figures 6.16, 6.17 & 6.20)**. To conclude, in all three lessons learners had to answer questions to give their understanding of what is taught in class.
Condition 5	

How do participants **create a space for learners to reflect** on their own work?	The participant constantly asked questions when teaching. Questions from the teacher, assisted learners to give their perspectives and through assisting each other learners presented their understanding. In lesson 1, learners reflected on their understanding of characteristics of insects. On the other hand, in lesson 3 learners had to present their findings about shapes, size, and the structure of different leaves around the schoolyard. Therefore, the participant created the space through asking questions from learners and in giving learners an opportunity to present their thoughts **(see figure 6.18).**
Condition 6	

How does working or **cooperating with a teacher assist learners** to achieve the intended objective?	In the case of this participant, she assisted learners to understand the activity at hand. She guided learners on how to do some activities when necessary. During individual and group activities the teacher made sure that, she guided her learners. In this way, this cooperation was on understanding of the activity or the question at hand **(see figure 6.18 & 6.20).** For the learners to understand the concept of a life cycle, the teacher demonstrated how a life cycle takes place. In drawing from her learners' prior knowledge learners were able to understand the content of the lessons **(see figure 6.15, 6.18 & 6.20)**.

Data Presentation for section B2 of the Analytical Framework

Scientific Process Skills developed and taught by T1 & T2 in their lessons

Section B2: Basic scientific process skills developed in each lesson			
BSPS	Indicators (Table 11 chapter 2)	T1	T2
		Lessons	

Observe	• Use more than one sense, • Notice and identify the observable properties of objects, • Notice and state changes in objects or events, • Notice and state similarities and/or differences in objects or events, and • Interpret describe and draw details of their observations	L1: Learners observed which solution prevented fruit from colour change. L2: Learners observed which anthill would stand longer compared to others. L3: Learners observed which method worked to identify the cooked from the uncooked egg.	L1: Learners observed and identified the characteristics of insects (using models of insects) L2: Although not practically done, learners compared babies of animals with their mothers L3: Learners observed the properties of different leaves from different plants.

Compare	• Use appropriate senses to observe similarities and differences in objects or events, • Can tell about the characteristics of objects, and • Compare objects and discuss how and why the objects are alike or different	L1: learners, with the assistance of their teacher compared L2:learners compared their anthills and the materials used to build them. L3: Learners compared the methods that can be used to test for cooked or uncooked eggs when they are mixed.	L1: In this lesson, learners together with their teacher compared properties of insects with other animals. L2:Although it was not practically done, learners with the help of the teacher compared the life cycles of different animals L3: learners compared different types of leaves.
Classify	• Group objects or events by their properties or functions, • Identify properties that are common to all objects in a collection, • Give sound rationale foe classification, • Can create their own criteria, and • Can form groups or subgroups using accurate properties	Throughout the three lessons, this skill was not taught or developed in learners.	In lesson 2 this skill was taught. Learners had to classify or group babies of animals with their mothers. In L3, learners classified or grouped leaves according to their properties.

Measure	• Arrange objects in sequence by length, weight and volume, • Arrange objects in a chronological order, • Use measurements to draw conclusions, • Use tools to determine quantity, and • Select and use measuring instruments appropriately.	L1: In lesson one, during the practical investigation on fruits learners had to make sure variables are the same across each dish of solution. Therefore measuring of quantities was part of the investigation. L2:learners had to decide on best they can build the strongest structure and therefor quantity, shape and size of the materials was significant L3: When doing an experiment about testing which egg is	For this participant, this skill was not taught in any of the lessons that were observed.

		cooked and which one is uncooked, one of the activities was to spin the eggs and to count the slowest	
Predict	• Think systematically and logically about what might happen next, • Make simple predictions, • Extend patterns, • Extend and form patterns, • Provide sound logic for the reasons of their predictions, and • Suggest ways to check the accuracy of their predictions	This skill was not taught in any of the lessons.	This skill was not taught in any of the lessons.
Inference	• Describe the relationship among the objects and events they observed, • Use all appropriate information in making an inference, • Give reasonable explanations of their observations but may not be correct, • Need to understand that they make inferences through evidence	In all three lessons, l learners had to compare their results and reflect on them. In doing this, they had to give reasonable explanations for their observations.	

Communicate	• Describe objects or events in verbal or written format, • Verbalise thinking, • Describe objects or events accurately, • Record data, • Transmit understanding accurately to an audience in verbal or written format, and • Justify explanations through formulating reasonable and logical arguments	Throughout all the three lessons observed, learners had to record findings, discuss findings, answer questions and report their findings. Hence, the skill of communication was the dominant one.	In all her three lessons, communication was dominant. She created a platform for learners to answer her questions and to report on their findings.

SECTION C: Shows components for transformation of knowledge (T1 & T2' s components for transformation of knowledge in their lessons)

(Adapted from Mavhunga & Rollnick , 2013 and Mavhunga & Rollnick, 2017)

CATEGORY	CRITERIA	COMMENTS (T1 & T2)	
Learner Prior Knowledge (LPK)	What learners already know and includes common misconceptions known in a topic.	**Lesson 1, 2 & 3:** • Used fruits • Anthills • Used eggs • Used houses as examples • Asked learners' experiences about the topic (L1, 2, 3)	**Lesson 1, 2, & 3** • Used models of insects • Used plants • Asked learners' experiences
Curricular Saliency (CS)	Refers to the identification of the most important meaning of the major concepts in a topic, without which understanding of the topic would be difficult for learners. It also includes the knowledge to logically sequence the learning and the knowledge of	**Lesson 1, 2, 3** • Understanding what can be used to prevent colour change • Understanding how the how is built • Understanding how to test cooked and uncooked eggs	**Lesson 1, 2, 3** • The content was taught through giving explanations and descriptions

	pre-concepts needed prior to teaching a topic.		
What is difficult to understand (WDU)	Refers to gate keeping concepts which are difficult to understand often because they cause conflict with previously established understanding.	**Lesson 1, 2, 3** • Explained all instructions clearly, the use of discussions (Teacher and the Learners), stories clarified misconceptions • Question and answer method used to clarify misconceptions. • Following up with questions and drawing other learners in discussion helped with clarification of misunderstanding	**Lesson 1, 2, 3** • The teacher explained all instructions and defined concepts where necessary.
Representations (RP)	Refers to a combination of representations at *macro*, *symbol* and *sub-microscopic*	**Lesson 1, 2, 3** • The use of a representation of an apple, to show how an apple has changed colour	**Lesson 1, 2, 3** • To make her learners to understand, models, diagrams and pictures were used by this teacher.

	levels that may be employed to support an explanation.	• Use of diagrams and drawings to make sense of the task	
Conceptual Teaching Strategies (CTS)	Refers to teaching strategies derived from the considerations made from the other components and excludes general teaching methodologies.	**Lesson 1, 2, 3** • Learners explained their work/diagrams to the teacher • Teacher and learner interactions to clarify concepts • Learners to explain their thoughts and give reasons for their conclusions	**Lesson 1, 2, 3** • Allowed learners to reflect on their findings

APPENDIX P: Presentation

Inquiry-Based Learning Approach in Grade 3 Classrooms

RHODES UNIVERSITY
Where leaders learn

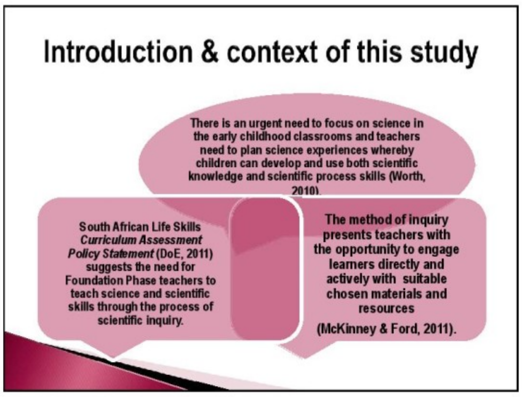
Zukiswa Nhase
(PhD)

1

Aim:

This study explored how Grade 3 Foundation Phase teachers mediate the development of the basic scientific process skills using inquiry based approach in their classrooms

2



3

Motivation for this study

- Various stakeholders in South Africa have recently recognised the need to support Foundation Phase teachers in teaching of science. I had an opportunity to conduct a workshop for Grahamstown district Foundation Phase teachers whose theme was ***"Developing Creative thinkers"***.
- It emerged from the workshop that, there is a difficulty for Foundation Phase teachers to plan creative science lessons and teachers find it challenging and time consuming to teach science in their classrooms. Bosman (2006) in her study also found out that Foundation Phase teachers tend to avoid teaching science in their classrooms because of its complex scientific concepts and scientific skills.
- In addition to this, I am currently teaching both the Life Skills and the Natural Sciences courses in the four year BEd Foundation Phase programme and this has afforded me an opportunity to pursue this research study so that I can improve my practice.

4

Significance of this study

- In the South African education context, there is very little research that has been conducted on science teaching and development of scientific skills in the Foundation Phase.
- This research has the potential to assist curriculum developers, Foundation Phase teacher training institutions and Foundation Phase teachers on the need to strengthen the teaching of science related topics or science themes and in improving the use of inquiry based approach in this phase.
- This study is also likely to provide evidence about the opportunities and challenges facing Foundation Phase teachers in the development of scientific process skills, teaching of science themes and the use of inquiry-based approach in this phase.

5

Research Process

Curriculum Analysis

Semi-structured interviews with the participants

Lesson observations (2 phases)

Group reflections & discussions with participants

Stimulated recall- Interviews

6

Research goal and questions

Main goal of this study:

The main goal of this study was to explore how Grade 3 Foundation Phase (FP) teachers mediate the development of the basic scientific process skills using inquiry based approach in their classrooms.

Research Questions:

1. What do grade 3 FP teachers understand about scientific process skills and inquiry based approach?
2. How do grade 3 FP teachers mediate the development of scientific process skills through inquiry based approach in their classrooms?
3. How do discussions and reflections in a community of practice influence (or not) grade 3 FP teachers' understanding of scientific process skills and inquiry based approach?

7

Research Methodology

For this research study, a qualitative case study research approach was employed (Stake, 2000). Cohen et al. (2011) also highlight that case studies observe the effects in real contexts, recognising that context is a powerful determinant of both cause and effect.

- Four grade 3 Foundation Phase teachers from four different quintile 3 and 4 schools (2 quintile 3 and 2 quintile 4).
- All four are isiXhosa speaking teachers as well as their learners.
- Bilingualism (English & isiXhosa) is often used in all four classes.

8

Data collections methods

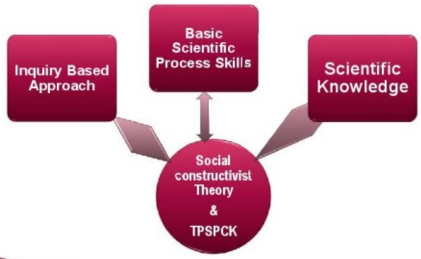
- Document Analysis (Life Skills CAPS document, lesson plans and Life Skills workbooks from each school);
- Questionnaires (Information on the participants' profiles and to understand perspectives of grade 3 FP teachers on the development of scientific process skills and scientific knowledge using inquiry based approach);
- Interviews (Semi-structured and stimulated recall interviews);
- Observations (Observation of 2 lessons from each teacher per term); and
- Discussions and reflections (After each phase of classroom observations).

9

Inquiry Based Approach, Scientific Process Skills & Scientific Knowledge

10

Theoretical Framework



11

Theoretical Frameworks

Socio-cultural theory:

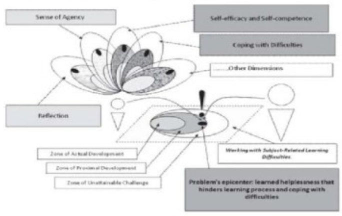
Vygotsky`s (1978) socio-cultural theory emphasizes that social interactions play a fundamental role in the development of cognition. Concurring, McRobbie and Tobin (1997) posit that social constructivism recognises the importance of social and personal aspects of learning. Within the social constructivist theory, my focus in this study was on the concepts of 'mediation of learning' and the 'zone of proximal development' (ZPD).

Pedagogical Content Knowledge:

Shulman (1986), in his research when it comes to knowledge in teaching; identified the 'missing paradigm'. His interest on how teachers transfer knowledge to learners lead to him highlighting few questions that need to be addressed when it comes to teacher knowledge. ***What are the sources of teacher knowledge, what does a teacher know and when did he or she came to know it, how is knew knowledge acquired and how the old knowledge is retrieved; and both combined to form new knowledge?***

12

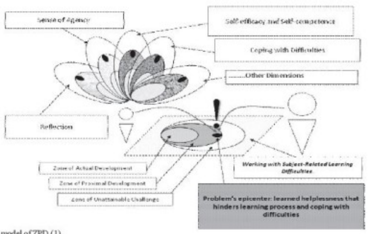
Lev Vygotsky's Principle " One step in Learning Represents a Hundred Steps in Development": From Idea to Practice (Zaretskii, 2016)



ZPD (1) as a generality of *dimensions of potential developmental* steps. Zaretskii (2016, p. 155)

13

Lev Vygotsky's Principle " One step in Learning Represents a Hundred Steps in Development": From Idea to Practice (Zaretskii, 2016)



The multidimensional model of ZPD (1). Zaretskii (2016, p. 157)

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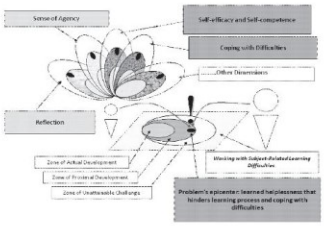
Vygotsky's Principle " One step in Learning Represents a Hundred Steps in Development": From Idea to Practice (Zaretskii, 2016)



The multidimensional model of ZPD (3) (Zaretskii, 2016, p.158)

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How Theory is used for analysis of data:

Six conditions:	Principles of IBA	Basic Scientific Process Skills
How do participants make their learners **understand** and **clear about the activity** and instructions?	There is **direct, hands-on experience** with the phenomena. Content is drawn from the environment in which learners live, allowing for direct observation.	***Scientific observation***
How do participants encourage learners to take **full responsibility** of the activities at hand?	Secondary resources (**books, internet, and experts**) complement the direct experience.	***Comparing***
The **roles** of both the **participant** and the **learner** during the activity.	Learners must **fully own and understand the question** or problem they need to solve.	***Classification***
How do participants **create a space for learners to reflect** on their own work?	The starting point is what **learners already know** about the phenomena.	***Measuring***
How does working or **cooperating with a teacher assist learners** to achieve the intended objective?	**Language and argumentation** is developed in the **context of science.**	***Predicting***
How do **joint activities (if any) assist leaners** in achieving challenging activities?	Allow learners to work in small groups, **science is a cooperative endeavor.**	***Communication***
	Learners need to be taught science enquiry skills	

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The relationship between theory and literature in this study

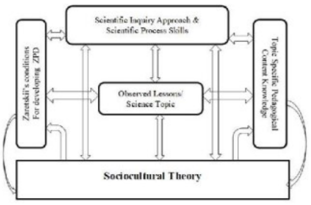

Figure 6.21: The relationship between Theory and Literature used for Lesson observations

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Analytical tool for the study:

Components for Teacher Transformation of Subject Matter. Adapted from (Adapted from Mavhunga et al., 2016)					
Topic Specific components of Pedagogical Content Knowledge	Learners' prior knowledge'	Curriculum Saliency	What makes the topic easy or difficult to understand	Representations including powerful examples and analogies	Conceptual teaching strategies
Criteria for Each Component	What learners' already know and this includes common misconceptions known in a topic	Refers to the identification of most important meaning of the major concepts inn a topic, without which understanding of the topic would be difficult for learners. It also includes the knowledge to logically sequence the learning and the knowledge of pre-concepts needed prior to teaching a topic.	Refers to gate keeping concepts which are difficult to understand often because they cause conflict with previously established understanding.	Refers to a combination of representations at macro, symbol and sub-microscopic levels that may be employed to support an explanation.	Refers to teaching strategies derived from the considerations made from the other components and excludes general teaching methodologies.
Participants					
Lesson 1					
Lesson 2					
Lesson 3					

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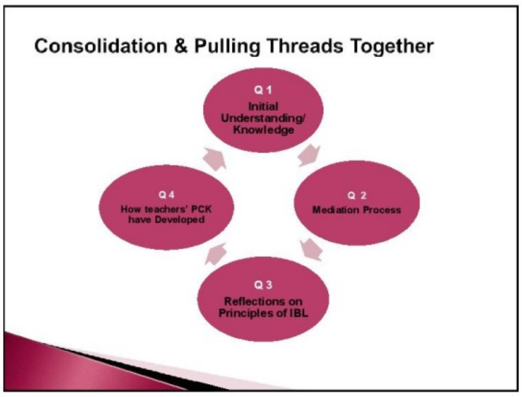
Consolidation & Pulling Threads Together
Q 1
Initial Understanding/ Knowledge
Q 2
Mediation Process
Q 3
Reflections on Principles of IBL
Q 4
How teachers' PCK have Developed

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Examples of Lessons: Participant 1

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Examples of Lessons: Participant 2

21

Examples of Lessons: Participant 3

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Examples of Lessons: Participant 4

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Successful teachers resort to a variety of activities to achieve planned classroom outcomes and to enable learners to use these techniques to take control of their own learning. (Bosman et al., 2016, p. 17)

Findings:

- In conclusion, the findings of this research showed that the importance of the instructional language used in teaching or developing an Inquiry-Based Approach in this phase is crucial. Learners at the Foundation Phase level (Grades R-3) are known to be active and energetic. Their curiosity affords teachers an opportunity to fully engage and allow them to explore materials and resources.

- The use of an Inquiry-Based Approach in this phase has been demonstrated to be a good method of teaching in developing both basic Scientific Process Skills and scientific literacy. In addition, the use of easily accessible resources or everyday materials during the use of an Inquiry-Based Approach ensured learners were relaxed and indirectly the learners were taught basic Scientific Process Skills.

- The findings motivate the need for Foundation Phase teachers to be supported and to be equipped through professional development spaces on how to use or to strengthen the use of an Inquiry-Based Approach in their classrooms. The critical engagement with the Life Skills Curriculum with regards to how it was designed and how it is perceived in the Foundation Phase, is crucial in order to achieve its aims and objectives. Higher institutions of learning need to engage with Life Skills education and Life Skills as a subject in a manner that equips pre-service teachers so that they are able to teach all the required and the expected knowledge embedded in Life Skills.

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Successful teachers resort to a variety of activities to achieve planned classroom outcomes and to enable learners to use these techniques to take control of their own learning. (Bosman et al., 2016, p. 17)

Recommendations:

- With reference to the research question 1 of this study, I recommend that there is a need for the research with more Foundation Phase teachers. For example, this can be done by adapting and using the VASI questionnaire by Lederman et al. (2014) so that more Foundation Phase teachers in all various quintile schools are reached.
- Regarding my research question 2, there is a need to have in-depth lesson observations on the teaching of science related topics in the Foundation Phase and across all quintiles. Additionally, there is a need for research that focuses on the learners' experiences on the use of an Inquiry-Based Approach.
- Pertaining to my research question 3, there is a need for continuing professional development or professional learning communities for Foundation Phase teachers so that they are supported on how to promote basic Scientific Process Skills through an Inquiry-Based Approach. For example, there is a need to promote the use of easily accessible resources when teaching science, especially in under-resourced schools.
- Finally, in research, there is a need to relook at how ethics influences the research process especially in an African context.

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