SCHOOL OF EDUCATION

# NATURAL SCIENCES TEACHERS UNDERSTAND AND PRACTICE INQUIRY-BASED SCIENCE TEACHING IN A PRIMARY SCHOOL: A CASE STUDY PROJECT

**BY**

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## ABSTRACT

Primary school natural sciences teachers are as per the curriculum policy documents required to possess the skills, knowledge, and attitudes to engage learners in the subject (Natural Sciences). The researcher used a case study strategy to investigate how grades 6 and 7 natural sciences teachers understood and practised inquiry-based science teaching (IBST), in the process of teaching the subject to their learners. The social constructivist theory of Vygotsky as a theoretical framework underpinned this research. Five grades 6 and 7 natural sciences teachers from a primary school located in the district of Pinetown Department of Basic Education, KwaZulu-Natal were purposefully selected and participated in the study.

The research methods employed to generate data included the teachers' biography and their responses to teaching scenario-based questions from questionnaires, individual semi-structured interviews, which was followed by focus grouping discussions. The five participants responded to the questions that explored their understandings and practices of IBST. The findings generated indicated that the natural sciences teachers had different understandings and perceptions of IBST. All participants confirmed attending IBST workshops and trainings. They either viewed IBST as involving learners in creating their understandings of phenomena based on evidence or connected the pedagogy to various types of learner participation in the learning process. They associated IBST with teacher-controlled activities such as experiments, demonstrations, and worksheets, but agreed that teaching natural sciences involved both practical and theoretical lessons.

The participants' practice of IBST before the intervention laid more emphasis on the conceptual domain and less emphasis on the knowledgeable application domain. In terms of the IBST's guidance component, they mostly assisted learners in generating judgments that are evidence based. Their understanding regarding the cognitive aspect of inquiry and its methods of application for promoting learning through inquiry-based largely informed how they implemented IBST. After the focus group discussion aimed at providing the participants with interventions, the teachers identified several measures they thought would improve the effectiveness of implementing inquiry-based teaching. The most emphasised issues were the science resources for teaching offered to schools and the implementation of suitable professional programmes that would develop teachers considering the context of their teaching environments. These results are expected to benefit a broad range of audiences, including

science teachers, curriculum planners, and science teacher educators, given the dispute involving various interpretations of IBST surrounding this topic in science education.

# DECLARATION

**I, Andrew Chebure, declare that:**

i) The study described in this thesis is all my originated work unless otherwise stated.

ii) This dissertation has not been submitted to any other university for a different degree or examination. Unless otherwise noted, this dissertation does not use any information, data, graphs, table, or other material that belongs to another individual.

iv) Where sources from other authors have been used, either the content has been rewritten with credit given to them by way of reference, or, in cases where the authors' words have been quoted as they were used exactly, the text has been cited and put in quotation marks. Except as otherwise noted, no one else's writing has been used.

v) Unless explicitly recognised and the source has been specified in this project and referenced, no text, tables, or visuals taken and written as part of this project from the internet.

[redacted]

07/02/2024

Andrew Chebure Date

**SUPERVISOR'S AUTHORISATION**

As the supervisor of the candidate, I agree to the submission of this thesis.

**Supervisor: Professor Angela James**

Signed: [redacted]

Date: 07/02/2024

## DEDICATION

In celebration of **Professor Angela James**, I dedicate my thesis. I wish there was a different way to say this, Mom. I sincerely appreciate all your help and encouragement along the process. You grabbed my hand and helped me get back on my feet when I was about to give up on myself. I am forever grateful.


## ACKNOWLEDGEMENT

Although the PhD path was challenging, I am confident that I was able to complete it successfully because of the grace and mercy of God, our LORD Jesus, who brought many priceless people into my life to support and bless me throughout the process. There were times I thought giving up was my only option, but these individuals encouraged and supported me in diverse ways to carry on and the most above them all was my better half, Mrs Sanelisiwe P. Chebure, who would deny herself her sleep in her bed, but painfully squeeze herself into the couch just to keep me company while I journey through the night.

To you Mr. Fred Charles Laskey, affectionally called King Charles, I thank you for your presence in life and family. Doctors Opoku, Haruna, Oduro and Ohemeng, I say may God bless you all my brothers.

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| CAPS | Curriculum Assessment Policy Statement |
| DoE | Department of Education |
| FGDP | Focus Grouping Discussion Programme |
| IBST | Inquiry-Based Science Teaching |
| NS | Natural Sciences |
| NST | Natural Sciences Teachers |
| ZPD | Zone of Proximal Development |

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# ORIENTATION AND OVERVIEW OF THE STUDY

## 1.1 Introduction

Over the past thirty years, the landscape of teaching has transformed globally as teachers continually seek innovative approaches to enhance their pedagogies in the 21st and 22nd centuries. One such pedagogical approach championed for preparing learners in these contemporary times is inquiry-based science teaching (IBST). IBST goes beyond traditional methodologies in the realm of science teaching. It requires teachers to actively engage learners, providing guidance, facilitating the learning process, and assessing their progress. This approach used by teachers extends to shaping their teaching methods, fostering a conducive environment for science learning, and formulating learning programmes that actively offer support to learners during learning (Adisendjaja et al., 2017; Bradbury, 2015; Ramnarain, 2023).

Implementing inquiry-based teaching in schools is crucial for improved learner learning. This necessitates teachers' comprehensive understanding of the associated theory and underlying principles (Anderson, 2002; Bansal & Ramnarain, 2023) of inquiry-based teaching. Teachers are at the forefront of educational policies, and therefore their grasp of policy changes, such as the shift towards inquiry-based science teaching (IBST), holds paramount importance for successful implementation. Teachers often encounter challenges in both comprehending the intricacies of inquiry-based science teaching and effectively incorporating these processes into their pedagogy. Scholars argue that addressing these challenges requires robust professional development programmes (Hassard & Dias, 2013; Lee et al., 2004; Luft et al., 2011). Personal and professional development enables science teachers to reshape their perceptions and thoughts about science and science teaching, leading to enhanced knowledge and skills in the classroom. This transformation, in turn, contributes to improved learner outcomes and increased interest in science (Crawford & Barbra, 2007).

Notably, teachers' personal beliefs and learning experiences significantly influence their teaching approaches, with many teachers relying on their knowledge and beliefs in their teaching practices (Mansour, 2013; Mugabo, 2015). Debatably, studies reveal a prevalent lack of understanding of scientific inquiry among natural sciences teachers (NSTs), hindering their ability to effectively employ IBST methods (Abdal-Haqq; Brumann et al., 2022; Capps & Crawford, 2013; Çavaş et al., 2013; Ramnarain, 2022).

This chapter established the background, rationale, and purpose of the current study. It introduced the research problem, outlined the research questions guiding the study, and underscored the relevance and significance of undertaking this research endeavour. This chapter further presented an overview of the methodology adopted for the study and concluded by briefly outlining the structure of this research.

## 1.2 The study background

In the aftermath of decades of systematic segregation and legislated racial exclusivity, the post-apartheid government of South Africa faces the daunting task of not only rebuilding social cohesion but also addressing the entrenched issues of widespread unemployment and inequality while facilitating economic growth. Despite the rhetoric surrounding improved education as a means to bridge societal gaps and foster scientific advancement promising enhanced sustainability for the marginalized majority there is a disconcerting reality that belies these aspirations. Since 1994, various curricular implementations have largely failed to produce the expected educational outcomes, as evidenced by a notable decline in learners' interest in science and careers within the scientific domain (Penn & Ramnarain, 2022). This situation raises critical concerns regarding the effectiveness of the educational reforms undertaken. At the heart of any curricular change are teachers, whose practices profoundly influence learners' engagement and progress. However, the reliance on pedagogical models such as Inquiry-Based Science Teaching (IBST) reveals significant shortcomings in implementation and support, as research indicates that while students exposed to IBST demonstrate better academic performance and practical application of knowledge (Ainley & Ainley, 2011; Dobber et al., 2017), systemic barriers including inadequate teacher training, resources, and institutional support undermine the transformative potential of these approaches. This discrepancy highlights the urgent need to critically examine the broader educational framework and the support systems in place for educators, as well as to question whether current reforms are genuinely addressing the underlying structural inequities that persist within South African society.

The inclusion of IBST into school science curricula dates back to 1910, when Dewey, a former science teacher observed that the teaching of science in schools centred around facts, rather than the attitude of the mind and thinking (Barrow, 2006; Dewey, 1910; Penn & Ramnarain, 2022). Dewey's observation in 1910 has entrenched, and today, IBST has attracted much consideration in educational policies and theories around the world. The assertion that Inquiry-Based Science Teaching (IBST) significantly enhances learner engagement and collaboration in the learning process is well-supported (Bin Ahmad et al., 2023; Mkandla, 2021). However, this perspective warrants a critical examination. While numerous researchers describe IBST as a pedagogical method in which learners uncover new causal relationships, formulate hypotheses, and conduct experimental testing with keen observations (Geier et al., 2008; Ramnarain & Hlatswayo, 2018), the approach's effectiveness and practicality in diverse educational settings can be problematic. In the IBST framework, learners are expected to independently conduct experiments with minimal teacher intervention, applying deductive skills to explore relationships between variables (Xaba & Sondlo, 2023). This assumption presumes a level of student autonomy and prerequisite knowledge that may not be universally attainable, thereby raising questions about the method's inclusivity and scalability across varied educational contexts. IBST is able to make improvement in different skills of inquiry, for example in the identification of problems, generation of questions to develop hypotheses, before the planning stage and undertaking of experiments, the collection process and the analysing of data, which leads to the presentation of results, and conclusion drawings (Mäeots et al., 2008). Minner et al. (2010) maintain that IBST involves, "teaching that actively engages learners in the process of learning by means of investigating scientifically that increase the conceptual process of understanding better than the strategies of passive approaches" (p. 474).

Arguably, there is a notable lack of emphasis on the incorporation of IBST in schools by teachers from numerous professional institutions that provide training for teachers and within teacher education programmes (Furtak et al., 2012; Xaba & Sondlo, 2023). Society anticipates that upon graduation from professional training institutions, teachers should possess the capability to teach science using IBST and effectively convey knowledge and skills to their learners. This is often not the case (Marshall & Smart, 2013). Hence, it has become necessary for researchers to find ways to understand these phenomena and offer suggestions to solve them. Studies have shown that IBST enhances motivation, critical thinking, understanding of a concept, positive attitudes during learning, and science content comprehension (Capps & Crawford, 2013; Furtak et al., 2012; Ramnarain, 2023).

In the South African context, the current curriculum, Curriculum and Assessment Policy Statement (CAPS), stipulates that natural sciences should be taught with an emphasis on enabling learners to:

> *work effectively as individuals and collaboratively within a team, organize and manage themselves and their activities responsibly and effectively, and show the ability the knowledge to collect data, analyse it, be able to organise it, and then critically evaluate information. Additionally, learners are expected to be involved in effective communication by applying visual symbols, together with language skills involved in various ways (Department of Education, 2011, p. 21).*

These are aspects and characteristics of inquiry-based teaching. Curriculum and Assessment Policy Statement (CAPS) for Natural Sciences, which is in effect in South Africa, requires teachers in grades 6 and 7 to provide teaching that is in line with the curriculum objectives. The document places a strong emphasis on a learner-centred approach, which encourages teachers to actively involve learners in the scientific inquiry process. To promote a thorough comprehension of the subject matter, teachers are instructed to cover the essential ideas and skills listed in the CAPS. Emphasis is placed on practical experimentation as crucial elements that encourage experiential learning. The CAPS statement also emphasises the value of cross-curricular connections and effective communication of scientific ideas, as well as the development of critical thinking and problem-solving abilities. These guidelines provided in the CAPS document are also in line with IBST according to the literature (Bansal & Ramnarain, 2023; Bybee, 2018; Mugabo, 2015). Even though the CAPS document does not explicitly define IBST, Table 1.1 depicts the similarities between the guidance the CAPS document provides for the natural sciences (NS) teaching and the review of the literature on IBST.

**Table 1.1**

*Similarities between IBST characteristics and CAPS Natural Sciences guidelines*

| **Natural Sciences CAPS Document** | **Inquiry-Based Science Teaching (IBST) Characteristics** |
|---|---|
| Specifies learning outcomes and objectives for Natural Sciences. | Emphasises effective participation, and engagement of students in the learning process. |
| Identifies key concepts, skills, and content to be covered in the Natural Sciences curriculum. | Focuses on student-driven exploration and investigation of scientific concepts. |

| | |
|---|---|
| Outlines assessment strategies and methods to evaluate student understanding. | Encourages continuous assessment and formative evaluation to support student learning. |
| May include specific inquiry-related skills or methodologies to be developed. | Prioritises the development of critical thinking, problem-solving, and inquiry skills. |
| Highlights the importance of practical work and experiments. | Incorporates hands-on experiments, investigations, and real-world applications in teaching. |
| May emphasise cross-curricular connections and interdisciplinary learning. | Supports connections between science concepts and other subjects, promoting holistic understanding. |
| Addresses the process of developing scientific literacy and skill for communication. | Advocates for effective communication of scientific ideas, findings, and arguments. |
| Encourages teacher-guided and student-initiated learning experiences. | Promotes a balance between teacher guidance and student exploration in the process of learning. |

The above table provides a brief explanation of the similarities between the standards listed in the Natural Sciences Curriculum and Assessment Policy Statement (CAPS) document for South Africa and the fundamentals of IBST. From the CAPS document, teachers working with learners in grades 6 and 7 must match their teaching strategies to the curriculum's specified goals, placing a strong emphasis on a learner-centred approach that engages learners in scientific inquiry. The document supports experiential learning by highlighting the value of real-world activities and experiments. In addition, the CAPS document aligns with the fundamental principles of IBST by emphasising developing critical thinking, problem-solving, and good scientific communication abilities. The CAPS document supports a teaching strategy that is in line with the IBST tenets, emphasising learner participation, real-world application, and the development of fundamental scientific competencies (Kinyota, 2020).

This study about IBST aligns itself with the definition provided by Flick and Lederman (2006) and will maintain IBST as its central term, thus:

> *Inquiry-based science teaching stands for the fundamental principle of how modern science is conducted. Inquiry refers to a variety of processes and ways of thinking that support the development of new knowledge in science. In addition to the doing of science, inquiry also refers to knowledge about the processes scientists use to develop knowledge which is the nature of science itself. Thus, inquiry-based science teaching is*

*viewed as two different student outcomes, the ability to do scientific processes and the knowledge about the processes (p.6).*

The statement emphasises how IBST is based on a fundamental premise that is in line with the essence of contemporary scientific methods. In science education, inquiry is more than just carrying out scientific procedures; it encompasses a wide range of cognitive methods and processes that support the creation of new scientific knowledge. The literature on science education, especially the writings of eminent academics like Bybee, supports this view. The seminal work "Teaching Science as Inquiry" by (Bybee, 2014) emphasises the importance of inquiry as a grasp of the epistemological nature of science itself, as well as an active participation in scientific processes. There are two types of learner outcomes in the context of IBST: the development of practical expertise in scientific procedures and a conceptual knowledge of the methods applied by scientists in the production of knowledge (Bybee, 2014). This dual focus promotes both the capacity to actively participate in scientific research and a thorough comprehending the nature of science inquiry, which is in line with the larger objectives of IBST.

### 1.3 Problem statement

South Africa has had three national curriculum reforms in schools, post-apartheid in 1994. The first was Outcomes-Based Education which ran between 1997 and 2005 (Bogdan & Biklen, 1997). The National Curriculum Statement (NCS) of 2002, and the introduction of the Curriculum and Assessment Policy Statement (CAPS). Gumede and Biyase (2016) give a detailed account of how each of these curricula had challenges with implementations and practices by teachers in schools, hence the introduction of the CAPS to augment the NCS. The curriculum developments were introduced in an attempt to redress the challenges that basic education experienced, which resulted in the dwindling interest of learners in the learning of sciences, and venturing into careers in the field of sciences (Juan et al., 2018; Makgato, 2007).

Even though each of these curricula does mention aspects of IBST such as “observations, testing and providing ideas” (Education, 2011, p. 21), clear directions to the teaching of sciences in schools through inquiry-based science teaching were not stated. Careful observations in many science classrooms today in South Africa reveal that teachers still deliver science concepts through basic primary teacher-centered means, where learners are likely to listen and take notes as passive participants in the teaching and learning process in primary schools (Mhlolo, 2022; Nemadziva et al., 2023). Where laboratory activities are involved, learners will likely be rushed through step-by-step procedures to simply justify or verify a result in primary schools (Mkimbili, 2023; Nhlengethwa et al., 2021). The nature of the guiding document makes it difficult for some teachers who are unfamiliar with and confuses those who are aware of the IBST, leaving teachers in oblivion as to how to go about teaching sciences using this approach.

## 1.4 The purpose of the study

The aim of this qualitative case study was to examine how grades 6 and 7 natural sciences teachers comprehend and implement Inquiry-Based Science Teaching (IBST) in a primary school setting. Furthermore, the study aimed to investigate the intricate network of factors influencing these teachers' understanding and pedagogical strategies (Olivier & Kruger, 2022). Although there has been a surge in research on IBST, much of this research has primarily focused on natural sciences teachers' beliefs, which in turn shape their teaching practices (Chauke, 2023; Mavuru & Ramnarain, 2020). By conducting an in-depth analysis of teachers' perspectives and instructional approaches, the study sought to provide a nuanced understanding of the challenges and successes associated with the integration of IBST into primary education. The examination of the participants' experiences and instructional choices aimed to yield significant insights to inform policy and practice in teaching and to promote advancements in scientific education at the primary level.

Moreover, the study aimed to bridge the existing gap between the theoretical foundations of IBST and its practical application in primary education. By focusing on natural sciences teachers and their understanding and implementation of IBST, the research sought to elucidate how these theoretical principles align with classroom realities. Employing a rigorous case study and qualitative methodology, the study captured the lived experiences of teachers, highlighting their instructional methods, the challenges they encountered, and the extent to which IBST principles were reflected in their practices (Bansal & Ramnarain, 2023). The goal was to contribute practical insights to the ongoing discourse on effective scientific education, thereby enhancing the quality of natural sciences teaching in primary schools.

## 1.5 Research questions

To understand how natural sciences teachers, understand and practice IBST in a primary school, this study was guided by the main research questions: *How do natural sciences teachers understand and practice inquiry-based science teaching in a primary school?* To further address the main question, the study addressed the following critical sub-question:

1. What are the grades 6 and 7 natural sciences teachers' understandings and practices of IBST at the start of the intervention programme?
2. How do the grades 6 and 7 natural sciences teachers construct their understandings and practices of IBST during an intervention programme?
3. Why do the grades 6 and 7 natural sciences teachers understand and practice IBST in the ways that they do before and during an intervention programme?

## 1.6 Rationale

The justification for a research study involves elucidating the researcher's interest in the chosen topic and articulating the significance of conducting the study (Cohen et al., 2018). The impetus for my interest in this research emanated from both personal observations and a review of existing literature. Throughout his work as a natural sciences teacher, the researcher noticed a concerning pattern in the learners' declining interest in the subject. It was observed throughout the years that where learners' performance in a particular subject was falling, their interest in those subjects equally suffered a decline. This was an observation the researcher made in his years of teaching. This connection made the researcher think critically about the methods that are used to teach by teachers and for that matter, the natural sciences. The researcher was tempted to blame the pedagogical strategies that natural science teachers, the researcher included, have employed for the learners' declining performance. Further concerns that spurred the researcher to embark on this project were his observations and experiences as a natural sciences teacher seeing learners struggling to comprehend science concepts because of factors such as a lack of textbooks, teaching-learning materials, and laboratory resources. Literature shows that the application of teaching through inquiry-based improved learning experiences (Veloo et al., 2013)

Although IBST has been practiced in schools around the world for some time now, there is still a lot of misunderstanding as to what inquiry-based science teaching is according to literature and how teachers understand and practice it in their classrooms (Mugabo, 2015; Sheehy et al., 2019; Wenning, 2011). Various studies conducted in the South African context (Dudu & Vhurumuku, 2012; Ngema, 2022; Ramnarain, 2023; Ramnarain, 2014; Robinson, 2009) show that many primary schools struggle with basic resources such as infrastructure, science laboratories, and access to the internet and in many cases, they lack qualified natural sciences teachers. All these factors have contributed negatively to the implementation of IBST in schools in South Africa (Dudu & Vhurumuku, 2012; Mavuru, 2023; Ngema, 2022; Ramnarain, 2014; Robinson, 2009). Over the years, there were some interventions such as the provision of science resource centers, mobile laboratories, and professional development of teachers as supported by the government, but the problem seems far from over since not all schools are covered by these interventions  (Dzansi & Amedzo, 2014; Ramnarain & Fortus, 2013).

There are differing opinions about how IBST benefits the learning of sciences. According to Alake-Tuenter et al. (2012), inquiry-based science education is a driving force behind learners' growth in terms of their ability to conduct research, create meaning, and learn scientific concepts. This claim is supported by the findings of other researchers, including Exline (2004), Russell and Martin (2014), and Tavares et al. (2015). Even with these confirmations, there are still unanswered questions in the South African setting, particularly concerning the understanding and practices of IBST by natural sciences teachers in primary schools. The rationale of this research is to answer important questions, such as the following: What do the grades 6 and 7 natural sciences teachers of natural sciences understand and practice teaching inquiry-based science in primary schools? In primary school settings, how do the teachers of natural sciences practice IBST? Why do teachers in the natural sciences choose to practice specific interpretations and methods of inquiry-based scientific teaching in primary schools? Furthermore, the study intended to investigate the challenges that primary school teachers have while using inquiry-based science teaching in the teaching of the sciences. The study aimed to provide insights that could improve scientific teaching methods in South African primary schools by addressing all the above questions.

The need for research on IBST in primary school’s stem from a complex justification based on current educational theory. According to recent studies (Juan et al., 2018; Mavuru, 2023; Mkimbili, 2023), IBST has the transformative potential to encourage greater learner involvement, critical thinking, and scientific literacy. Furthermore, the implementation of IBST is consistent with contemporary frameworks for educational policy that place a strong emphasis on the development of 21$^{st}$ century abilities, such as inquiry, teamwork, and problem-solving (National Research Council, 2012; UNESCO, 2015). Given that IBST deviates from conventional didactic approaches, it is critical to examine its use and effects in primary school settings. Prior studies by Hofstein and Lunetta (2004) and Windschitl and Sahl (2002) have shown that IBST can foster a thorough comprehension of scientific ideas and motivate learners to take an active role in the scientific method. The integration of IBST in primary school settings in the changing nature of educational methodologies informs the shaping of teaching practices, adds to the body of knowledge on science education, and ultimately could influence young learners' opportunities to receive a modern and high-quality science education.

### 1.7 Significance of the study

Current research emphasises how educational practices are changing, especially in response to advances in pedagogical approaches and the sociocultural elements influencing learner-learning results (Taylor et al., 2021; Johnson & Smith, 2020). Although the body of literature that has already been written about IBST at different levels is quite helpful, there is still a clear knowledge vacuum regarding how natural sciences teachers understand and practice this teaching strategy when working with learners in particular grades, and in this instance, grades 6 and 7 in primary schools.

This study sought to close the gap and continue the ongoing conversation about successful science teaching by providing nuanced insights into natural science teachers' practices and understandings of IBST. Through a case study exploration of how teachers in grades 6 and 7 natural sciences teachers understand and practice IBST, this study sought to both add to the body of knowledge already in existence and provide guidance for evidence-based methods that will promote improvements in science teaching in primary schools. The significance of the study is to contribute to the continuing conversation about the impact of IBST on natural sciences classrooms by conducting a thorough analysis of teachers' understandings and practices.

For many stakeholders in the South African education system, the results of this study on how grades 6 and 7 natural sciences teachers understand and practice IBST in a primary school will be extremely valuable. Policymakers in education can gain knowledge about the unique possibilities and difficulties teachers face when putting IBST into practice. The creation of evidence-based policies that facilitate the incorporation of IBST practices in primary scientific education can be influenced by these findings. By matching curricular frameworks with the real experiences and needs of natural sciences teachers, curriculum developers can improve the efficacy and relevance of science education resources. The study's findings can be used as a professional development tool for any natural sciences teachers, providing them with information on best practices, resolving issues, and building a practice community around successful IBST techniques. In the end, research helps to raise the standard of science teaching in South Africa by offering a sophisticated grasp of the dynamics surrounding the practice of IBST, which in turn promotes better decision-making and teaching practices.

### 1.8 Methodological overview

This section stated and outlined the research design and methodology that was chosen, including the justification for this choice.  Bertram and Christiansen (2014) define research design as “a plan of how the researcher will systematically collect and analyse data that is needed to answer the research question” (p. 40). This research was suited par within the social interpretivism paradigm that is seen largely as an approach to qualitative research (Creswell & Creswell, 2018). Researchers working in the interpretivism paradigm aim to understand “the human experience world” (Cohen & Manion, 1994, p. 36), which implies that to effect any changes to the professional experiences of teachers, researchers need to first understand the situation under investigation (Burns, 2003). According to Creswell and Creswell (2018), the social interpretivist researcher often relies on the views of the participants of the situation under study and, hence, collaborates with participants to develop new knowledge.

The approach to this study was qualitative which was used to gather and interpret the data.  As a methodological tool, qualitative research is essential to understanding the complexity of human experience and behaviour which was exactly the focus of this research aimed at understanding how natural sciences teachers understand and practice IBST in grades 6 and 7. A researcher working in a qualitative approach sets out to understand and describe a setting she or he is familiar or unfamiliar with, by  “describing the observable and learned patterns of behaviour, customs, and ways of life and practices of a shared group” (Bertram & Christiansen, 2014, p. 43).

This study adopted a case study as its research strategy. A case study research project explores and analyses a particular person, group, organisation, or phenomenon in-depth within the context of real-world events (Yin, 2018). By investigating special situations, evaluating various viewpoints, and producing rich, contextualised data, case study research seeks to develop a thorough understanding of complicated subjects such as IBST. A case study emphasises an in-depth analysis of a specific subject or circumstance, and this is what distinguishes case study research from other types of research (Stake, 2010). To obtain rich, in-depth, and comprehensive data, it makes use of a variety of data-gathering techniques, including interviews, observations, document analysis, and archive research, which enables researchers to record subtle insights, contextual factors, and correlations to between variables.

The selection of a case study allows a researcher to explore difficult phenomena, unearth unusual experiences, and develop a thorough understanding of the topic under investigation.

They make it possible to explore complex social, cultural, and contextual aspects that affect how people behave both individually and collectively in the way they do (George & Bennett, 2005). Secondly, through the discovery of patterns, causal links, and theoretical assertions, case studies offer the chance to develop or improve theories (Eisenhardt, 1989; García-Montoya & Mahoney, 2023). By offering data and insights into complicated events, they can aid in the creation of theories, strengthening the theoretical underpinnings of diverse fields of study. In addition, case studies provide insights into actual circumstances and assist in decision-making, case studies have practical value. Organisations, politicians, and practitioners confronting comparable problems offer useful ideas, lessons learnt, and best practices (Creswell & John, 2018; Flyvbjerg, 2006; Remenyi, 2022).

### 1.9 Overview of the Study

**Chapter One** presented and contextualized the study**.** The researcher described the study's purpose and problem description. It was stated that IBST is recognised as an effective teaching methodology to enhance science teaching. It helps learners think critically and deeply and can help them grasp science concepts in a practical meaningful way. It is among the pedagogical approaches that emerged from social constructivism theory. Notwithstanding, the curriculum provision of IBST in the CAPS document in South Africa, teachers of Natural Sciences persist in depending on conventional, teacher-centred methods in teaching natural sciences. Teachers' diverse understandings were the primary forces behind their classroom practices and one of the many explanations for the dearth of IBST. To understand why teachers, teach the way they do, the researcher developed study questions that investigate the relationship between teachers' understandings and their IBST practice. Finally, the researcher covered a quick synopsis of the chapter's research design and methodological considerations. The rationale, the purpose and significance of the study were also presented.

**Chapter Two** reviewed the literature on NS teachers' understandings and practices of IBST. The chapter began with definitions as provided by various scholars, and of how the pedagogy finds resonance with the teaching of science. From the various definitions, the researcher indicated the definition that this study aligned with and justified his stance. The literature review also included the history of IBST, where and how it found its way into science education, and how it has evolved over the years and become synonymous with the teaching of sciences in schools. The researcher also reviewed the literature surrounding NS teachers' understandings of the concept of IBST, as against the literature, and their practices of IBST in the teachings of natural sciences. This conversation was underpinned by the idea that teachers' teachings are informed by their understanding of the teaching pedagogy they practise in their classrooms. Based on the literature review, it was discovered that IBST was introduced in many curricula around the world more than two decades ago, yet its understanding, interpretation and practice were not as common as it ought to be among science teachers. Moreover, the research indicated that science teachers were comfortable teaching science through conventional methods, where they took centre stage in the teaching processes. The challenges they faced in practising the approach were also discovered in the literature. These could be social or physical, like time, policy, and departmental culture, or physical like the school, classroom, and resources. The results of the investigations demonstrated the persistent disparity between teachers' understandings and practices of IBST. Many studies linked the absence of physical factors such as a lack of science laboratories, textbooks and other teaching and learning resources to the mismatch between teachers' understandings and practices of IBST.

In **Chapter Three,** the researcher outlined the theoretical framework that guided the study's data collection and analysis. The social constructivist theory of Dewey (1933) and Vygotsky (1978) was selected concerning IBST-related classroom activities during the teaching of NS. Constructivism gave rise to IBST, therefore the debate concerning the nature of the constructivist classroom, teacher duties, values, and practices also applied to it. The idea that teachers' understandings influence their classroom practices served as the basis for the constructivist teacher understanding and practice of IBST, and the impact of school context that contributes to teaching methods practised.

**Chapter Four** offered a research design methodological introduction to the study and an analysis discussion. The researcher presented the research paradigm of interpretivism and the qualitative approach to data generation. The strategy of a case study was applied to understand how NS teachers understand and practise IBST in a primary school. The participants were NS teachers from grades 6 and 7. Purposive sampling was adopted. The teachers were contacted and requested for their participation, and they were willing participate in the research as participants. Questionnaires, semi-structured interviews, and classroom observations which are constructivist were used in the process of data generation. Lastly, the researcher engaged in post-classroom observation interviews to ascertain the level of impact the workshop had on their teachings and in the conclusion of the chapter, the trustworthiness and ethical considerations necessary for the study were considered.

**Chapters Five to Seven,** this study presented exploration and elucidation of the methodologies employed in data generation and subsequent findings analysis, all within the confines of the adopted conceptual framework. Chapter Five scrutinised the perceptions of natural sciences teachers regarding IBST before and after an intervention. Subsequently, Chapter Six undertook an in-depth exploration of the practical application of IBST within the educational context. The researcher conducted an intervention workshop to discuss their teaching as against the literature of IBST and post-workshop classroom observations were organised again which is also captured in this chapter. Chapter Seven served as an insightful discourse, elucidating the myriad factors influencing the implementation of IBST by natural science teachers, analysed and discussed within the framework established by the overarching research design. These chapters collectively contribute to a nuanced understanding of the intricacies surrounding the generation, analysis, and application of data, shedding light on the multifaceted landscape of inquiry-based science teaching in the domain of natural sciences education.

**In Chapter Eight**, the culmination of this research was encapsulated through the recapitulation of its pivotal objectives and the corresponding conclusions drawn in response to the research questions posited. This section not only served to synthesise the key findings but also underscored the contribution of the study to the extant body of knowledge within the subject area. Furthermore, Chapter Eight ventured into the realm of prospective research endeavours, delineating recommendations for future investigations and illuminating potential avenues for further scholarly inquiry into the researched topic. After the conclusive discussions, the chapter appended a comprehensive list of references and appendices that have been instrumental in shaping and substantiating the empirical foundations of this study. The integration of these elements in Chapter Eight collectively advanced the scholarly discourse surrounding the research, offering a conclusive synthesis of insights while concurrently guiding the trajectory for future academic pursuits in the field.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.1 Introduction

In Chapter One, the foundation of the study was laid thus the background, the purpose of the study, rationale, and motivation of the study. Additionally, the context of the study was discussed in the chapter, along with the problem, objectives, the research questions that guided the research, the significance of the study, and the research design with the methods to apply in the study. The literature review served as a comprehensive synthesis of existing research relevant to the study's overarching topic. This section aimed to contextualise the current investigation within the broader scholarly discourse. As Johnson (2018) noted, a well-constructed literature review not only identifies the gaps in existing knowledge but also highlights the key theories and empirical studies that have laid the foundation for the present research. According to Smith and Brown (2019), a thorough literature review is crucial for establishing the significance of the research and demonstrating the researcher's awareness of the existing body of knowledge in the field. By critically analysing and synthesising previous research findings, the literature review set the stage for the identification of research gaps and the formulation of research hypotheses. The discussion of the literature reviewed was categorised into five main headings. These included the definition and history of IBST, the development of inquiry-based teaching, science teachers' understanding of inquiry-based science teaching, the practice of inquiry-based science teaching by science teachers, and the factors that account for science teachers' implementation of IBST. The discourse considered the local settings as against the international context in the application of IBST in primary schools.

## 2.2 Definition of inquiry-based science teaching

Since IBST became a method for teaching science, the method has posed challenges in its understanding and practice among many science teachers and has caused so much confusion in science education (Mugabo, 2015a). Webster (2011) defines the term inquiry-based as an "instance of looking for truth, knowledge or information through research, investigation or inquiry" (p.504) and "to seek for information about, investigate, search or to question" (p.504) represents the root meaning of the word 'inquire.' But in the area of science education, the definition of the word inquiry has numerous interpretations leading to an identity crisis even among science teachers (Barrow, 2006; Osborne, 2014). To some teachers, inquiry-based is just like discovery learning or only hands-on activities (Capps & Crawford, 2013; Demir &

Abell, 2010). Others equate the term with increased levels of learner attention and direction that allows learners to ask questions, lead data collection, and design procedures (Morrison, 2013a; Rodgers, 2012; Sheehy et al., 2019). The goal of inquiry-based science teaching is to cultivate critical thinking abilities and a deeper comprehension of scientific concepts in learners by emphasising their active participation in the learning process through the methodical investigation of issues, phenomena, or questions (NRC, 2000). Inquiry-based science education, according to the National Research Council (NRC), is a methodology that encourages learners to make inquiries, develop hypotheses, plan experiments, gather and evaluate data, and make conclusions supported by evidence (NRC, 1996). This method encourages curiosity and a hands-on, experiential learning environment by replacing the conventional teacher-centred paradigm with a learner-centred one (NSTA, 2003). Inquiry-based learning fosters critical abilities like problem-solving, communication, and teamwork in addition to improving material knowledge by having students actively engage in the scientific process (Hmelo-Silver, Duncan, & Chinn, 2007). Essentially, IBST is a framework for teaching science that encourages learners to actively participate in the scientific method and develops a lifetime love of learning.

In all of those are some characteristics of inquiry-based, they are not a full representation of inquiry-based teaching. Inquiry-based emphasises that learners work under the guidance and supervision of teachers who are experienced to develop knowledge and understanding of scientific concepts as they interact with data and questions which are scientifically based (Mugabo, 2015; Ramnarain & Education, 2014). Several researchers have provided definitions for inquiry-based science teaching as "there is no one true definition of inquiry-based science teaching waiting to be discovered, but an understanding of inquiry-based science teaching is constructed by the individual participant" (Pedaste et al., 2015, p. 32). The terms inquiry-based teaching, inquiry-based teaching methods, and inquiry-based approach have been used synonymously by researchers. The term refers to the central theme of the scientific method of teaching science, which is learner-centered. In this study, the researcher worked with the central theme, which is IBST. This position taken and stated has become necessary because various studies have sort of made use of these terms synonymously when dealing with the subject of IBST as this study. This study about inquiry-based science teaching aligned itself with the definition provided by Flick and Lederman (2006) and maintained inquiry-based science teaching as its central term, thus:

> *Inquiry-based science teaching embodies the essential principle underlying modern scientific practice. Inquiry encompasses a range of processes and cognitive approaches that facilitate the creation of new scientific knowledge. Beyond the execution of scientific tasks, inquiry also includes understanding the methodologies employed by scientists to generate knowledge, which reflects the nature of science itself. Therefore, inquiry-based science teaching is seen as fostering two distinct student outcomes: the capability to engage in scientific processes and the comprehension of these processes.(p.6)*

Minner et al. (2010) maintain that inquiry-based science teaching involves "teaching that actively engages learners in the learning process by means of scientific inquiries [that] are likely to increase their conceptual comprehension than techniques that rely on passive strategies" (p. 474). Inquiry-based science teaching can also be defined as an educational method in which learners follow methods and practices like those of professional scientists to construct knowledge (Dobber et al., 2017).

In summary, so far as the meaning of inquiry-based is known, researchers for over a hundred years have not come to a consensus on the term inquiry-based in science education, and it affects the understanding and practice of inquiry-based science teaching in schools (Osborne, 2014). There is, therefore, the need for science teachers to come to a consensus about the meaning of inquiry-based to reduce the confusion that comes with its application in class. Re-examining the development of inquiry-based teaching will give insights towards attaining the much-needed agreement so that the practice can be contextualized to suit South African primary schools.

### 2.3 The history and development of inquiry-based teaching

Over 500 years inquiry-based teaching has evolved since the days of Socrates in the 1500s (Sharon Friesen & David Scott, 2013; Laase, 2011), followed by Dewey's ideas in the 20$^{th}$ century (1910, 1938, 1944) then came (3E and 5E models) of learning cycle by Atkins and Karplus between 1950 and 1970 (Simpson, 2012; Van Doorn & Van Doorn, 2014) to the current practice of inquiry-based teaching (Guerrero & Bautista, 2023; Ramnarain & Hlatswayo, 2018; Sheehy et al., 2019). A lack of clarity on what it means to teach science through inquiry-based teaching among science teachers accounts for the continuous evolution of inquiry (Osborne, 2014), resulting in science education researchers continuously trying to conceptualise the concept of inquiry-based science teaching with the hope of providing clarity and helping science teachers to understand and practice inquiry-based teaching (DeGraff, 2010; Osborne, 2014).

In the review of literature on the development of IBST, the researcher synthesized the growth and development of inquiry-based teaching under five major areas: the ancestry of inquiry-based teaching, the middle age, the modern age, the learning cycle, and the shift from inquiry to present-day science practices. The ancestry of inquiry-based teaching, also known as the Socratic era, advocates logical reasoning. It merely involves questioning and probing to discover the underlying truth (Sharon Friesen & David Scott, 2013). The process further creates an enabling environment where both the teacher and the learner learn from each other through a formal structural process by interacting with a topic to solve questions and, in the end, develop new knowledge. Considering the development of inquiry, it was noticed that the term inquiry dates to the 13$^{th}$ century, which meant to seek and find through questioning (Ridgeway, 1910).

The work of Dewey (2010), a key proponent of the progressive movement in education, paved the way and motivated the application of inquiry in the teaching of science in schools. He advocated for a type of teaching that encouraged learners to solve learning problems by using their own experiences and the application of knowledge. Through Dewey's work, the learning cycle was developed, which involves exploring an idea, then developing a concept to define the idea and, in the process, discovering new means of applying the original concept to an entirely new situation, thereby generating new knowledge. The shift from inquiry to science practices meant that learners were not taught the theory of investigation only but were also motivated to engage in practice when learning science.

Mackenzie (2014) gives a historical account of how Socrates used disciplined and systematic processes of questioning to discover fundamental truths about the natural world. Through questioning, Socrates disproved many assumptions that were commonly held about teaching and learning. Glaser (1997) wrote that the Socrates method suggests that experience in the classroom experience is often a shared conversation between the teacher and learners in which both are in charge initiating the dialogue through the process of questioning which suggests that both teachers and the learners engage in probing questioning meant to deepen understanding and clarify assumptions that underpin a truth, a thought, or a claim of logic. The understanding of the Socrates method and tradition enables us to recover some of the elements that are missing in how some people understand and interpret inquiry-based teaching in education.

In the Socratic method or tradition, learners are not given free rein to the learning process or a topic they want to explore with little or minimum guidance from the teacher. Instead, the Socratic tradition or method involves the creation of a classroom or space where the teacher and learners actively engage in dialogue in pursuit of solutions or answers to questions through thinking. To him, inquiry-based was a way of life rather than a sporadic or step-by-step process (Mackenzie, 2014). In the Middle Ages, the assumption is that inquiry emerged from Ancient Greece and can be traced to the $13^{th}$ century by a Latin word, 'inquire,' which means "to seek for" (Sharon Friesen & David Scott, 2013). The desire to find answers to unanswered questions drives inquiry.

As a science teacher, Dewey encouraged primary school teachers to use inquiry as a strategy in teaching science (Barrow, 2006; Sharon Friesen & David Scott, 2013). According to Dewey, an inquiry should be modelled on a scientific process and suggested it involves identifying confusing circumstances, elucidating the issue, developing a working hypothesis, evaluating the hypothesis, rewriting the exacting tests, and taking appropriate action (Kidman & Casinader, 2017). According to Dewey, the mere transmission of knowledge from teachers to learners and the acquisition of facts rather than encouraging models of attitudes of the mind and thinking relates to the way and processes that scientific knowledge is constructed (Barrow, 2006; Sharon Friesen & David Scott, 2013). As time evolved, Dewey advocated for the advancement and broadening of the scope of inquiry in schools to cover other subjects. He suggested and encouraged learners to develop the habit of formulating problems that relate to their experiences to improve their understanding and personal knowledge.

According to Dewey, teachers should not view teaching as a process that involves merely passing information to learners to absorb, but as a collective and interactive process where learners are actively involved in the teaching process, and to some extent, have some amount of control over what they learn. Dewey added that the role of the teacher in the teaching process is that of providing guidance and facilitation and not allowing an anything-goes or free-for-all approach, but a carefully guided path and process that leads to the creation of knowledge. Dewey argued that in addition to the acquisition of knowledge, an inquiry should apply to learn how to live. In line with the present, the goal of scientific literacy is to produce responsible, active learners. They are required to make informed decisions based on science and technology for the benefit of humanity instead of giving remote training to learn and practice.

Dewey (2010) emphasised that the goal of education is to help learners come to terms with their full potential to become actors of democracy and promote the common good of humanity. Even though Dewey felt that the teaching of science was for the common good of humanity many years ago, science education has continued to be interested in learners learning content for the sake of good grades or acquiring careers in the fields of science. The factory model of education, which encourages the traditional mode of teaching, that disregards the ideas and principles of Socrates and Dewey about inquiry, is responsible for this phenomenon.

Inquiry-based teaching underwent a rebirth in the 1950s in the United States of America when Sputnik, a satellite, helped to bring inquiry back to the limelight of science education (Barrow, 2006; Bybee, 2018; Spronken-Smith et al., 2011). Science teachers in the 20$^{th}$ century predominantly relied on expository methods of teaching, which consisted of presenting science concepts to learners through reading and lecturing. Teachers merely led learners through the concepts and verified some thoughts in the laboratory as a procedural (Silm et al., 2017). As inquiry continued to evolve, the ideas of Dewey expanded and developed which led to the conception and creation of "The Learning Cycle" by Rober Karplus and Myron Atkin in 1962 which they called "Guided Discovery" out of which they came by learning cycle in 1967 (Fuller, 2003; Obe, 2018). According to Karplus and his colleagues, the learning cycle consists of three phases: the exploration stage, the invention phase, and the discovery phase (Bybee, 2014). At this stage of the developmental process of inquiry, the focus shifted to the learning cycle.

Sunal (2015) gives an account of the learning cycle as a teaching process that involves following activities that begin with an exploration of a concept or idea, which leads to a guided exploration of the idea or design, and further expansion of the concept or idea through repeated trials and practices in different settings. The exploration stage in the cycle of learning exposes learners to the phenomena to be studied and is followed by the introduction of new terms found in the concept which forms the object of the learning. At this stage, the teacher takes centre stage in the teaching and learning process to make up for the intervention phase, and lastly, learners apply what they have discovered in a new setting. In the learning cycle, learning is through practice and replication, which consolidates understanding of concepts (Bybee, 2014). The idea of the learning cycle allows learners to apply the knowledge they gain in class to new settings and areas by way of reasoning. This they do by examining each situation they encounter and deciding on what concept to apply when necessary. By so doing, they gain confidence in themselves and their learning (Sunal, 2015). The learning cycle continued to evolve, and by 1980, the Biological Science Curriculum Study added *engagement* and *evaluation* stages to the beginning and end of the period (Bybee, 2014). This became known as the 5E learning cycle, and the phases include engagement, exploration, explanation, elaboration, and evaluation.

From the stages and processes through which inquiry has evolved to the 21st century, one question that comes to mind is, has the teaching of science in schools changed over the years? Osborne (2014) argues that since scientific practices in schools have not been remarkably different from one era to the other through the developmental process of inquiry, the difference lies in the clarity of experience and outcomes learners are expected to arrive at, and the kind of professional engagement learners encounter from their teachers in the scientific process. Osborne (2014) identified that the primary challenge that confronts teachers in teaching science through inquiry is the lack of shared understanding and interpretation of what teaching science through inquiry-based is and the difference between science activities and teaching science through inquiry-based. According to Ainley and Ainley (2011), inquiry-based teaching has four significant features, which include developing descriptions, explaining, predicting, and the use of models as evidence in concluding, that without those features, a teaching process cannot be described as inquiry-based teaching. Studies conducted to establish whether science teachers understand and practice inquiry-based science teaching in schools, both globally and locally come mainly to the same conclusion the teachers do not have a common understanding of IBST (Botha, 2016; Mugabo, 2015; Ramnarain & education, 2014; Silm et al., 2017; Wee et al., 2007).

In summary, the literature reviewed showed that the development of inquiry-based teaching has evolved over the years, which has affected how it is perceived, understood, and practised, as it travels the journey of transformation through the years. Today, inquiry-based is known globally in science education. Still, the grappling, with its understanding, interpretation, construction, and use, keeps growing among science teachers, especially in developing countries such as South Africa. This proposed study is to explore science teachers' understandings and practices of inquiry-based science teaching in a classroom in the context of South Africa.

## 2.4 Principles of inquiry-based science teaching

Effective science education requires a strong integration of the ideas of IBST. The purpose of the current study was in exploration of how grades 6 and 7 natural sciences teachers understand and practice IBST in a primary school, leading to improved learner active involvement, critical thinking, and the development of problem-solving skills, all of which are in line with the objectives of modern science education, according to Windschitl and Stroupe (2017). Education professionals can establish a learner-centered learning environment that promotes inquiry and discovery by implementing IBST concepts into the curriculum. It has been demonstrated that using this method would help learners retain scientific knowledge over the long term and develop their conceptual comprehension (Windschitl et al., 2012). Thus, in the context of natural sciences, understanding and putting IBST concepts to use can greatly improve learners' scientific literacy, as well as participation.

Furthermore, the IBST tenets are essential in resolving the problems with conventional teacher-centered methods. Through the integration of these principles, teachers can cultivate a more profound understanding of NS topics and motivate learners to take responsibility for their learning. This strategy aligns with the study by Windschitl and Calabrese Barton (2016), which shows that IBST has a favourable effect on learners' motivation and interest in science. Therefore, implementing IBST concepts in NS classes in primary schools shows promise in meeting the changing demands of science education and getting learners ready for active engagement in the scientific community.

## 2.5 Science teachers' understandings of inquiry-based science teaching.

Inquiry is the process of investigating a scenario, to find out, analyze, investigate, or review. For this study, the researcher explored natural sciences teachers' understandings and practices of IBST in a primary school. The teaching of science through inquiry-based approaches has proven to be the most effective for teaching science (Asay & Orgill, 2010; Ngema, 2022). Regrettably, inquiry-based science teaching has not completely become the norm in schools as yet in this 21$^{st}$ century since science teachers still struggle to reach a common understanding, construction, and application of the method. Mugabo (2015) found that science teachers show different views on IBST, while some view it as a process; others believe it is a means of learning science. To a large extent, how some teachers interpret and practice IBST is influenced by how they are taught at school, available resources and the context of their teaching environment (Asay & Orgill, 2010; Mugabo, 2015a; Obe, 2018).

Several definitions and conceptions have been given for IBST, which may have been misinterpreted. Morrison (2013) defines conceptions as thoughts, understandings, and ideas, whereas beliefs define one's conviction, faith, or trust in something. It is, therefore, common to find teachers showing divergent and conflicting views about IBST, which affects the way they practice IBST in class. Perception could also be one's opinion, feelings, or beliefs, and it is, therefore, necessary to determine how these impact teachers' practice of IBST. Eick and Reed (2002) allege that the kind of learning orientation and the previous exposure teachers receive play an essential role in their understanding and practices of IBST. They added that without a reconciliation of teachers' previous beliefs and perceptions because of their experiences as learners and pre-service teachers, it is almost impossible to develop the teachers' mindset about an educational reform such as inquiry-based teaching. The assertion means that the ability of a teacher to implement IBST is directly affected by his or her previous experiences in an evolving world which requires that teachers are up to date on or apar with this changing world. According to Wang and Zhao (2016), culture affects teachers’ understanding of inquiry. Furthermore, Mugabo and Nsengimana (2020) asserted in their case study in Rwanda that there is still a lack of common knowledge of inquiry-based teaching among science teachers in many countries, especially in Africa.

Another group of researchers found that science teachers' knowledge of the nature of science affects their teaching of science using inquiry-based teaching. They further agreed that teachers who had a sound knowledge of the nature of science were more likely able to teach science through inquiry-based teaching (Sharon Friesen & David Scott, 2013; Mumba et al., 2015; Ramnarain 2014; Sunal, 2015). From the literature reviewed, the researcher gathered that the level of teachers’ comprehension of the concepts of science determines how well they can implement IBST in class. Teachers who have greater accuracy of the concepts of science did better with the teaching of science through IBST (Botha, 2016; Minner et al., 2010; Mugabo, 2015). To this end, Larrivee (2008) suggested that it was important that teachers are trained reflectively such that they could infuse personal ideas, conceptions, and values into their professional identity, which will result in a much-developed voluntary code of conduct in the discharge of their duties. The researcher believes that teachers should be able to find and draw that thin line that distinguishes their conceptions and beliefs for the nature of science required of them as science teachers and in the process overcome the barriers posed by those conceptions and beliefs in the teaching of science through an inquiry-based approach.

Teachers' divergent views on the nature of science and the absence of common perception is another challenge confronting the implementation of IBST in schools. Atar and Gallard (2011) found that teachers' views and understanding of the nature of science had a direct impact on their implementation of IBST. He gathered that teachers who had more understanding and knowledge of science content found it easy and were willing to conduct science lessons via IBST. Meanwhile, teachers with less content knowledge of science were reluctant to make any shift from the old method of teacher-centered teaching. This phenomenon of these teachers suggests that they hardly change from the way they were taught at school, even in a fast-changing world.

**2.6 Science teachers' practice of inquiry-based science teaching**

Inquiry-based science teaching has been emphasised more in primary schools, as a pedagogical approach to improve learners' scientific literacy and critical thinking abilities (NGSS Lead States, 2013; Bybee, 2002; Xaba & Sondlo, 2023). With this method, the conventional teacher-centred paradigm with a learner-centred one in which learners actively participate in the scientific method by asking questions, looking into topics, and doing analyses (Duschl et al., 2007). Since teachers' teaching methods have a great impact on learners' experiences and comprehension of scientific concepts, science teachers are essential to the effective application of inquiry-based learning (Windschitl et al., 2012). Researchers have investigated the several elements that affect primary school science teachers' adoption of inquiry-based techniques. For example, research by Blanchard et al. (2010) indicates that teachers' desire to use inquiry-based teaching may be influenced by their level of confidence in their pedagogical abilities and subject matter expertise. It has been determined that inquiry-based professional development programmes are useful interventions for building teachers' competence and confidence in applying these approaches (Banilower et al., 2013; Roth et al., 2011). Additionally, it has been established that organisational support, which includes resource availability and a positive school climate, is essential to making inquiry-based learning more easily incorporated into primary science classrooms (Anderson, 2013; Windschitl et al., 2008). Inquiry-based teaching allows learners to take an active role in their learning, which results in a deeper understanding of scientific ideas. Science teachers can stimulate learners' natural curiosity and inspire them to ask questions that advance their learning by encouraging curiosity and encouraging an exploratory mindset. This strategy has its roots in constructivist theories of learning, which contend that knowledge is actively built by learners through their interactions and experiences with the outside world (Finch, 2021).

Learners can bridge the gap between abstract ideas and practical applications by participating in hands-on activities and research, making science more meaningful and applicable. The advantages of inquiry-based science teaching are highlighted by recent science education research. For instance, Inel-Ekici and Ekici (2022) indicated that, in comparison to conventional lecture-based or teacher-cantered methods, inquiry-based teaching approaches considerably enhanced learners' knowledge of complicated scientific ideas. As a result, learners engaged more fully and actively in class discussions and activities (Adhami & Taghizadeh, 2022). Learners exposed to inquiry-based science teaching also showed improved desire and excitement for science. Additionally, inquiry-based instruction promotes the growth of crucial 21$^{st}$ century skills including communication, problem-solving, and critical thinking. Students learn to analyse data, make inferences, and successfully explain their findings as they participate in the scientific discovery process (Council, 2012). These abilities are important for future professions in a technology culture that is rapidly expanding as well as for academic success. However, it takes a lot of work and professional development on the part of science teachers to practise inquiry-based science teaching. It might be difficult to design meaningful activities, develop lesson plans that are inquiry-based, and oversee learner-driven learning. To support learners in their inquiry process, teachers must change their responsibilities from knowledge disseminators to learning facilitators (Wilson, 2020).

### 2.7 Factors that influence science teachers' implementation of IBST

The readiness and willingness of science teachers to adopt the method of teaching science through inquiry-based are critical to the implementation of it. Several aspects affect the use of IBST in primary schools. These include the qualities of the teachers, chances for professional development, and the surrounding setting of the school. Research reveals that teacher views on and attitudes towards inquiry-based techniques strongly impact their willingness and ability to adopt IBST (Blanchard et al., 2010; Windschitl et al., 2012). Positive attitudes towards inquiry-based approaches are associated with teachers who are more enthusiastic and committed to implementing them in their classrooms. Furthermore, a key factor in the effective application of IBST is teacher efficacy, which is described as the conviction that one can achieve desired results through teaching methods (Ramey-Gassert et al., 1996). Studies indicate that focused training programmes increase teachers' ability and confidence in applying inquiry-based methods and that professional development plays a significant role in determining their readiness to adopt IBST (Banilower et al., 2013; Roth et al., 2011). These results highlight how critical it is to address teachers' beliefs and offer efficient professional development to cultivate a favourable attitude towards IBST in elementary science instruction.

In addition, the school environment's contextual elements have a big impact on how IBST is implemented. It has been determined that one of the main factors influencing the adoption of IBST is access to resources, such as lab equipment, teaching materials, and technical assistance (Anderson, 2013; Windschitl et al., 2008). The successful integration of IBST is dependent on a strong school culture that supports and promotes innovation in teaching practices. In this regard, administrative support and school leadership play a critical role (Windschitl et al., 2008). Moreover, policy frameworks at the school or district level can either restrict or promote the implementation of IBST, underlining the necessity for alignment between educational policies and the aims of inquiry-based science education (Blanchard et al., 2010; Bybee, 2002). To put it simply, encouraging the successful implementation of IBST in primary schools requires an awareness of and attention to the intricate interactions among teacher qualities, professional development, and contextual circumstances.

Using data from current studies in the area, the researcher outlined some of the crucial elements that affect science teachers' adoption of inquiry-based science teaching in schools. Effective application of IBST depends on science teachers' capacity for teacher professional development. According to Kim (2022), teachers who took part in comprehensive professional development programmes centred on inquiry-based techniques showed more competence and confidence in using this approach in their classrooms. Teachers can gain a deeper grasp of inquiry-based methodologies through effective workshops, seminars, and collaborative learning experiences, which encourages their inclusion in regular lesson planning.

Another element is the learner learning. Results as received by teachers: According to a study by Smith (2022), teachers were more willing to use inquiry-based learning when they believed their learners would gain academically and develop greater critical thinking abilities. Despite any initial difficulties, teachers are encouraged to continue with inquiry-based science teaching by the successes and involvement of their learners. Classroom Resources and Support: Having access to the right resources and receiving support from colleagues and school administration are key elements affecting the adoption of inquiry-based science teaching. The availability of science kits, technology tools, and lab supplies can make it easier to incorporate practical experiments and investigations into the classroom curriculum (Strat et al., 2023). Additionally, a supportive educational setting that encourages teacher cooperation, the exchange of effective teaching strategies, and positive criticism can increase teachers' self-assurance and enthusiasm to use inquiry-based teaching approaches.

A further element is time restrictions and curriculum requirements. Time restrictions imposed by curriculum requirements and standardised testing present one of the difficulties science teachers have while implementing IBST. According to Krajcik et al. (2023), teachers may feel under pressure to focus on the subject covered over the in-depth inquiry, which would limit the use of inquiry-based teaching approaches. To allow for exploration and discovery in the classroom, it is necessary to balance the demands of the curriculum with efficient inquiry-based teaching methods.

## 2.8 Chapter summary

In winding up, this chapter looked at the definition, history and development of the approach, science teachers' understandings of the concept, their practices, and the factors that influence their implementation of IBST. It was important to mention that IBST implementation in schools by science teachers is an ongoing process in science education (Mkimbili, 2023; Ramnarain et al., 2022), especially in the South African context and that in this study, the researcher explored how, why, and which challenges natural sciences teachers faced with the practice of IBST. The preceding chapter presented the theoretical framework that structured the study and provided guidance to the data analysis.

# CHAPTER THREE
# THEORETICAL FRAMEWORK

## 3.1 Introduction

This chapter presented the theoretical framework that underpinned this research. The theoretical framework clarified the critical concepts in this study. According to Lynch et al. (2020, p. 24), a theoretical framework is a structure that directs research by utilising a formal theory developed through a logical, well-established explanation of particular relationships and events.Sekaran, as cited in (Ramaila, 2020), mentioned that a theoretical framework is a conceptual model of how one theorises or makes logical sense of the relationships among several factors that have been identified as relevant to the problem. Based on the research objectives and questions the research is seeking to answer, the theoretical framework that underpinned this research lay in the social constructivist theory of  Lev Vygotsky.

Using cutting-edge teaching strategies is essential in the field of science education if learners are to develop critical thinking and in-depth comprehension. IBST, a pedagogical approach that encourages learners to actively engage in the scientific process via questioning, exploration, and discovery, is one such approach that is becoming popular. To better understand how constructivism fits into IBST and how it may improve science education, this study examined the theoretical foundations of IBST within that framework. According to constructivism, which was first proposed by Piaget (1973) and Vygotsky (1978), people actively create their knowledge through interactions with their surroundings and social relationships. This viewpoint highlights the significance of learners' experiences, knowledge, and sociocultural environments in influencing how they comprehend new material.

Constructivist teaching aims to make students active learners in the setting of science education by providing them with opportunities for experiential learning and group inquiry that help them expand their scientific knowledge (Driver et al., 1994; Fosnot, 1996). The IBST model aligns seamlessly with the tenets of constructivism. By providing learners with opportunities to ask questions, design investigations, and make connections between their existing knowledge and discoveries, IBST facilitates the construction of meaningful scientific understanding (National Research Council, 2000). As learners engage in the inquiry process, they not only develop essential scientific skills but also cultivate a deep appreciation for the dynamic nature of the scientific inquiry, mirroring the constructivist emphasis on active engagement and personal construction of knowledge (Windschitl, 2002).

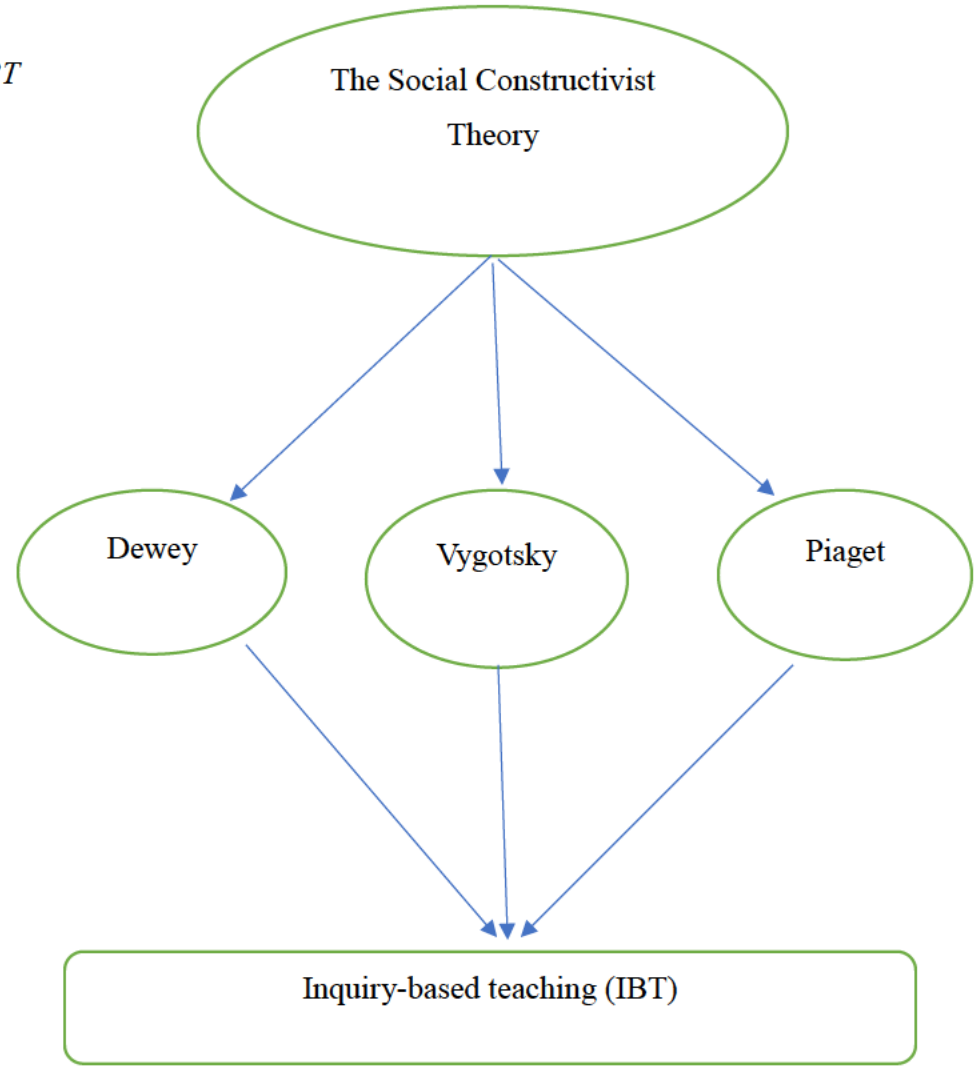
Constructivism has three belief systems: Radical constructivism, cognitive constructivism, and social constructivism. According to Fosnot (2013), radical constructivism views learning as a process in which the learner actively constructs or builds new ideas or concepts based on his /her own experience. Cognitive constructivism believes that knowledge is acquired through an adaptive process that develops from a learner's cognising of events. On the other hand, the social constructivist view of learning forms a foundation for formative assessment practices in the classroom. According to Vygotsky (1980), social constructivism is grounded on the notion that knowledge construction is the product of an object's interaction with its social surroundings. Sjøberg (2010) also defined social constructivism as a pedagogy that states that knowledge results from social interaction and language usage; thus, knowledge is shared rather than an individual experience. For social constructivists, knowledge construction is consistent with social activity (Ramaila, 2020), which this study aligns with. This further explains why the environment within which knowledge is constructed influences the kind of knowledge constructed.

## 3.2 The social constructivist theory

Constructivism is a well-known learning theory that emphasises how learners actively construct knowledge via their experiences, interactions, and reflections. As a result, it has had a substantial impact on educational methods. This theoretical framework is based on the writings of influential academics, Jean Piaget and Lev Vygotsky, among others who have influenced our understanding of how people learn and construct knowledge. According to constructivist theory, learning is a dynamic process in which learners actively create their conceptions of reality from their past experiences, social interactions, and prior knowledge (Piaget, 1973; Vygotsky, 1978). The Swiss developmental psychologist Jean Piaget established the groundwork for cognitive constructivism by highlighting the developmental phases that people go through as they become more adept at assimilating and adapting to new information (Piaget, 1973). Through the processes of assimilation, in which new knowledge is assimilated into preexisting cognitive frameworks, and accommodation, in which preexisting structures are adapted to accommodate new information, Piaget argues that learners constantly adapt their mental structures. The socio-cultural component of constructivism was advanced by Soviet psychologist Lev Vygotsky, who postulated that learning is a social process enmeshed in cultural contexts (Vygotsky, 1978). The Zone of Proximal Development (ZPD), which is the gap between what a learner is able to do on his or her own and that which they can do with assistance and teamwork, was a notion he introduced. To promote cognitive development, Vygotsky highlighted the value of social interactions, such as scaffolding by more experienced individuals, in which case are teachers in the school setting. The work of Vygotsky, Piaget and Dewey intersect, and constructivism becomes the product of these ideological intersections. Figure 3.1 illustrates how the theories of these scholars emerged into the modern constructivism theory.

Figure 3.1

*History of IBT*




Constructivism is characterised in an academic setting as a theory of learning that sees learners as active creators of their knowledge and reality (Brooks & Brooks, 1993; von Glasersfeld, 1989). According to constructivism, learning is most successful when it is reflective, collaborative, and contextual because it enables learners to create links between newly learnt material and their preexisting mental models (Duffy & Cunningham, 1996). It emphasises problem-solving, inquiry-based learning, and real-world experiences to help students develop a thorough and meaningful comprehension of the material. This study will examine constructivism as the theoretical underpinning of IBST, examining how its tenets complement and enhance the dynamic, inquiry-driven learning opportunities that are central to it.

In this study, the social constructivism theory was chosen because it exhibits characteristics similar to those of IBST, in the report by Symington et al. (2013), and includes:

> *Starting with the premise of prior information or experience and building new knowledge upon it, with prior knowledge acting as a basis or launching pad for future knowledge development;*
>
> *The new knowledge is constructed by the learners rather than existing knowledge passed on to learners from the teacher. By so doing, learners can link their new knowledge with their prior experience;*
>
> *The process is active where learners learn by engaging in activities they promulgate themselves, rather than those of the teacher;*
>
> *To a large extent, the social environment from where the teaching and learning take place influences the teaching.*

Sjøberg (2010) also explained that constructivist teaching methods are learner-centred, emphasising creating an enabling environment for the learner to explore and develop new knowledge. Constructivism theory suggests that learners' ability to understand should be at the centre of the teaching process, which is the focus of the current study with IBST. This study took into account forms of constructivist views that depict an inquiry-based classroom situation. These included cooperative teaching and learning, problem-based teaching, and inquiry-based teaching. Below are the descriptions of constructivist theory that align with IBST:

**Cooperative teaching and learning:** Cooperative education is one way the constructivist theory has been conceptualised with classroom practice. With a coordinated instructional strategy, the teachers ensure that learners are put into mixed-ability groups or heterogeneous groups to work on the assigned activity. They are rewarded based on group success. Von Glasersfeld (2013) found that cooperative education, which is in line with inquiry-based learning, works best when group members are taught social skills, positive interdependence, and individual accountability.

**Problem-based teaching**: This is a learner-centred pedagogy in which learners learn about a subject through the experience of solving an open-ended problem (Ali, 2019). This problem launches their inquiry into action as they work together in finding the solution to a problem. It offers learners the opportunity to explore the process and consider a wide range of ideas on a given condition. In the process, they develop flexibility in thinking and reasoning skills as they compare and contrast various possibilities before and draw conclusions(Mabope et al., 2023).

**Inquiry-based learning**: This is a modern method of instruction. The teacher assigns a problem for learners to construct their understanding by directing the inquiry line and using the techniques. Teachers in inquiry-based science teaching draw on learners' previous knowledge that is integrated with the new knowledge. According to Von Glasersfeld (2013), the constructivist paradigm, which is supported by Dewey and other proponents and examined in the literature, is the foundation of inquiry-based learning. information holds that people create knowledge via their experiences and the world around them, rather than passively absorbing information from the outside world or authoritative sources. Instead of being empty vessels waiting to be filled, learners are intellectually productive persons with the ability to ask questions, find solutions to issues, and create theories and knowledge. According to Vygotsky's theory, social contact plays a key role in the formation of cognition. (Vygotsky, 1978).

### 3.3 The constructivist theory and NS teachers' applications of IBST

Many researchers agree that both social and cognitive lenses play fundamental roles in how natural sciences teachers understand and practice inquiry-based science teaching (Minner et al., 2010; Mugabo, 2015; Mumba et al., 2015; National, 2000). Due to these perspectives, the researcher submits that natural sciences teachers grow comprehension of IBST from their previous exposures, beliefs, and knowledge. However, taking into account the viewpoint of Vygotsky on social theory, the researcher believes that natural sciences teachers' knowledge and practices of IBST are influenced not only by their previous experience and social interaction but also by their peers within the teaching space (Mumba et al., 2015).

Among the factors that influence teachers' understanding and practice of IBST, teachers' beliefs are the most influential factor (Mugabo, 2015). According to Raths (2001), beliefs are prepositions and understandings held psychologically about what is thought to be right about the world. Together with the values teachers share and their social settings, including time, beliefs form a pattern that develops into lenses through which teachers see the world around them. Based on this knowledge, this study contends that participating natural sciences teachers in this study can have different understandings, interpretations, and applications of IBST. Often, natural sciences teachers' knowledge of IBST is influenced by their peers within the school setting they find themselves in as they interact and share experiences.

In line with Vygotsky's (1978) social constructivist theory, the researcher believes that the prevailing social factors influence natural sciences teachers' understandings and constructions of inquiry-based science teaching in the settings they find themselves in. For example, teachers in urban schools are well placed in terms of resources for the teaching of sciences compared to their rural schools' counterparts. The social constructivist theory considers teaching activities teachers to assist and guide learners in acquiring knowledge. This process is coordinated and mediated by the setting they find themselves in and other factors such as the school culture and policies. It is therefore significant that how natural sciences teachers construct IBST is shaped and influenced by several coordinated factors in their social settings, and not just an individual cognitive activity (Alzahrani & Woollard, 2013).

### 3.4 The current study and the social constructivist theory

The IBST methods has gained significant attention in the current scientific education landscape due to its capacity to promote learners' deep comprehension and involvement. The researcher hopes to shed light on the social and collaborative nature of IBST and its influence on learners' scientific learning experiences by firmly rooted in the social constructivist ideas presented by scientists like Vygotsky (1978) and others. IBST is beneficial in fostering meaningful teaching experiences and the development of critical scientific abilities in learners. Scholars have emphasised how IBST improves learners' attitudes towards science, problem-solving skills, and conceptual knowledge (Windschitl & Andre, 1998; Minner, Levy, & Century, 2010). Furthermore, studies on the application of IBST in numerous educational situations have yielded insightful information about the flexibility and expandability of this teaching strategy (Keeley, Eberle, & Tugel, 2007; Bell, Smetana, & Binns, 2005). The literature currently in the publication also highlights how IBST is in line with modern educational objectives, including the development of 21$^{st}$ century skills, scientific literacy, and critical thinking (National Research Council, 2012; American Association for the Advancement of Science, 1993). IBST develops as a pedagogical technique that not only satisfies traditional learning objectives but also corresponds with the larger educational aim of educating students for a complex and ever-changing world as science education continues to evolve.

The integration of IBST utilising the framework of social constructivism forms the theoretical basis of this research. According to Vygotsky's (1978) social constructivism, knowledge is co-constructed through cooperative interactions within a cultural framework, and learning is a socially mediated process. IBST easily conforms to the social constructivism tenets because of its emphasis on student-led inquiry, group problem-solving, and meaningful conversation (Driver et al., 1994; Windschitl, 2002). By utilising the Zone of Proximal Development (ZPD) and promoting cognitive development through peer interactions and discourse, the collaborative aspect of IBST enables learners to participate in shared learning experiences (Vygotsky, 1978; Windschitl & Andre, 1998). The ZPD for teachers covers the cognitive gap between their current knowledge and abilities and the required level of proficiency in IBST, much as how it does for learners' learning. Acknowledging and supporting teachers' ZPD entails designing professional development and support interventions that improve their understanding and practice of IBST, facilitating a phased shift from traditional methods to more sophisticated, inquiry-based pedagogies. This method recognises that to successfully integrate and improve their instructional practices in the teaching of natural sciences, teachers, like learners, benefit from specific coaching within their ZPD.

Central to social constructivist theory assumes that a particular social context plays a significant role in how individuals construct knowledge (Adisendjaja et al., 2017). To make sense of the present study in terms of data generation instruments, data analysis, interpretation, and conclusion, the researcher relied on primary data collection instruments that align with the social constructivist theory: questionnaires, semi-structured interviews, lesson observations, and focus group protocol. These instruments were used by the researcher to understand how natural sciences teachers construct their understandings of IBST and apply the knowledge to their natural sciences teaching. Furthermore, the researcher relied upon constructivist theory to establish the effect of social factors on how natural sciences teachers construct their understanding and practices of IBST in the manner they do.

### 3.5 Chapter summary

The goal of this study was to add to the current conversation on successful scientific education as we investigated IBST within the social constructivist paradigm. It aimed to give teachers and researchers a thorough knowledge of the synergies between these two teaching approaches by synthesising existing research findings on IBST and placing them within the framework of social constructivism. In the end, it was expected that this research would influence educational policies and practices, encouraging the incorporation of IBST as a socially constructed means of improving scientific learning. This chapter focused on the theoretical framework that underpinned this study. The section began by identifying and aligning itself with Vygotsky's social constructivist theory as the study's principal theoretical framework. The corresponding discussion showed that the process of understanding and application of IBST could not be seen as a unique construction alone that depended on natural sciences teachers' cognitive ability, but more of a coordinated process because of the society and the environment the teachers find themselves in and the world view around them. The next chapter focused on the research design and methodological considerations for this study and gave a detailed account of the processes considered in designing this study. It elaborated on the selection of participants, the development of instruments used in the data generation, and the data analysis processes.

# CHAPTER FOUR
# RESEARCH DESIGN AND METHODOLOGY

## 4.1 Introduction

Using cutting-edge teaching methods in primary school is essential to building a solid foundation in science education (National Research Council, 2012). Among these methods, one that promotes learner participation, analytical thinking and a more thorough comprehension of scientific concepts is IBST (Harlen & Holroyd, 1997). This chapter explored the complexities of the research design and methods used to explore how primary school natural science teachers understand and apply IBST in their classes. In the previous chapter, the researcher presented the theoretical framework underpinning this study which was the social constructivist theory. This chapter presented the research design and methodology. Many researchers argue that the type of research design and methodology adopted in research depends on the purpose and the nature of the questions the study intends to answer (Cohen et al., 2017; Cope & Elwood, 2009; Creswell, 2009; Creswell et al., 2007). Research design is defined as the full research process, which includes problem formulation, research question development, data collection, analysis, interpretation, and report preparation (Creswell & Poth, 2018, p. 5). The research design and methodology discussed are intended to address the main research question: *How do natural sciences teachers understand and practise inquiry-based science teaching in a primary school?* The associated sub-questions were as follows:

1. What are the grades 6 and 7 natural sciences teachers' comprehensions and applications of IBST at the start of the intervention programme?

2. How do the grades 6 and 7 natural sciences construct their understandings and practices of IBST during an intervention programme?

3. Why do the grades 6 and 7 natural sciences teachers understand and practice IBST in the ways that they do before and during an intervention programme?

This chapter was presented under the following subheadings: research paradigm, research approach, research strategy, participants of the study, the data gathering instruments, data analysis, trustworthiness, and ethical consideration of the study.

## 4.2 Research paradigm

Selecting a research paradigm is a fundamental option that affects how data is collected, analysed, and interpreted throughout the whole research. There are several paradigms used in educational research. For example, the positivist paradigm is distinguished by an empirical and scientific approach to understanding social phenomena. It was developed by researchers such as Emile Durkheim, drawing inspiration from the philosophy of Auguste Comte (Bryman, 2016). According to this paradigm, studying social reality entails looking at observable, objective facts that can be measured and examined in a methodical manner (Neuman, 2011). In social science, positivism places a strong emphasis on the scientific method, the value of empirical data, and the quantification of social phenomena (Bryman, 2016). Positivists contend that researchers can find universal rules guiding social behaviour by using the concepts of the natural sciences in the study of society. Many researchers rely on this paradigm for their studies. For purposes of this study, the researcher chose to work in the interpretivist paradigm for various reasons which the following discussion alluded to.

An interpretive paradigm has been used for the investigation of Natural Sciences Teachers' Understanding and Application of Inquiry-Based Science Teaching (IBST). Using pertinent literature and philosophical foundations, this part sought to describe and defend the use of interpretivism in this study. According to Denzin and Lincoln (2018), interpretivism, which has its roots in the hermeneutic tradition, highlights the subjectivity of human experiences and the importance of interpretation in comprehending social processes. This paradigm states that reality is socially produced and context-dependent, recognising the complexity of the social world (Creswell & Creswell, 2017). The goal of expressing the breadth and depth of natural sciences teachers' experiences and viewpoints regarding IBST is in line with interpretivism (Denzin & Lincoln, 2018). This paradigm enables a comprehensive knowledge of the numerous realities generated by teachers in their classroom situations by utilising qualitative approaches such as observations and interviews (Creswell, 2013). Classrooms for the natural sciences are dynamic, context-specific spaces. Interpretivism acknowledges the significance of context in influencing teachers' perceptions and behaviours (Guba & Lincoln, 1989). Understanding the complex interactions between individual experiences, beliefs, and the sociocultural environment is necessary to investigate how teachers perceive and apply IBST in their situations.

Studying how teachers interpret their experiences and the environment around them is a good fit for interpretivism (Denzin & Lincoln, 2018). Deciphering the significance teachers attach to inquiry-based methods in the context of IBST is essential to revealing the nuances present in the pedagogical decisions they make. An interpretative paradigm allows the researcher to investigate the interrelated components that lead to the comprehension and application of IBST, given the complex nature of instructional practices (Creswell & Creswell, 2017). Developing thorough insights that can guide educational practices and policy requires a holistic viewpoint. Interpretivism emphasises that meanings and interpretations are liable to change over time in recognition of the fluid and dynamic nature of social processes (Guba & Lincoln, 1989). An interpretive paradigm works well to capture these dynamic processes in the field of education, where practices are always changing. Because of the intricacy and context-dependency involved in the investigation of natural sciences teachers' understanding and application of IBST, an interpretive paradigm was used for this study.

This paradigm provides a deeper understanding of the complex relationships between teachers, their interpretations of IBST, and the educational contexts in which they operate by facilitating a rich, contextually grounded exploration that goes beyond surface-level observations through qualitative methods that emphasise the interpretation of meanings. By adopting interpretivism, this study aimed to add significant knowledge to the discussion of scientific education and deepen our comprehension of the variables that affect the efficacious application of inquiry-based learning in primary school environments.

## 4.3 Research approach

A study's methodological design and data generation techniques are influenced by its research methodology, which is a crucial choice to make. A qualitative research approach has been selected for the study of how natural sciences teachers understand and practise inquiry-based science teaching (IBST). Using pertinent research and methodological issues as a guide, this section outlines and explains the choice of qualitative investigation. A thorough examination of events in their natural settings, highlighting the variety and diversity of human experiences, is what defines qualitative research (Merriam & Tisdell, 2016). It investigates the interpretations people make of their experiences and the social processes that influence those interpretations (Denzin & Lincoln, 2018). Comprehensive investigations of complicated phenomena are ideally suited for qualitative research (Creswell, 2013).

A qualitative method enables a thorough analysis of the complex layers that contribute to teachers' understanding and practice in the context of IBST, which encompasses diverse elements of teaching and learning. Classrooms for the natural sciences are dynamic, context-specific spaces. The significance of context in influencing people's experiences and behaviours is recognised by qualitative research (Merriam & Tisdell, 2016). This methodology allowed the researcher to capture the contextual details impacting teachers' conceptions and implementation of IBST using techniques like observations and interviews. Exploring people's subjective viewpoints and lived experiences is a particularly good use for qualitative research (Denzin & Lincoln, 2018). This approach enabled the investigation of the meanings teachers of natural sciences ascribe to IBST through in-depth interviews, and observations, providing insight into the variables driving their pedagogical choices.

According to Creswell (2013), qualitative research is flexible and recognises that the research process is iterative. Because educational environments are dynamic and practices may change over time, a qualitative method offers the flexibility required to document these changes and understand how IBST is changing in primary school classrooms. Finding the rich, contextually embedded nuances that lead to a deeper understanding is the aim of qualitative research, not only quantifying phenomena (Merriam & Tisdell, 2016). Qualitative methods can capture the nuances of teaching practices and the various interpretations that teachers bring to their instructional approaches when investigating IBST. Using a qualitative study approach made sense given the difficulties in figuring out how natural sciences teachers interpret and apply IBST. Qualitative research offers an in-depth knowledge of the elements that influence teachers' engagement with inquiry-based techniques by emphasising depth, context, and the investigation of individual perspectives. By using a qualitative approach, this study aimed to add to the methodological conversation as well as the field of scientific education specifically, emphasising the value of contextually embedded insights in educational research.

### 4.4 Case study strategy

A key component of the research design, the research strategy establishes the general framework and focal point of the study. A case study research technique was used for the investigation of natural sciences teachers' understanding and application of inquiry-based science teaching (IBST). This section offered a thorough defense of the case study approach, highlighting its benefits, applicability to diverse research issues, and prospective applications. Using pertinent research and methodological issues as a guide, this section identified and explained the choice of a case study. A case study is a detailed analysis of a specific phenomenon in the context of real-world events, frequently utilising a variety of data sources to offer a thorough grasp of the problem being studied (Yin, 2018). It works especially well for investigating intricate and situation-specific phenomena in their natural environments. In contrast to other research designs, researchers can examine how different variables interact (Jinnah, 2020), especially in the case of teaching methods, and the factors that influence teachers' choices and implementation of those teaching methods in a class.

According to Yin (2018), case studies are well known for their capacity to offer deep, contextually grounded insights. Owing to the dynamic and context-dependent character of teaching strategies, a case study enables a thorough investigation of how teachers of natural sciences understand and apply IBST in the setting of their classrooms. A case study enables a comprehensive understanding of the phenomena in the field of IBST, where the interaction of multiple elements leads to its successful implementation (Merriam & Tisdell, 2016). Through the analysis of individual cases' teaching practices, underlying attitudes, and contextual factors, this approach facilitates a thorough investigation of the complexity involved in the implementation of IBST. According to Yin (2018), case studies are an excellent tool for examining dynamics and processes over time. A case study design enables the assessment of how teachers' understanding and practice of IBST develop and change throughout the study because teaching practices and educational contexts are dynamic.

In educational research, where the goal is frequently to comprehend the intricacies of teaching and learning in real-world circumstances, case studies are very useful (Stake, 1995). Through a case-based approach, this study methodology offers valuable insights into the opportunities and challenges faced by teachers in primary school settings (Goodrick, 2020). The implementation of a case study research approach was consistent with the goals of deciphering the complexities of natural sciences teachers' understanding and application of IBST. This technique allows for the analysis of dynamic processes, the capture of diverse views, and the discovery of contextual details through a focus on individual examples. Triangulating data using several sources, including observations, interviews, and document analysis, in a case study enables the capture of multiple perspectives on the topic being studied (Merriam & Tisdell, 2016). This method gave the data additional depth and legitimacy while providing a more complex picture of how teachers are interacting with IBST. In addition to the justifications alluded for the selection of a case study strategy, the use of this strategy was noted for its appropriateness for different research questions which affords a researcher the opportunity for a deeper understanding of the phenomena under investigation (Rasmitadila et al., 2022; Remenyi, 2022). For example:

i). Descriptive Research: Case studies are ideal for topics in descriptive research when the goal is to give a thorough explanation of a particular phenomenon. This approach is especially helpful when the researcher wants to investigate novel or under-researched subjects (Baxter & Jack, 2008).

ii) Explanatory Research: The case study approach can help develop insights and explanations when researchers are trying to understand the causes and effects of a specific event or phenomenon (Toyon, 2021).

iii) Exploratory study: Case studies enable researchers to develop first ideas and examine potential study directions for exploratory investigations or research in unexplored territory (Seidel & Watson, 2020). By using a case study methodology, this research highlighted the value of contextually embedded insights in educational research while also contributing to the larger methodological discourse and the area of scientific education. The current study aligned with explanatory case studies to explore how natural sciences teachers understand and practice IBST in a primary school.

**4.5 Purposive sampling**

Five natural sciences teachers from a primary school in the Pinetown area were purposefully selected to participate in the study after they were approached and requested to participate. This school has specialised natural sciences teachers. As per the prescript of the CAPS document, the natural sciences are a composition of physics, chemistry, biology, astronomy, and earth science. The natural sciences teachers were trained to teach these subjects in primary schools. Per the description given by the CAPS policy, teachers who teach any of the mentioned natural sciences topics that could fall under any of the branches of science mentioned above are required to employ inquiry-based teaching methods. Therefore, these teachers were appropriate for investigating natural sciences teachers' understandings and practices of inquiry-based science teaching in primary schools.

Identifying the five natural sciences teachers for the study was done in conjunction with the principal of the school, who organised a meeting between the natural sciences teachers and me. At the meeting, I laid down the objectives of the study and what I sought to achieve at the end of the study. I discussed with the teachers the criteria I had proposed concerning participation, which included that any participant who should be teaching natural sciences at the start of the study must have taught natural science for at least five years and above and must be willing to participate in the process. With those guidelines, five teachers who volunteered formed the participants of the study.

### 4.6 Data generation methods and instruments.

In this study, the researcher employed multiple data sources and methods to understand better the phenomenon under investigation (Bertram & Christiansen, 2014; Cohen et al., 2011). The data collection methods included questionnaires, interviews, lesson observations, focus group discussions, and document analysis. The literature review influenced the choice of these methods, as it showed that previous researchers found those methods helpful in understanding similar phenomena under study. All five participants agreed to participate in all the data-collecting methods, which strengthened and contributed to the trustworthiness of the study (Cohen et al., 2011).

#### 4.6.1 The questionnaire

A questionnaire was deemed suitable to gather data on the teachers' biography and the number of years they had been teaching the subject. According to McGuirk and O'Neill (2016), a questionnaire allows gathering data from both a larger or smaller group of participants quicker than other data generation methods. I noted that it provided reliable data on natural sciences teachers' understanding of inquiry-based science teaching in primary schools. A questionnaire generally consists of two main types of questions, closed-ended, open-ended, or a combination of both types. Many researchers in the qualitative domain agree that allowing participants to provide detailed responses, as in open-ended, gives rise to rich data generation (Cohen et al., 2011; Maree, 2016; McGuirk & O'Neill, 2016). However, according to Mugabo (2015a), open-ended questions do not always provide detailed responses desired by participants' knowledge about inquiry-based science teaching. Because of that, this study employed a semi-structured questionnaire type which ensured clear answers. According to  Cohen et al. (2011), a semi-structured questionnaire contains a string of questions, items, or statements that allow respondents to comment or address based on their understanding, opinions, or knowledge. Such a feature of the questionnaire makes it powerful as it will enable respondents to express their views freely on the subject under investigation.

The questionnaire was divided into sections A, B, and C in this study. Section A was relatively straightforward and focused on respondents' biographic data, which was crucial to make sense of respondents' ages and years of teaching. This was to give the researcher an understanding of when the teacher completed college and if inquiry-based teaching had been introduced or not. Section B consisted of six questions centred on teachers' inquiry-based teaching experiences through teaching scenarios and professional knowledge of IBST. The aim of using the semi-structured questionnaire was to obtain and measure the levels of respondents' understanding of inquiry-based science teaching and the characteristics they considered to be inquiry-based science teaching. The third part of the questionnaire, section C, described how teachers practised inquiry-based teaching of natural sciences. Here, the questionnaire sought to determine the learner activities they engaged their learners in and considered inquiry-based teaching. I developed a range of questions with multiple options to cover different science instructions. Participants selected what best suited their learners' actions during teaching. Appendix A contains specimen copies of the questionnaire.

### 4.6.2 Semi-structured interviews

Questionnaires alone do not provide dependable findings to a study. Therefore, it was necessary to use multiple data sources to validate the study's conclusions (Furtak et al., 2012). Many researchers have found interviews to be the most frequently used method for data generation in qualitative research (Creswell & Poth, 2017; Freire, 2018; Mugabo, 2015). The process of an interview involves a conversation between a researcher and respondents, where the researcher poses questions to participants to answer while learning about the participants' opinions, beliefs, behaviours, or views (Bertram & Christiansen, 2014). Like many studies in inquiry-based science teaching, this study also employed semi-structured interviews as one of its data-collecting instruments (Constantinou et al., 2018; Duran & Duran, 2004; Furtak et al., 2012; Mugabo, 2015a). The researcher is often guided by interview schedules in semi-structured interviews, allowing the researcher to ask all participants the same questions. However, the researcher may ask questions or seek further clarifications from individual participants when necessary (Duran & Duran, 2004; Magaldi & Berler, 2020).

In this study, I employed semi-structured interviews for the following reasons: to provide an additional source of data to strengthen the reliability of the research and to give the researcher a more profound perception of the natural sciences teacher's understanding of inquiry-based science teaching. Per my proposed plan, the interviews were supposed to have been an audiotaped recording between participants and himself; however, the advent of COVID-19 forced me to adopt other workable means of interviewing the participants within the COVID-19 prescripts of the regulations since that was the peak of the pandemic where such interaction was prohibited by law. In place of that, I sent the interview questions to participants who responded in writing. All five participants participated in this exercise, and the researcher transcribed their responses accordingly.  Appendix B contains specimen copies of the semi-structured questions.

### 4.6.3 Document analysis

Documents or lesson plans are sources of gathering information about teaching. Teachers explicitly outline their teaching processes, teaching modes, and outcomes (Osborne, 2014). According to Onwuegbuzie et al. (2010), document analysis allows researchers to examine and use all documented resources and materials that offer data study under consideration. The participants in this study prepared lesson plans for every lesson they taught, including the lessons observed; therefore, a copy of each of the lessons observed had their corresponding lesson plans together with group meeting records and notes as appearing in Appendix C. The aim was to ascertain the colouration between the lesson plans they prepared and the actual teaching they did in class.

In educational research, it is customary to use documents or lesson plans as sources of information regarding teaching. In these documents, teachers carefully describe their pedagogical approaches, modalities of instruction, and anticipated results (Osborne, 2014). According to Onwuegbuzie et al. (2010), document analysis is a technique that enables researchers to methodically look through and make use of all documented resources and materials pertinent to the study they are considering. Within the framework of the study, participants prepared lesson plans for every teaching session; these plans included the teachings observed afterwards. The extensive collection of data comprised not only the lessons that were observed but also the lesson plans, minutes from group meetings, and notes that went along with them. For scholars looking to learn more about the participants' teaching methods, this thorough documentation offers a wealth of data. The significance of triangulation, a technique frequently employed in educational research, is highlighted by the emphasis on tying the lesson plans to the real teaching that takes place in the classroom. To improve the validity and reliability of the results, triangulation entails comparing data from several sources (Creswell & Creswell, 2017).

### 4.6.4 Classroom observations

Many researchers have used classroom observations as a method of generating data in classroom orientations and inquiry-based studies (Mugabo, 2015; Nadelson et al., 2013; Ramnarain & Hlatswayo, 2018; Silm et al., 2017). Lesson observation is described as a step-by-step process of recording the teaching and learning patterns of participants of a study without any communication with them (Nadelson et al., 2013). The researcher of this study could not carry out this observation due to COVID-19 restrictions; therefore, the participants videotaped their lessons by setting up video cameras themselves while they taught and sent them to the researcher. Two lesson observations were considered from all five participants for this study, one before the workshop on inquiry-based and the other after the intervention. The lesson observations gave the researcher first-hand information on how teachers taught natural sciences rather than relying on the teachers' documents such as lesson plans and self-reporting through the questions and interviews.

Even though this study employed semi-structured interviews, the classroom observations did not follow the semi-restricted approach but considered every process that ensued in the teaching process. Each lesson lasted between 15 and 20 minutes which centered on the portions of the teaching the teachers considered inquiry teaching. To minimise the intrusion from a full-scale camera that could cause the teaching and learning, the researcher asked the teachers to use their cell phones for the video recordings, which was also very easy and convenient to send to the teacher. Due to the excellent placement of the cameras, the entire teacher-learner activities during the lessons were adequately captured. The videos accompanied the lesson plans for those lessons, which the researcher could immediately access and reflect on. Ideally, the researcher intended to hold a meeting with the participants after the lesson observations, but that was impossible due to the COVID-19 restrictions. Therefore, participants were advised to keep records of their reflections after the lessons until we could meet later.

Three weeks after the lesson’s observations, the COVID-19 restriction was revised so that the researcher could meet the participants for post-lesson observation discussions and interviews. This meeting aimed at understanding the teachers' reasons for the methods and teaching and learning activities observed in the recordings and their reflections on things they would have done differently. The researcher took notes and video-taped these responses. All the five participants were present and shared their views freely.

### 4.6.5 Focus group discussion

According to Hennink (2013), a focus group involves a predetermined group of people participating in an interactive discourse about a common subject. Focus group interviews gather in-depth qualitative data about a group's perceptions, attitudes, and experiences about the phenomena under study (Olsen, 2011). The exercise is intended to offer participants the opportunity to share their views, experiences, and knowledge gained throughout the study process. The focus group was chosen as a data-gathering strategy because it allows participants to investigate the phenomenon from various angles and understand the difficulties from the participant's point of view (Hennink, 2013). The goal of the focus group was to allow participants to exchange ideas, discuss their perspectives on IBST, and shed light on their practices to widen the scope of IBST conversation beyond one-on-one to group discussions after their initial classroom observation and offer support to them. According to Marée et al. (2016), participants in a focus group can build on one other's thoughts and remarks to provide a more in-depth understanding of the phenomenon than obtained from an individual interview. According to Hennink et al. (2020), an optimal focus group should have six to eight participants. Connelly (2015) added that the number of participants in a focus group should be between six and eight. However, this study only had five participants, and all five teachers duly participated in the discussion. Aside from the numerous benefits of focus groups, it should be highlighted that group dynamics can be challenging to manage. As a result of social pressure, Hennink and his colleagues claim that some players will dominate or not contribute. To minimise such feelings, the researcher asked the participants to write down their responses, The researcher led a thorough analysis of the fundamental ideas of inquiry-based science teaching (IBST) throughout the focus group discussion.

The objective was to clarify and provide guidance to the teachers on how to successfully include IBST in their teaching methods. The conversation particularly focused on using the 5Es teaching model—which stands for "engage, explore, explain, elaborate, and evaluate"—as a framework to clarify how NS teachers may use IBST approaches in their classrooms. The 5Es framework was purposefully incorporated into the teaching of natural sciences as an illustrative tool to demonstrate the smooth transition of IBST principles after which the researcher read each for the group to discuss. The debate revealed that there was a noticeable discrepancy between the IBST theory and the way these principles were applied in the NS teachers' observed courses. The discrepancy that was found highlighted the need for deeper comprehension and use of IBST in the context of education. The researcher attempted to close this gap by utilising the 5Es framework in the focus group discussions and offering specific examples and recommendations to improve the natural sciences educators' ability to apply IBST in their daily teaching practices.

### 4.7 Data analysis

The data analysis was presented with the research questions for clarity and consistency under three sub-sections. Table 4.1 illustrates an overview of the data analysis process.

**Table 4.1**

*Research questions, data generation, and analysis*

| **Research question** | **Data generation method** | **Data analysis** |
|---|---|---|
| What are the grades 6 and 7 natural sciences teachers' understandings and practices of IBST at the start of the intervention programme? | A questionnaire with three sub-sections and semi-structured questions | Participants' questionnaire responses and interview data, statements about how they understand IBST were identified.<br>From the responses, recurrent codes were developed into categories and themes that present how the participants understood IBST. |
| How do the grades 6 and 7 natural sciences construct their understandings and practices of IBST during an intervention programme? | Observation schedule<br>Lesson plans | |

| | | |
|---|---|---|
| Why do the grades 6 and 7 natural sciences teachers understand and practice IBST in the ways that they do before and during an intervention programme? | administration of the focus group intervention.<br>individual consultations before observations of lessons during teaching | |

A crucial stage in the research process is data analysis, where the gathered data is converted into insightful knowledge. This section defined and justified the choice of data analysis procedures for the investigation into natural sciences teachers' understanding and application of inquiry-based science teaching (IBST), a qualitative research approach that included in-depth interviews, classroom observations, and document analysis. It did this by referencing pertinent literature and methodological considerations. Finding patterns, themes, and meanings in the gathered data is a fluid and iterative process that is commonly associated with data analysis in qualitative research (Creswell, 2013). Data analysis must be done methodically and rigorously due to the nature of the research questions and the abundance of data sources. The following steps and procedures were followed in the data analysis.

*Thematic Analysis:* According to Braun and Clarke (2006), thematic analysis is a popular and adaptable technique for finding, examining, and summarising patterns in qualitative data. Thematic analysis enables the methodical discovery of recurrent themes, patterns, and meanings within the data in the investigation of natural sciences teachers' understanding and application of inquiry-based science teaching of IBST, enabling a thorough and nuanced knowledge of teachers' perspectives and practices. Among these are thematic analysis, narrative, inductive and deductive, and cross-case among others (Kesuma et al., 2022). In-depth interviews, classroom observations, and document analysis are some of the qualitative data gathered for this study to fully comprehend how natural science teachers in elementary school contexts perceive and apply IBST. Several codes reflecting different facets of teachers' understandings and practices about IBST were discovered through open coding. The early codes included terms like "pedagogical beliefs," "implementation strategies," and "challenges faced." After compiling the first codes, several potential themes surfaced that showed recurrent trends among various educators and classroom settings. Topics included "Embracing Student-

Centred Approaches," "Navigating Challenges in Implementation," as well as "Adapting Pedagogical Strategies." The core of the teachers' experiences with IBST was captured by the meticulous definition of each theme. The "Embracing Student-Centred Approaches" topic, for example, captured situations in which educators gave priority to student inquiry and active learning in their teaching strategies. Themes were examined for uniqueness and internal coherence. To guarantee that every topic appropriately depicted the data and made a significant contribution to the investigation of teachers' involvement with IBST, adjustments were implemented. Each theme's narrative description was created by combining data-driven statements and examples to create a compelling picture of the viewpoints of the teachers. The study emphasised the themes' importance in advancing successful science teaching by placing them within the larger educational framework.

*Constant Comparative technique:* According to Glaser and Strauss (1967), the constant comparative technique compares data as it is gathered and examined, allowing for the formation of categories and patterns that show up during the investigation. This approach fits in with the iterative structure of qualitative research, enabling the investigation of differences within and between instances as well as the development of themes. With the constant comparative method, data were continuously compared as new information was gathered. Through this repeated approach, new patterns, similarities, and differences between the data sources could be found. The ongoing comparative research produced patterns that were methodically identified and given names. For example, the "learner-centred philosophies" pattern captured situations in which educators demonstrated a strong dedication to supporting students' curiosity and participation in science education. This study employed inductive and deductive approaches for the analysis of the data based on the research questions. The application of the using an inductive method made sure that the individuals' understanding of inquiry-based science teaching was reflected in the findings. To measure the extent to which the participants' understanding and enactment of inquiry-based science teaching matched the conceptual framework, deductive data analysis was employed (Cope & Elwood, 2009; Creswell & Poth, 2017). The data generated from the five natural sciences teachers provided an understanding of the population of natural sciences teachers across primary schools and how they understood and enacted inquiry-based science teaching.

The theoretical basis of this study was based on social constructivism, which holds that knowledge is actively produced through social interactions and contextual effects rather than existing as an objective fact (Vygotsky, 1978). The goal of the research design and data collection techniques was to capture the dynamic process of knowledge formation within social contexts by deliberately aligning with this theoretical approach. To uncover the collaborative character of knowledge generation inherent in a social constructivist paradigm, the study explored the perspectives and shared meanings generated by participants through qualitative methods like interviews and observations. The next round of data analysis followed social constructivist guidelines, using thematic analysis to find recurrent themes derived from participants' common understandings and exchanges (Braun & Clarke, 2006). Understanding how the created meanings were located within the larger social context—which reflected the influence of participants' relationships and shared experiences—was emphasised throughout the investigation. Through reflexivity, the researcher's participation was acknowledged, acknowledging the potential influence of personal biases on the process of interpretation (Denzin & Lincoln, 2018). To validate interpretations within the social constructivist framework and emphasise the value of diverse views in the co-construction of knowledge, validation procedures like member checking were used. When viewed through the prism of social constructivism, the results have theoretical significance for the understanding of how knowledge is constructed as well as practical ramifications for situations in which social interactions are essential to learning and the sharing of knowledge.

### 4.8 Trustworthiness of the study

Making sure qualitative research is trustworthy is essential to proving the validity and dependability of the results (Lincoln & Guba, 1985). Several techniques were employed in the current study, which examined how natural sciences teachers understood and applied IBST, to improve the validity and transferability of the research methodology. The study maintained the tenets of trustworthiness to ensure that it was credible and reliable by incorporating the procedures identified by Lincoln and Guba (1985).

*Credibility:* Its goal is to verify the veracity and legitimacy of the research findings. In qualitative research, credibility is essential since it answers the question of whether the study's conclusions are credible, dependable, and valid (Creswell & Creswell, 2017). In a study focusing on the complex and context-dependent facets of natural sciences teachers' engagement with IBST, credibility assurance was crucial. Credibility was maintained through:

*Member-checking:* defined as providing participants with the preliminary results so they can provide input and confirmation and ensure the accuracy of the interpretations (Creswell &

Creswell, 2017). Member-checking was essential to the investigation. Participants were asked to assess the results once themes were identified using thematic analysis and a continual comparative approach. This gave them a chance to confirm or refute the researcher's conclusions.

*Peer debriefing*: According to Merriam and Tisdell (2016), it is the practice of talking with peers or experts to get their outside opinions on the study process and results. Regular debriefing sessions with advisors and peers were held throughout the research. These meetings functioned as platforms for deliberative talks, enabling a range of perspectives and insights that improved interpretations and preserved the analytical rigour.

*Transferability:* The term "transferability" in qualitative research describes how well study results may be transferred or generalised to situations or contexts other than the study participants and conditions (Lincoln & Guba, 1985). It entails making the research applicable and meaningful to a wider range of people or contexts. For qualitative research to be more widely recognised and influential, transferability is necessary. The practical usefulness of research is increased when it can be applied to similar situations, even though qualitative studies typically concentrate on the richness and depth of contexts (Creswell & Creswell, 2017). For teachers, policymakers, and academics looking for insights applicable to a variety of educational settings, transferability was critical in the study of natural sciences teachers' engagement with IBST. This was achieved through thorough and in-depth explanations of the research procedures, subjects, and surroundings to aid in comprehension of the specifics of the study (Lincoln & Guba, 1985). Rich explanations of the study's procedures, participant characteristics, and distinctive aspects of the learning environments were integrated into the research report. The potential transferability of findings to comparable contexts was increased by this transparency. By situating the found themes and patterns within a larger educational framework, readers can evaluate the study's applicability to other educational contexts (Stake, 1995). Themes and patterns were examined in the body of prior research as well as in the larger field of education. The contextualisation improved the study findings' applicability to various primary school settings. To guarantee the validity and relevance of qualitative research, transferability was an essential element. This study on the comprehension and use of IBST by natural sciences teachers included techniques to improve the findings' potential transferability to a variety of educational settings, including comprehensive descriptions and contextualization. These procedures supported the study's overall impact by being consistent with the transparency and relevance principles of qualitative research.

*Dependability:* In qualitative research, reliability is defined as the process and results' consistency and stability throughout time, between researchers, and across contexts (Lincoln & Guba, 1985). Its main goal is to demonstrate the study's repeatability and dependability. To guarantee the validity of the results of qualitative research, dependability is essential. It tackles the issue of whether the procedures, techniques, and interpretations used in the study can be reliably implemented and yield comparable outcomes under various conditions or upon replication (Creswell & Creswell, 2017). Reliability was crucial in determining the robustness and consistency of the research findings in the study on natural sciences teachers' use of IBST. According to Creswell and Creswell (2017), maintaining a thorough record or audit trail of the decisions, activities, and research process is necessary to improve transparency and enable examination and replication. A meticulous audit trail recording all decisions made about data collection, coding, and analysis was kept throughout the project. Thorough recording guarantees the study's traceability and enhances the reliability of the investigation (Lincoln & Guba, 1985).

Using several data sources or techniques to strengthen study dependability and confirm findings (Denzin, 1978). In this study, triangulation was an important tactic. A variety of data sources were used, such as document analysis, in-depth interviews, and classroom observations. Triangulation provided convergent evidence from multiple sources and perspectives, which increased the study's reliability. The credibility of qualitative research is largely dependent on dependability. This study on natural sciences instructors' knowledge and application of IBST guaranteed the uniformity and dependability of the research procedure and results employing the careful upkeep of an audit trail and the application of triangulation. These procedures added to the study's overall dependability by being consistent with the reliability, accountability, and transparency principles of qualitative research.

*Confirmability:* In qualitative research, confirmability refers to the impartiality and objectivity of the study's conclusions, guaranteeing that the researcher's prejudices, values, or viewpoints do not influence the data gathered and interpretations produced (Lincoln & Guba, 1985). It entails proving that the research findings are shaped by the data rather than the researcher's assumptions. Maintaining the objectivity and integrity of qualitative research depends on confirmability. It discusses the possibility of subjectivity and bias in the research process and highlights the need to present results that accurately represent the opinions and experiences of the participants (Creswell & Creswell, 2017). Confirmability was crucial in ensuring that research findings about natural sciences instructors' use of IBST were free from undue influence and accurately reflected the viewpoints of the participants. Throughout the study process, the researcher should practise self-reflection to identify and resolve any potential biases, values, and prejudices (Charmaz, 2014). The investigation was permeated with reflexivity. The researcher thought about their positionality, biases, and possible effects on the study process regularly. To improve confirmability and transparency, reflexive statements were incorporated into the analysis (Lincoln & Guba, 1985). This was achieved by obtaining outside opinions on the research procedure and conclusions from people who were not directly involved in the study (Lincoln & Guba, 1985).

By providing the preliminary results and interpretations to advisers and research colleagues who were indirectly involved in the study, an external audit was carried out. The external viewpoint had a role in validating the research findings. The reliability of qualitative research is contingent upon its confirmability. This study on natural sciences teachers' understanding and practice of IBST guaranteed that the research conclusions were neutral, and objective, and accurately represented the voices of the participants using reflexivity and the execution of an external audit. The general confirmability of the study was enhanced by these procedures, which were consistent with the ethical standards of accountability, objectivity, and transparency in qualitative research.

### 4.9 Ethical consideration

To protect the rights, welfare, and privacy of those engaged, doing education research, especially when involving human subjects, needs to pay close attention to ethical issues (Bryman, 2016). The ethical aspects of the study on natural sciences teachers' knowledge and application of IBST were examined in this discourse, with particular attention to participant permission, confidentiality, potential damage, and transparency. A key ethical precept is informed consent, which calls for subjects to freely assent to participation only after fully comprehending the purpose, methodology, and any dangers of the research (Bryman, 2016).

Consent was received from all participating natural sciences teachers in this study. Participants received comprehensive information regarding the goals of the study, the extent of their involvement, and any possible dangers before data collection. They were made fully aware of their unrestricted ability to withdraw at any time. Maintaining participant confidentiality entails protecting their name and personal data, making sure that it is handled discreetly, and not shared without express authorisation (Bryman, 2016). To protect participant privacy, results were reported with participant identities anonymised. Any information that may be used to identify the participants was removed, and participant codes or pseudonyms were utilised. The raw data was only accessible to the research team, and precautions were taken to protect it at every stage of the investigation.

According to Bryman (2016), ethical research entails a dedication to reduce any possible injury or pain that study participants may encounter. The study participants might have had similar personal experiences or difficulties with IBST. To reduce the possibility of injury, the researcher ensured that delicate subjects were handled with tact and care and offered support resources, such as information on counselling services. Fostering trust and accountability, transparency entails candidly sharing with participants and other stakeholders the goals, procedures, and any ramifications of the research (Bryman, 2016). Transparency was upheld during the entire research procedure. The general study design, data collection techniques, and possible applications of the results were explained to the participants. After the study was over, the researcher promised to give participants a summary of the findings. The study on the comprehension and application of IBST by natural sciences teachers involved ethical concerns that were steered by the following principles: informed consent, confidentiality, minimising potential harm, and transparency. The research sought to uphold the integrity of the study, safeguard participant rights and welfare, and properly and ethically advance the area of scientific education by abiding by these ethical guidelines.

### 4.10 The chapter summary

In conclusion, this chapter outlined the research design adopted for this study. After careful consideration of the available design, I settled for an interpretive paradigm on the basis that this paradigm was best for answering the research question. I used a qualitative approach in this study. A case study was adopted for this study. In addition, the chapter outlined data collection instruments adopted for this study and alluded to the significance of each selected instrument. Lastly, this chapter described the data analysis strategy selected for the study and the validity and reliability issues of this study.

# CHAPTER FIVE
# TEACHERS' UNDERSTANDINGS AND PRACTICES OF IBST

## 5.1 Introduction

Chapter 5 serves as a critical exploration of the methodologies employed in this study, providing a comprehensive overview of the research design, participant selection, data collection, and data analysis processes. The chapter begins with a detailed description of the research design, outlining the qualitative approach adopted to capture the nuanced understanding of natural science teachers' perceptions and practices regarding Inquiry-Based Science Teaching (IBST). Following this, the participant selection process is elaborated, highlighting the criteria for choosing educators from grades 6 and 7 and ensuring a diverse representation of experiences and perspectives. The chapter then delves into the data collection methods, which include semi-structured interviews and classroom observations, emphasizing how these techniques facilitate a deeper insight into the teachers' instructional practices. Lastly, the chapter concludes with an explanation of the data analysis procedures, illustrating how thematic analysis was employed to identify patterns and themes that emerged from the data, ultimately shedding light on the complexities of implementing IBST in natural science education. This structured approach provides a solid foundation for understanding the subsequent findings and discussions presented in the later chapters.

This chapter provided the findings that responded to the first research question, which is stated as follows:

*What are the grades 6 and 7 natural sciences teachers' understandings and practices of inquiry-based science teaching?*

The researcher used information from the questionnaire as well as data from individual interviews to answer this study question. The demographic details of the participants' interviews and questionnaires are provided in subsection 5.1. The findings regarding participants' comprehension of inquiry-based science teaching were presented in Section 5.2. Based on their classification of the instructional scenarios, participants' understanding of inquiry-based science teaching we discussed in section 5.2. Similarly, in section 5.2, I presented participants' understandings of the cognitive and guiding attributes of inquiry-based science teaching based on the theoretical underpinnings of the pedagogical strategy used in this study. In section 5.3 also, the researcher presented the results relating to how participants practice inquiry-based science teaching.

## 5.2 Demographic Characteristics of Participants

The first part of the data presentation was to present and discuss the data relating to the teachers who participated in the study. Data relating to their demographic characteristics such as age, years of experience as a teacher, years of experience as a natural sciences teacher, teacher, and their respective qualifications were presented and discussed. These details appeared in a table earlier. The results revealed the age distribution of the participants which ranged between 30 and 50 and showed that all year groups of the teaching population were represented in the study. The broad distribution of the participants in terms of age suggested that the results represented all age categories of teachers.

In terms of the teaching experience of participants, the results indicated that all five teachers had taught for above 15 years. This indicated that the participants had a considerable amount of experience in the teaching profession. Apart from the years of teaching experience, the results presented indicate that all five participants had taught natural sciences for at least above years, which was between 13 and 21 years respectively. Three out of the five had taught the subject between 15 and 21 years.

## 5.3 Workshops attended on the teaching of natural sciences

Teachers would function well and discharge their responsibilities effectively if they were given regular training and updates on how to teach learners (Lipowski & Seidel, 2009). The participants were asked if they had attended a workshop or training on how to teach natural sciences. The response indicated that the participants had attended training on teaching natural sciences, and the various workshops on teaching natural sciences attended were presented as summarised in Table 5.1. The results show that the participants received some training on how to teach natural sciences. Some of the workshops attended by the participants include the Department of Education Training at Pinetown Circuit Training Centers, Primary Schools Science Experiments presented by CASME, CAPS, NCS workshop, RNCS and OBE workshop, Natural Sciences as Technology workshops, Natural Sciences for intermediate phase and Departmental workshops on assessments. However, it appeared that the emphasis of most of the workshops was on assessments, not teaching.

**Table 5.1 Names of workshops attended.**

| Participant | Attendance to a workshop: yes or no | Names of workshops attended | Content of the workshop attended |
|---|---|---|---|
| Mr. Govender | Yes | Department of Education training at Pinetown Circuit Training Centers | Living things: plants and animals, materials and structures, energy and energy transfer, solar system, movement, and control. |
| Mrs. Zwane | Yes | Primary schools' science experiments presented by Casme | Basic experiments within the school science curriculum. |
| Miss. Solai | Yes | CAPS, NCS workshop, RNCS, and OBE workshop | Discussions on lesson plans and content; planets, electricity, and assessment and curriculum |
| Mrs. Buthelezi | Yes | OBE workshop, NCS workshop, RNCS workshop, Natural Sciences as Technology workshops, CAPS. | About the curriculum from teaching to assessment |
| Miss. Basi | Yes | CASME Science to go; Natural Sciences for senior phase; Departmental workshops on assessments | Networking with other educators; annual teaching plans and assessments; and practical investigations in natural science |

Apart from the names of the training received, the study further asked the participants to state the content of the training received, and some of the contents of the workshops included the following: living things: plants and animals, materials and structures, energy and energy transfer, solar system, movement, and control; basic experiments within the school science curriculum; discussions on lesson plans and content; planets, electricity and assessment and curriculum; curriculum from teaching to assessment; networking with other educators; annual teaching plans and assessments; and practical investigations in natural science. The results demonstrated that most of the contents of the workshops focused on teaching, assessment, and curriculum, suggesting that, indeed, the teachers had received some training on how to teach natural science. However, the response from Mr Govender suggested that the content of the workshop attended was not on teaching.

### 5.4 Participants' understandings of inquiry-based science teaching

This section presents the findings relating to the participants' understandings of inquiry-based science teaching. The findings were obtained from the analysis of responses from the questionnaire and the structured interview. A pedagogical strategy known as IBST places a strong emphasis on students' active participation, inquiry, and critical thinking during the learning process (NSTA, 2000). This scholarly discussion explores the complex and diverse conceptions of IBST that primary school natural sciences teachers held based on findings from a qualitative research study. The goal of the research was to reveal these educators' complex viewpoints and methods within the framework of IBST.

*Character of Participants' Understandings: Varying Views*

The findings of the study demonstrated that participants' opinions on the core ideas and objectives of IBST varied widely. While some educators saw IBST as an approach that focused primarily on students' independent research, others placed more emphasis on group projects and practical learning opportunities.

*Educational Theories:* The educational philosophies of the participants were closely linked to their understanding of IBST. IBST was seen by educators who supported constructivist methods to help pupils build knowledge by inquiry and investigation (Dewey, 1916). On the other hand, teachers who were based on conventional frameworks approached IBST with cautious optimism, striking a balance between student inquiry and structured content delivery.

*Opportunities and Challenges: Pedagogical Changes*

The participants agreed that adopting new educational approaches is essential to implementing IBST successfully. Concerns over the shift from teacher-centred to learner-centred methods were voiced by a few, who mentioned difficulties in letting go of authority and adjusting to a helping position (Windschitl, 2004). Others, on the other hand, saw this change as a chance for improved learner-learning outcomes and professional development.

*Limitations on Resources:*

The impact of resource limitations on IBST implementation was a recurrent subject in the understanding of the participants. Teachers were forced to creatively adapt IBST tactics to their unique circumstances due to several problems, including limited access to materials, time limits, and large class numbers (NGSS Lead States, 2013).

*Support and Development for Professionals:*

*Training Requirement:*

A common demand among participants was for focused professional development to improve their comprehension and application of IBST. According to Loucks-Horsley et al. (2010), the study shed light on the value of continuous professional development programmes, seminars, and collaborative learning communities in assisting educators in their professional development and establishing an IBST community of practice.

*Collaboration and Mentoring:*

The significance of mentorship and teamwork surfaced as crucial elements impacting the participants' understanding of IBST. Teachers who collaborated with peers on planning and reflection reported feeling more confident about implementing IBST and having a deeper understanding of its concepts (Little, 1990). The qualitative investigation into the IBST practices and understandings of natural sciences teachers uncovered a diverse range of viewpoints, difficulties, and opportunities. The study offered insightful information that can guide future research projects, educational policies, and professional development programmes by examining the complex perspectives of participants. Fostering a culture of inquiry and discovery in primary school classrooms and improving science instruction requires an understanding of the various ways that teachers approach and use IBST.

## 5.5 Teachers' understanding of how natural sciences should be taught

The study ascertained the participants' understanding of how natural science should be taught. The views of the participants regarding this issue were obtained through an interview. It came out clearly that the various science teachers had various views on how natural science should be taught. The responses provided by the participants indicated that they understood the teaching of natural sciences as involving both practical and theoretical lessons. This point was amplified by Mr Govender who stated:

*Natural sciences teaching should involve class lessons, backed-up demonstrations, and worksheets.*

Mrs. Buthelezi also echoed how natural sciences should be taught by claiming the following:

*Science should be taught through experiments, and the learners should be hands-on.*

The views of Mr. Govender and Mrs. Buthelezi suggest that teaching natural science should involve both theoretical and practical lessons through experiments, demonstrations, and worksheets. The other three participants added the expected outcome of the teaching method. For instance, Mrs. Zwane provided the following statements about how natural sciences should be taught, thus:

*Science teaching should be as practical and functional as can be to daily experiences.*

Similarly, Miss Solai provided a comprehensive view of how natural science should be taught with the following response:

*By teaching learners, the skills, knowledge, and values and developing their critical thinking using resources, conducting, and actively engaging with learners to prepare them for real-life situations.*

The following quotation is also attributed to Miss. Basi on how natural sciences should be taught, thus:

*Learners should be encouraged to learn through discovery, stimulation, and practical investigations*

The foregoing demonstrates that the natural sciences teachers conceptualised the teaching of natural sciences differently. Despite the various understandings of how natural sciences should be taught, it appeared that all the teachers had a fair understanding of the teaching of natural sciences. Apart from the understanding of the teaching of natural sciences, the source of such understandings needs to be interrogated. Given this, the participants were further asked to indicate what informed their understanding of how natural science should be taught. The response obtained through the questionnaire is presented in Table 5.4 below. It can be ascertained from Table 5.4 that all the participants indicated that their understanding of how natural sciences should be taught was informed by professional studies. Professional studies are conceptualised as the formal education received that enables them to function as natural science teachers, which in this case was the bachelor's degrees they had all obtained. This result was unsurprising because the knowledge obtained through formal education influences one's view on a particular topic and how it should be taught.

In addition, two of the participants indicated that their interactions with colleagues influenced their understanding of how natural science should be taught. This suggests that as natural sciences teachers interact among themselves, they tacitly learn from each other. Apart from the two, four also indicated that their understanding of how natural sciences should be taught was informed by the support they received from the school management. They claimed that the support from the school management could be in the form of in-service training, peer training, or group discussions facilitated by the management of the schools. Finally, they all agreed and responded that their understanding of how natural sciences should be taught was informed by the workshops received from the Department of Education. Its worth mentioning that pseudonyms were used, and not the real names of participants.

**Table 5.2 Sources of understanding of how NS should be taught.**

| Participants | Sources of understanding or information about NS | | | |
|---|---|---|---|---|
| | Professional studies | Interaction with other teachers | Support from school management | Workshop from the Department of Education |
| Mr. Govender | ✓ | ✓ | ✓ | ✓ |
| Mrs. Zwane | ✓ | | ✓ | ✓ |
| Miss. Solai | ✓ | ✓ | | ✓ |
| Mrs. Buthelezi | ✓ | | ✓ | ✓ |
| Miss. Basi | ✓ | | ✓ | ✓ |

### 5.6 Sources of grades 6 and 7 natural sciences understandings of the subject

To effectively document how natural sciences teachers understood and practiced IBST, it was necessary to explore their understandings and perspectives on natural sciences. As a result, the study asked the participants some questions related to natural sciences, which enabled the researcher to evaluate how the teachers understood natural sciences. The study provided some statements about the natural sciences subject and the participants were asked to indicate their level of agreement with each statement. The technique was developed to make teachers feel comfortable and to prevent at all costs the perception that they were being "tested" and possibly found to be lacking. In essence, a sequence of "events" was created, each of which was related to a different statement about natural sciences. Six statements were provided, and they served as a way of assessing the teachers' understanding of natural sciences. The results are presented in Table 5.3 below.

**Table 5.3 Participants' Perceptions of Sciences as a Subject**

| Teacher/perception constructs | Mr. Govender | Mrs. Zwane | Miss. Solai | Mrs. Buthelezi | Miss. Basi |
|---|---|---|---|---|---|
| Science is primarily an abstract subject | **A** | **A** | **NS** | **A** | **A** |
| Science is a formal way of representing the real world | **A** | **NS** | **A** | **A** | **A** |
| Science is primarily a practical and structured guide for addressing real situations | **A** | **A** | **A** | **A** | **A** |
| Some students have a natural talent for science and others do not | **A** | **NS** | **A** | **A** | **NS** |
| Teachers need to give learners prescriptive and sequential directions for doing experiments | **A** | **A** | **A** | **A** | **A** |
| Focusing on rules is a bad idea which gives rise to memorising | **NS** | **A** | **D** | **NS** | **A** |
| **REACTIONS:** AGREE **(A)** DISAGREE **(D)**NOT SURE **(NS)** | | | | | |

Table 5.3 presents the level of understanding of natural sciences teachers in grades 6 and 7 about the natural sciences subject. Six constructs or response items were used to achieve the objective of this task. The six response items used for this construct comprised science is primarily an abstract subject; science is primarily a formal way of representing the real world; science is primarily a practical and structured guide for addressing real situations; some students have a natural talent for science and others do not; teachers need to give learners prescriptive and sequential directions for doing experiments; and focusing on rules is a bad idea which gives rise to memorising. Each construct is represented by *'agree, disagree, and not sure'*.

The first response item was for the teachers to indicate whether they agreed that science was primarily an abstract subject. This response item indicated that most of the participants disagreed with the view that science is an abstract subject. The second response item asked the participants to indicate whether they agreed that 'science is primarily a formal way of representing the real world'. This response item also obtained a score of 3 teachers agreeing which suggested that almost all the participants agreed that 'science is primarily a formal way of representing the real world'. In addition, the participants were asked to indicate whether 'science is primarily a practical and structured guide for addressing real situations. Here, all the teachers strongly agreed that 'science is primarily a practical and structured guide for addressing real situations.

Three of the participants strongly agreed with the statement whereas two were unsure. The findings suggested that a slight majority of the teachers agreed that some students have a natural talent for science and are unsure about others. Table 5.3 further shows the results concerning whether the participants agree that 'it is important for teachers to give learners prescriptive and sequential directions for doing experiments. This response item indicated that all participants agreed that 'it is important for teachers to give learners prescriptive and sequential directions for doing experiments. The last response item was for the participants to indicate whether they agreed that focusing on rules is a bad idea that gives rise to memorising. There was a lack of agreement among the participants on this response item, evidenced by Mr Zwane and Miss Basi agreeing, while Miss Solai disagreed, and Mr Govender and Mrs Buthelezi were unsure. The findings suggested that most of the participants disagreed that focusing on rules is a bad idea which gives rise to memorizing.

**5.7 Teachers' understanding of teaching natural science in grades 6 and 7**

The study further assessed the level of understanding of the participants about the teaching of natural sciences. A questionnaire and structured interview approach were used to collect data from the participants on this issue. This was also a crucial factor that could influence how teachers understood and practiced inquiry-based science teaching. Firstly, the participants were asked to indicate whether they involved learners in the teaching of natural sciences. All the participants answered in the affirmative, indicating that they involved the learners in teaching natural sciences. The participants were further asked to indicate how they involved learners in their teaching process. The responses provided by the participants were identical because they all suggested that they mainly involved the learners by giving them some work to do, be it practical or theoretical. Mr Govender indicated that students were involved in the teaching process through practice, where they were given some tasks to perform during class. The quotation attributed to Mr Govender is as follows:

> *I involve the students through group and practical work. This involves making my lessons group-orientated and engaging learners in self-discovery.*

A similar sentiment was shared by Mrs. Buthelezi, who also suggested that students were involved in the teaching process through experiments, observations, and discussions. Mrs. Buthelezi reiterated the following response about how learners are involved in the process of teaching:

> *I involve them through the question-and-answer method. I also involve them through demonstrations or experiments to draw conclusions or relations and knowledge consistent with content outcomes. I also encourage the application of knowledge to different contexts and comparisons.*

It is clear from the response provided by Mrs Buthelezi that learners are actively involved in every process of teaching. By providing the learners opportunities to ask questions and answer them by themselves, these learners would be active participants in the teaching and learning process. Miss. Basi echoed that learners are involved in the teaching process by encouraging them to ask and answer questions, in addition to encouraging them to bring materials and equipment to participate in experiments and demonstrations. The following direct quotations are attributed to Miss Basi:

> *The learning process in science is to understand the learners' content knowledge which is gained from prompts of questions and answers leading to teaching of new content through inquiry. Students are encouraged to answer questions, bring materials or equipment participate in experiments and demonstrations. The best methods for them to be actively involved are peer teaching, project methods, and hands-on learning.*

Mrs. Zwane and Miss. Solai shared similar views on how they involved learners in teaching natural science. According to these participants, the ability to communicate certain threshold concepts and keywords with the learners is vital. They explained how things work to the learners in a manner they would understand them (learners). This also involves encouraging the students to explore and express their views on the subjects being discussed. The following are the direct quotations of Mrs. Zwane and Miss. Solai, respectively:

*I involve them. This includes communicating with them using scientific terms. Learning new science vocabulary and through research projects.*

*Each group explores new concepts to see how an experiment works. For thinking or reasoning skills, focus on revising prior skills. They are encouraged to conclude. Interpretation of results* *and assessment of conclusions, accessing or recalling information, company, measuring. Sort or classify products and raise questions.*

Given the above responses, the researcher further assessed how well the teachers understood the process of teaching natural sciences by the teaching methods as detailed below.

**5.8 Teaching methods and strategies of the natural science teachers**

To gain a deeper understanding of how teachers understand and practise inquiry-based science teaching, the researcher first ascertained the teaching methods adopted by the natural sciences teachers. The first question posed to the participants was: How do you go about teaching science in class? The interview analysis showed that the teachers adopted different methods to teach natural sciences. Here, the participant indicated that he/she acted as a facilitator by providing resources to the learners. This teaching method is related to the one used by Mr. Govender. The following direct quotations are evidence of his natural sciences teaching method:

*As practically as possible, through learners' discovery and providing resources.*

According to Mrs. Zwane, different teaching methods are adopted to teach natural sciences to make the teaching engaging and interactive. Mrs. Zwane provided the following information about the natural sciences teaching method:

*To teach science in class or use different methods that will make them fully engaged in learning activities. I give them activities where they work in groups, give projects where they research, and come back with different findings to share with others in the class.*

Miss Solai and Mrs. Buthelezi also shared similar teaching methods, where they allowed learners to explore the topics themselves. The direct quotations of Miss. Solai and Mrs. Buthelezi are provided below about this subject matter, respectively:

*Introduce new concepts, and hypotheses, answer questions, and identify the problem, need, specification, and practical investigation by learners. To think and to find solutions themselves in both groups and individual activities. Presentation of projects by groups.*

*They are hands-on when it comes to practical investigations. There are also question-and-answer sessions. They also formulate questions and hypotheses.*

The teaching methods of Miss Solai and Mrs Buthelezi suggest that learners are actively involved in the teaching and learning of natural sciences. Similarly, Miss Basi demonstrated a teaching method where the teacher mostly takes control of the teaching process and allows the learners limited roles in the teaching process.

The analysis of the interview responses from the participants indicates that the natural sciences teachers adopted different and various teaching methods. They involved the learners in the teaching process, thus making the learners active participants in the teaching and learning process. The specific question asked was: What are some of the strategies you use in teaching natural sciences in your class? Concerning this question, the teachers provided different responses. Most of the participants emphasised the use of materials and experiments as their main teaching approach. Table 5.4 summarises the responses from all five participants.

**Table 5.4 Question: *What are some of the strategies you use in teaching natural sciences in your class?***

| Participants | Responses |
|---|---|
| Mr. Govender | *A practical approach is used* |
| Mrs. Zwane | *To teach natural sciences in my class, I use instructional conversations, role play, hands-on learning, context-based learning, projects, and educational tours.* |
| Miss. Solai | *CAPS documents assessment plans, skills, attitudes and values social transformation, and integration. Goal orientated by using keywords, visualising new concepts, driven by questions or answers.* |
| Mrs. Buthelezi | *Planning, organising, observing, and assessing.* |
| Miss. Basi | *Chalk and talk, diagrams, experiments, and demonstrations* |

### 5.9 Assessment of methods of teaching on the learning outcomes of learners

After obtaining the teaching methods and strategies adopted by the natural sciences teachers, the researcher further obtained an understanding of the teachers about how the various methods and strategies affected the learning outcomes of the learners. To achieve this, the following question was asked: How does the method you employ in the teaching affect the learning outcomes of your learners? All the participants maintained that their respective teaching methods positively affected the learning outcome of the learners. For instance, Mr. Govender asserted that the method adopted enabled the learners to understand and practise science daily. The direct quotation provided by Mr. Govender is provided below:

> *Learners understand science in daily life as compared to textbook knowledge.*

Similarly, Mrs Zwane was positive that the teaching method she adopted had a favourable effect on the learning outcomes of the learners because it made the students actively involved in the teaching and learning process. In this way, it helped the learners to understand the subject because they were active participants in the process. Mrs Zwane stated:

> *It is hands-on learning. This is where they are actively engaged in class activities. They get to understand well if they are part of the process.*

Both Miss. Solai and Mrs. Buthelezi agreed that their teaching methods had positive influences on the learning outcomes of the learners. According to the two participants, with their teaching methods, the learners would be able to recall what they learnt in class, thus emphasising the cognitive outcome of learning. Miss Solai further insisted that the teaching method she adopted could assist learners in critically analysing information and making informed conclusions. The direct quotations attributed to Miss. Solai and Mrs. Buthelezi are stated below, respectively.

> *It enhances and stimulates learners to think better and draw conclusions. Promotes and learning and recall of information easier and quicker. Seeing a practical demonstration ensures that specific aims are achieved.*

*It makes it easier for the learners to remember what they have learned.*

Finally, the view of Miss. Basi was not different from those of the other participants. This participant indicated that her teaching method had a positive effect on the learning outcomes of the learners because it helped them to apply the aspects they learnt in class in real life. Miss. Basi justified the effect of her teaching method on the learning outcomes of learners with the following statement:

> *The methodology used enhances the grasp and understanding. Chalk and talk will only get an understanding of the content without demonstrations or experiments. Will bring out knowledge and affirm some and will lead to the application of gained knowledge in*

*different contexts and situations. The chosen methodology therefore impacts content understanding and application and functional value of some knowledge.*

The analysis of the responses from the participants demonstrates that they were optimistic that their teaching methods could positively affect the learning outcome of the learners. Interestingly, they all provided distinct ways that their teaching methods could affect learning outcomes. It was concerning that their teaching methods could only affect specific learning outcomes, which made them limited. It must be emphasised that there are various learning outcomes for natural sciences, including critical thinking, ability to analyse information, application of knowledge, effective communication, interpersonal skills, interpretation and application of scientific technological, and environmental information, and investigation skills, among others.

### 5.10 Participants' understandings of inquiry-based science teaching

Having ascertained the teaching methods and strategies adopted by natural sciences teachers, the study further examined their understanding of inquiry-based science teaching. The first question posed to the participants was: Have you heard about inquiry-based science teaching methods? Participants were to answer with a ‘yes’ or ‘no’. Interestingly, all the participants answered ‘yes’ to the question, indicating that they were all aware of the concept of inquiry-based science teaching.

Having confirmed that they had heard about inquiry-based science teaching, the participants were asked to describe how they understood the term. The interview question posed to the participant was: If yes, how do you understand inquiry-based science teaching? With this question, the participants provided various descriptions of inquiry-based science teaching, which demonstrated that some were yet to properly understand the concept. For instance, Mr. Govender provided a brief description of inquiry-based science teaching as follows:

*Learning through enquiring which is based on problem-solving activities.*

It is clear from the definition of Mr. Govender that he understood inquiry-based science teaching from the position of learning instead of from teaching. Mrs. Zwane provided a rather elaborate description of inquiry-based science teaching, which demonstrated her grasp of the concept. The following quotation is attributed to her about her description of inquiry-based science teaching.

> *It is a form of teaching where the educator provides facts to learners, and they are allowed to explore and are allowed to ask questions based on what they learn. Our knowledge or explanation of material/content is based on the inquiry or answers to questions we have about it. Facilitating learning through the provision of materials, equipment, and guidance.*

Miss Solai also described inquiry-based science teaching, which was not substantially different from that of Mrs. Zwane's. According to Miss. Solai, inquiry-based science teaching is described as follows:

> *It provides learners with the opportunity to investigate a program make observations and ask questions by thinking and using reasoning. It encourages learners to think logically based on scientific (facts) evidence and reason.*

The following direct quotation is Mrs. Buthelezi's understanding of inquiry-based science teaching:

> *The teacher asks questions about what the learners already know to what they do not. The educator acts as a facilitator, providing a platform for learners to learn through discovery.*

Lastly, Miss. Basi demonstrated an appreciable level of understanding of inquiry-based science teaching. The following is her description of inquiry-based science teaching:

> *Inquiring into or of the unknown will draw out an understanding of a concept, a body of knowledge that, when engaged with learners through interaction, will affirm contribute, or add to the previous knowledge of that concept. Visualise presentations or experiments. It motivates learners to think outside the box, especially when it comes to scientific knowledge.*

The preceding paragraph showed that the participants conceive inquiry-based science teaching variously. However, their responses indicated that they had some knowledge about the concept of inquiry-based science teaching. To this end, it was interesting to find out their understanding of the processes of inquiry-based science teaching and how inquiry-based science teaching affected the learning outcomes of learners. This issue is discussed in the next paragraph.

The preceding paragraphs provided evidence about the participants' understandings of inquiry-based science teaching. The researcher further asked them to indicate the activities and processes they considered as inquiry-based science teaching. The question asked to solicit a response from the participants about this subject was: What activities and processes do you consider inquiry-based science teaching? The various responses from the participants provided to this question are summarised in Table 5.5 below.

**Table 5.5 Question: What activities and processes do you consider as IBST?**

| Participants | Responses |
|---|---|
| Mr. Govender | *Practice tasks related to daily life.* |
| Mrs. Zwane | *Since I teach grade 4 as well as grade 6, in grade 4 this becomes a challenge in guiding them through the process of inquiry. Their attention span and focus affect open inquiries, it is fine with grade 6 learners* |
| Miss. Solai | *Projects, presentations, assessments, practical tasks, investigations.* |
| Mrs. Buthelezi | *Class activities, tests, assignments, and projects, etc.* |
| Miss. Basi | *Demonstrations and experiments.* |

The responses presented in Table 5.5 indicate a certain level of concurrence among the participants on the activities and processes that constitute inquiry-based science teaching. It can be observed that participants viewed projects, practical, experiments, demonstrations, class activities, and experiments as activities and processes that amount to inquiry-based science teaching. Finally, the participants were asked to indicate whether inquiry-based science teaching could affect the earning outcome of learners. To obtain a response to this issue, the following question was asked: Do you think teaching science through IBST makes any difference in learning outcomes? A 'yes' or 'no' answer was required from the participants. Unsurprisingly, all the participants averred that teaching science through IBST makes no difference in learning outcomes. Miss. Basi justified her response with the following statement:

> *A visual interpretation will enhance and affirm content knowledge and lead wisely to applications in different contexts. It is more tangible and leads to understanding concepts better thus giving credence to the learning outcomes.*

The responses demonstrated that the participants were convinced that inquiry-based science teaching could positively affect the learning outcomes of learners. The next section assessed the participants' familiarity with documents relating to inquiry-based science teaching.

### 5.11 Familiarity with documents related to inquiry-based science teaching

Every teaching activity and method is backed by certain guidelines and principles documented by experts and authorities. This is true for inquiry-based science teaching as various documents guide the practice of inquiry-based science teaching. Three main documents were prepared to guide teachers in practising inquiry-based science teaching. These documents are the CAPS document, the District Curriculum Guide, and the School Curriculum Guide. Thus, the investigator questioned the subjects to see if they were familiar with these documents related to inquiry-based science teaching. The responses were based on a 4-point Likert scale, ranging from 1 to 4, where 1 represents ‘no such document’, 2 denotes Not familiar, 3 signifies familiar, and 4 represents ‘very familiar with the document’. The results from the participants are presented in Table 5.6

**Table 5.6 Familiarity with Documents related to Inquiry-Based Natural Sciences**

| | CAPS Document | District Curriculum Guide | School Curriculum Guide |
|---|---|---|---|
| Mr. Govender | 4 | 4 | 3 |
| Mrs. Zwane | 4 | 4 | 3 |
| Miss. Solai | 4 | 4 | 4 |
| Mrs. Buthelezi | 4 | 3 | 3 |
| Miss. Basi | 4 | 4 | 4 |

The results, as shown in Table 5.6, showed that there was general agreement among the participants that they were familiar with the CAPS document. This was demonstrated by the mean score of 4 all through for this response item as being very familiar with. The study further found a general agreement among the participants about their familiarity with the District Curriculum Guide. This result implied that most of the participants were familiar with the District Curriculum Guide. In addition, Table 5.9 revealed that most of the participants were familiar with the School Curriculum Guide as well. In general, the results showed that most of the participants were familiar with the documents related to inquiry-based science teaching. This result was encouraging, given that a lack of familiarity with these documents would have raised questions about what guides these teachers in their practice of inquiry-based science teaching. The following section probes the specific inquiry-based science teaching adopted by the participants.

### 5.12 Factors that affect the Teaching methods of Science Teachers

This section describes the teachers' views on the factors that affect how teachers teach natural sciences in class. The results were based on the analysis of the data obtained from the questionnaire. To achieve this, the participants were given a series of statements to indicate how each of them affects or limits how they taught natural sciences in class. The specific question asked was: In your view, to what extent do the following affect or limit you in how you teach science class? This question contained twelve different statements that asked the participants to rate how each of them affects the way they teach natural sciences.

### 5.13 Tools, equipment, and materials that participants use in teaching

The teaching of natural science requires tools, equipment, and materials. This is because natural sciences require practical, experiments and demonstrations to enable the students to experience how science is applicable in real life. Given this, the study asked the teachers to provide some of the tools, equipment, and materials they used to teach natural sciences. The question put to the participants was: What are some of the tools, equipment, and materials that assist you in your teaching? It came to light that all the teachers used various tools, equipment, and materials they use to teach natural science. The responses provided by all the participants, Mr Govender, Mrs Zwane, Miss Solai, Mrs Buthelezi and Miss Basi are quoted below, respectively:

> *I use* p*ractical equipment, investigative booklets, and tasks (Connelly).*

> *I use* c*harts with science words on pictures, picture books, science kits, word walls, paint, brushes, and colour boards.*

> *Textbooks, posters, chalkboards, science apparatus, worksheets, extension activities, formal assessment programs.*

> *Science kit with apparatus, posters, pictures, books, class book record keywords, formal textbooks, extension activities, formal assessments, CAPS program.*

> *Charts of diagrams or models, video presentations, microscopes, beakers, chemicals, instruments (measuring), and gas.*

The results showed that the teachers use various equipment, tools, and materials to teach natural sciences. The analysis of the interview results showed that some teachers use modern tools, equipment, and materials to teach natural science. For instance, all the participants used science kits and apparatus for experiments and demonstrations. What missed from the listed tools, equipment, and materials were modern pieces of equipment such as computers and modern software.

**5.14 Teachers' practice of IBST**

Having ascertained the general teaching practices adopted by the natural sciences teachers, the study further examined if they taught natural sciences through inquiry-based science teaching and how they did it. Two main questions were asked to solicit the responses of the participants on this issue. The first question posed to the participants was: Do you teach science through IBST? If yes or no, why? A "yes" or "no" response was required from participants for the first part of this question.

Interestingly, not all the participants taught through inquiry-based science teaching. The results showed that four out of the five teachers, which represent 80% of the participants, practised inquiry-based science teaching, and one, representing 20% did not practise inquiry-based science teaching. The following statements were provided as a response to why the participants did not teach science through inquiry-based science teaching.

> *The age and the level of development of the learners I teach. I am teaching students who are not old enough and therefore need support and supervision in most given activities.*

After confirming that they practised inquiry-based science teaching, the participants were asked to provide reasons for teaching through inquiry-based science teaching. On this issue, various responses were provided by the participants to justify why they taught natural sciences through inquiry-based science teaching. According to Miss Solai, she taught science through inquiry-based science teaching to assist the learners to understand the key concepts and facilitate the evaluation of the teaching and learning. The following direct quotation is attributed to Miss. Solai on this issue:

> *I teach science through inquiry-based science teaching to see if the learners have grasped the various concepts taught. To assess learners' potential, what knowledge they have learnt and if they conclude based on thinking and reasoning.*

From the justification of Miss. Solai taught natural sciences through inquiry-based science teaching to enable the learners to remember what they learnt. The responses provided by Mr. Govender and Mrs. Buthelezi were similar, as they postulated that they taught natural sciences through inquiry-based science teaching to improve the learners' comprehension of the topics being discussed. The following are the responses from Mr. Govender and Mrs. Buthelezi, respectively:

> *Yes. It assists learners in understanding the subject on a deeper level by asking many questions that are rephrased and repeated.*

> *Yes, to know how much the learners know and how far they understand what they have been taught.*

> Miss Basi also offered the following response about why she taught natural sciences through inquiry-based science teaching:

> *Yes. For the years, I have taught sciences through IBST, experiments, demonstrations, and surveys giving my learners and me content understanding and functional applications through problem-solving.*

The foregoing paragraph shows that the various participants adopted IBST. The responses demonstrate that the participants had various reasons for teaching natural sciences through inquiry-based science teaching. According to survey replies, it was shown that teachers try to participate in some kind of inquiry-based activities. The researcher was then interested in knowing the key procedures the teachers used when implementing inquiry-based in their classrooms. The second question asked the participants to describe how they practise inquiry-based science teaching. The question was asked through a structured interview approach. The following was the specific question that the participants were asked: Briefly describe how you teach inquiry-based science teaching. The analysis of the interview results showed that some of the participants adopted some inquiry-oriented teaching activities that were more regimented. For instance, the inquiry-based science teaching approaches of Mr. Govender and Mrs. Buthelezi were oriented towards the old-fashioned teachers driving the teaching process. The following are the responses provided by participants Mr Govender and Mrs Buthelezi, respectively:

> *This method of teaching has been used by teachers of science and technology for a few years now. It leads to the OBE approach.*

*Questions are asked to check what learners know. I also ask questions during the lessons and after the lesson has ended.*

An analysis of interview replies from Mr. Govender and Mrs. Buthelezi revealed a predetermined order of actions and similar stages or activities in the investigation. The teachers' position continues to be crucial. These participants appeared to give off-topic answers, giving the impression that they did not grasp the question or the concept of inquiry-based science teaching. Other participants also adopted a mix of teaching styles that involved practical activities that appeared to take the shape of exploration and verification. The following statements are the quotations attributed to Mr Govender and Miss Basi about how they practise inquiry-based science teaching, respectively:

*We ask questions about a topic that we do not understand fully and then engage in an inquiry through content and experiments to develop an understanding and knowledge of the topic. Experiment guides to outcomes.*

*Practical investigative tasks- learners to investigate using research materials and tools provided- research booklets.*

The foregoing analysis demonstrated that the teachers employed a variety of teaching activities, some of which were linked to inquiries. These teaching activities were combined but varied depending on whether they were conducted in a classroom, laboratory, or outdoor setting. It was evident from the information gleaned from interviews that Mrs Buthlezi and Miss Solai engaged in inquiry while others did not. This indicated that the majority of those surveyed tried to incorporate some form of inquiry into their regular teaching. Most of the activities, however, were still traditional, and even those that appeared to be inquiry-related required students to follow teacher instructions or respond to questions that the teacher had created, giving them less freedom to create their questions and ways of answering them. Even the practical work seemed to focus more on idea demonstration and verification than on asking questions and coming up with an answer based on the available data.

Another observation from the survey and interview data was that there were differences among teachers in their practices and the activities they engaged in. Most inquiry-based science teaching activities occurred in conjunction with conventional classroom activities. Still, it seemed that the teachers played a major role. They combined several different instructional techniques. Traditional teaching methods were still more widely used. The response from many teachers (including those who do not use inquiry) suggested that they would prefer using inquiry to traditional direct teaching. This was a sign that teachers had the motivation to change their daily teaching practices to embrace inquiry-based science teaching.

### 5.15 Chapter summary

It was clear from the description above that teachers were still engaging in typical customary activities. Depending on the subject and circumstances, teachers who are aiming to include inquiry-based into their practices include some practical work that takes the shape of a structured investigation or inquiry in which the teacher sets the job before providing step-by-step directions. According to the study, the following activity sequence was the most frequently used: instructions; exercise or group project; introduction/brainstorming; supervision; task/question/activity; presentation and synthesis, notes, and conclusion. The teachers' responses confirmed the preponderance of structured inquiry when it occurred, but what was most frequently observed was the active participation of students in a variety of contexts.

# CHAPTER SIX
# TEACHERS' APPLICATION OF IBST

## 6.1 Introduction

Science education is crucial to learners' education as it provides them with the skills and knowledge needed to understand the world around them. Inquiry-Based Science Teaching (IBST) is a teaching approach that involves learners in the scientific process, allowing them to ask questions, collect data, and make observations before making conclusions. The inquiry-based approach is a teaching method that emphasises learner-centred learning and encourages learners to ask questions, explore, and make discoveries. Inquiry-based teaching is an effective way to teach science, as it allows learners to apply their knowledge to real-world problems and develop critical thinking skills. However, implementing inquiry-based instruction in science classrooms is not always straightforward despite its potential benefits.

This study aimed to explore the inquiry-based teaching practices of natural sciences teachers in a suburban school district and to identify the challenges they face in implementing this approach. This approach is beneficial for learners as it helps foster their curiosity, encourages hands-on learning, and promotes scientific literacy. The previous chapter presented the results and discussions on how natural sciences teachers understood and practised inquiry-based natural science teaching. In this chapter, the details of the teachers' practice of IBST in a classroom setting during the focus group discussion programme with the researcher provided support to the teachers on areas of the IBST lesson that needed attention. To explore the teachers' levels of IBST application in the classroom, I based this on the central theme of IBST as defined below, and this served as the guiding principle against which to access and make findings of the teachers as they taught their respective lessons:

> *Inquiry-based science teaching stands for the fundamental principle of how modern science is conducted. Inquiry refers to a variety of processes and ways of thinking that support the development of new knowledge in science. In addition to doing science, inquiry also refers to knowledge about the processes scientists use to develop knowledge which is the nature of science itself. Thus, inquiry-based science teaching is viewed as two different student outcomes, the ability to do scientific processes and the knowledge about the processes (Flick & Lederman, 2006, p. 6)*

## 6.2 The focus group discussion programme (FGDP): the intervention programme

To address the observed lack of essential elements of IBST in the teachings of the participants, it became necessary to organise the intervention programme in the research process. According to Flick and Lederman (2006), the basis of IBST stresses the dual character of science education, which includes knowledge about scientific methods as well as the capacity to perform them. The participants in the intervention took part in focused discussions and workshops that explored the various facets of scientific investigation. The definition provided by Flick and Lederman (2006) provided a framework for emphasising the significance of both carrying out scientific procedures and gaining a thorough grasp of the nature of science. By highlighting that IBST is about more than simply performing science—it is also about learning the methods scientists use to create new knowledge—the intervention sought to close the knowledge gap between theory and practice (Flick & Lederman, 2006).

The researcher conducted a workshop with the participants that centered on the fundamental principles of IBST to close this gap. The purpose of this workshop was to deepen participants' understanding of the processes involved in the production of scientific knowledge while clarifying the complex nature of scientific inquiry, which was absent during the lessons observed. The participants were led to understand that IBST encompasses more than just carrying out experiments; it also entailed developing a sophisticated grasp of the nature of science through in-depth talks and practical activities. The Focus Group Discussion Programme (FGDP) stressed the significance of learners gaining not only the capacity to undertake scientific processes but also the knowledge and awareness of the processes themselves by citing the work of Windschitl and Stroupe (2017). The goal of this intervention was to improve the teaching practices of the participants by bridging the knowledge gap between the theoretical understanding of IBST and its practical use in their natural science classes.

## 6.3 How natural sciences teachers (NTS) construct and practice IBST through a FGDP

Inquiry-based science teaching is a teaching method that is based on learners' questions and exploration. The technique emphasises hands-on experimentation and observation to develop scientific understanding. In this method, the teacher acts as a facilitator, encouraging learners to engage in the scientific process. The study was conducted through observation and analysis of a single lesson conducted by five natural sciences teachers. The five teachers were Mr. Govender, Mrs. Zwane, Miss. Solai, Mrs. Buthelezi, and Miss. Basi. The lesson focused on testing materials to determine whether they were waterproof or absorbent. The steps the teachers took during the lesson, including demonstration, explanation, and questioning, were recorded, and analysed to determine the elements of IBST in the lesson delivery. The following sections provide a detailed account of how the teachers taught IBST before and after a focus group discussion.

### 6.4.1 Mr Govender's practice of IBST before the FGDP

This section presented Mr. Govender's practice of inquiry-based science teaching during a focus discussion strategy or programme. Mr. Govender's lesson was about testing materials to see whether they were absorbent. He prepared a few materials, including paper, fabric, a plastic spoon, a glass, a slice of bread, and a plastic pocket. The paragraph below presented a narrative of the detailed activities during the lesson.

Mr. Govender: If you look at the worksheet that I have given you, we are going to test whether each material is waterproof. Does water pass through it? We want to check that it is absorbent. That is, does it soak up the water? Is it strong enough after it is dipped in water or is it weak? So, what we are going to do is we are going to take a pencil, so if the material is waterproof, we are going to tick (Adhemar) it and if it is not, we are going to put a cross (Abrahams). The teacher takes a dish filled with water and puts it on top of the table. The teacher continues.

Mr. Govender: OK, let us do the first one; it says a slice of bread. So, if I take some water and pour it on top of the slice of bread, who can tell me what will happen? Will it be waterproof?

Learners: No

Mr. Govender demonstrated to the learners: No, it will not be waterproof. Let us see that. So, I am taking water and pouring it on the bread. Is it waterproof? Can water pass through?

Learners: Yes

Teacher talking while demonstrating: Yes. So, put a cross next to it because it is not waterproof. Is it absorbent? If I dip it in the water, is it soaking?

Learners: Yes

Mr. Govender: Yes. So, put a tick. Is it strong enough if I try to break it (talking while demonstrating)?

Learners: No

Mr. Govender: Put a cross and if I must throw it into the floor while it is wet, will it break?

Learners respond with different answers: Yes.

Mr. Govender: Yes, it will break. Is it strong? You told me it is not strong. So, will it break?

Learners: Yes

Mr. Govender: Right. Let us do the next one. Tick. (Teacher starts demonstrating while talking) OK, this is a piece of material. Let us test it. Will it be waterproof?

Learners: No

Teacher talking while demonstrating: No. Let us try it. So, I am pouring water over it. Does water pass through it? So, is it waterproof?

Learners: No

Mr. Govender: No. Put a cross. OK, let us test whether it is going to absorb the water. If I dip it in the water, is it absorbing the water? (demonstrating).

Learners: Yes

Teacher talking while demonstrating: Yes, it is soaking up the water, so it is yes. Is it strong enough if I try to pull it apart?

Learners: Yes

Teacher: Yes, it is strong. Is it tearing?

Learners: No

Mr. Govender: No. So, it is strong. Put a tick. Does it break if I must throw it onto the floor (he threw it on the floor)?

Learners: No

Teacher talking while demonstrating: So, put a cross. Let us test the next one, which is a plastic spoon. Is the plastic spoon waterproof?

Learners: Yes

Teacher, while demonstrating: Yes. Is water passing through?

Learners: No.

Teacher talking while demonstrating: No. So, it is waterproof. Put a tick next to it. Is it absorbing if I take this and dip it into the water? Is it soaking up?

Learners: No

Mr. Govender: No. Put a cross. Is it strong if it is in water?

Learners: Yes

Teacher talking while demonstrating: Yes, it is strong. If I throw it onto the floor, does it break? Is it weak?

Learners: No

Teacher talking while demonstrating: No, put a cross. OK, we are going to do the next one, this is a plastic bag. Let us test whether it is waterproof. Is the water passing through it if I put water on top of it?

Learners: No

Mr. Govender: So, you will say it is waterproof and put a tick. Is it absorbing the water if I have to dip it in water?

Learners: No

Teacher talking while demonstrating: No, for a cross. Is it strong enough when it is in water?

Learners: Yes

Teacher talking while demonstrating: Yes, if I throw it onto the floor, will it be weak?

Learners: No

Teacher: No. Right, let us do the next one, a glass. If I pour water into it, is it waterproof?

Learners: Yes

Teacher talking while demonstrating: Yes. If I dip it into the water, is it absorbing the water?

Learners: No

Mr. Govender: No, is it strong enough to hold water if the water is in it?

Learners: Yes

Mr. Govender: Yes, but will the glass break if I throw it onto the floor?

Learners: Yes

Mr. Govender: Yes, it will shatter.

The last item is a piece of newspaper. We are going to test whether the newspaper is waterproof. So, I am going to pour water over it (demonstrating). Is the newspaper waterproof? Does water pass through it eventually?

Learners: Yes

Teacher: Yes. When you wet a piece of paper, will the water pass from underneath?

Learners: Yes

Teacher talking while demonstrating: OK, if I dip this piece of paper in water, is it absorbent? Is it absorbing the water?

Learners respond with different answers: Yes and No

Mr. Govender: Why are you saying no? Is it not soaking up the water?

Learner A: It is.

Mr. Govender: If I throw it on the floor, will it tear apart?

Learners: No

Mr. Govender: Yes, it will take apart if it is left wet on the floor. OK. Do you understand certain objects can be waterproof? Certain objects are absorbent, certain objects are strong, and certain objects are weak. Are all objects the same?

Learners: No

Teacher: No. So, we learnt something today?

Learners: Yes

Mr. Govender: OK, thank you.

The lesson highlighted the benefits of using IBST in the science classroom, such as fostering learner curiosity and encouraging hands-on learning. The findings of the study indicated that Mr. Govender used several key elements of IBST in the lesson. These elements included the essence of contemporary science, the diverse components of inquiry, the active role of learners in knowledge acquisition, the stress on the concepts of science, and the twin benefits of helping learners develop both theoretical and practical understanding. He demonstrated the properties of the materials, explained the scientific concepts being tested, and asked questions to encourage students' engagement and critical thinking. Additionally, Mr. Govender provided learners with a worksheet to record their observations, which helped to promote scientific literacy. Through demonstration, explanation, and questioning, the teacher engaged learners and promoted critical thinking, both essential for scientific literacy. Additionally, using a worksheet helped reinforce the scientific concepts being taught and provided learners with a record of their observations.

Despite the lesson conducted by Mr Govender having many attributes of IBST, several issues suggested that the teacher's appreciation and practice of IBST were limited. The lesson lacked the application of a variety of inquiry-based strategies such as the knowledge of the process. Through the observations, the researcher also identified challenges in implementing inquiry-based instruction, including a lack of active role of learners in knowledge acquisition, the emphasis on the nature of science, and the twin benefits of helping learners develop both theoretical and practical understanding. The study concluded that Mr. Govender could implement inquiry-based teaching, but more support was needed to overcome the challenges he faced. The findings of this study provided insight into how science teachers approach inquiry-based teaching and can inform the development of professional development programs, interventions, and resources to support teachers in this endeavour. These issues were addressed through the focus group discussion programme to see if the teacher's practice of IBST would be improved. The results of the discussion programmes are discussed in the section below.

#### 6.4.1.2 Mr Govender's Practice of IBST after the FGDP

This section described Mr. Govender's practice in investigating the properties of materials, specifically their waterproof and absorbent characteristics after the focus group discussion in a science class. This was a follow-up lesson after an initial class on the same topic. After the initial lesson, I engaged in a focus discussion session on IBST with Mr. Govender These discussions were necessary because Crawford and Barbra (2007) assert that through personal development, science teachers can make changes to their perceptions, practices, and thinking about science and science teaching which will improve their knowledge and skills in the teaching of science in schools and in turn will impact learner outcomes and interests in sciences. The aim was to assess whether the discussion strategy or programme would improve the teacher's practice of IBST.

In this lesson, the teacher demonstrated how to perform an investigation and involved the learners in observing and making predictions about the outcome. In this section, we described a teacher's practice of investigating the properties of materials, specifically their waterproof and absorbent characteristics. The materials tested included a slice of bread, material, a plastic spoon, a plastic bag, and a glass. The results of the inquiry-based science teaching practice implemented by Mr Govender in the provided interaction revealed several key findings. The first material tested was a slice of bread. The class determined that it was not waterproof but was absorbent and weak when wet. The observation and analysis of Mr. Govender's practice of IBST showed that he used hands-on and interactive methods to teach the concept of absorbency to the learners. He used various materials, such as paper, fabric, a plastic spoon, a glass, a slice of bread, and a plastic pocket, to demonstrate the properties of absorbency and waterproofing. The teacher asked the learners to predict what would happen when water was poured on each material and then confirmed their predictions through demonstration.

These findings were significant as they provided insight into the nature of different materials and how they react to water. They also demonstrated the importance of conducting experiments and testing materials, as well as the scientific methods of making predictions and observing results. The findings can also be used to support the teaching of science in the classroom, as they demonstrate the scientific method and the importance of conducting experiments to test materials and make predictions.

The findings from the second lesson suggested that Mr. Govender effectively used an investigation to engage the learners in hands-on science learning and develop their understanding of scientific concepts which are aspects of inquiry-based. This approach supported the notion that inquiry-based science teaching can foster critical thinking, problem-solving, and communication skills in learners. Additionally, his use of inquiry-based teaching strategies and his emphasis on involving the learners in making predictions and observations were in line with current trends in science education, which emphasise the importance of learner-centred and inquiry-based learning. Delving into the effectiveness of Mr Govender's teaching style and its impact on the learners' understanding of the concept of absorbency, it was ascertained that the hands-on and interactive approach he used engaged the learners, as they participated actively in the demonstration and the prediction.

Furthermore, the teacher's use of IBST aligned with constructivism and inquiry-based learning principles. Constructivism is a learning theory that emphasises the role of learners in constructing their understanding of the world through their experiences (Marshal & Rossman, 2006; Xiuhong, 2006); Harkness, 2009; Lederman, 2009; Lederman, 2009; Marshal & Rossman, 2006; Mugabo, 2015a). These authors affirm that inquiry-based science teaching is based on the views of the constructivist approach, where learners are encouraged to develop ideas and knowledge from scientific investigations and experiments. On the other hand, inquiry-based learning is a learner-centred approach that encourages learners to engage in their learning by asking questions and exploring answers. The teacher's use of IBST supported these principles by allowing the learners to make predictions, participate in the demonstration, and construct their understanding of the concept of absorbency.

The results of the study revealed that, after the focus group discussion on IBST, Mr Govender had a clear understanding of the inquiry-based approach to science teaching and its benefits for learner learning as was evident in his teaching post the focus discussion. This finding was consistent with his improved teaching. Creswell (2014) opined that through personal development, science teachers can make changes to their perceptions, and thoughts about science and science teaching which will improve their knowledge and skills in the teaching of science in schools, and in turn will impact learner outcomes and interests in science. In addition, some researchers assert that professional development programmes will go a long way in improving the IBST of teachers (Hassard & Dias, 2013; Lee et al., 2004; Luft et al., 2011). In his post-focus discussion teaching, Mr. Govender used a variety of inquiry-based strategies, such as problem-based learning, case studies, and hands-on activities. These strategies were used to help students develop critical thinking skills, such as problem-solving and decision-making, and to encourage them to take an active role in their learning. The teachers also noted that inquiry-based instruction helped to increase learner engagement and motivation.

Mr Govender identified several challenges to implementing inquiry-based instruction, including a lack of time and resources. He noted that it can be time-consuming to develop and plan inquiry-based activities. He added that it can also be challenging to find the resources needed. The teacher reported that assessing learner learning in an inquiry-based environment could be difficult, as traditional assessment methods, such as multiple-choice tests, may not be appropriate. Despite these challenges, the teacher was committed to using inquiry-based instruction and reported that he was constantly seeking new strategies and resources to improve his practice. The teacher also noted that the benefits of inquiry-based instruction, such as increased learner engagement and the development of critical thinking skills outweighed the challenges.

#### 6.4.2.1 Mrs Zwane's practice of IBST before the FGDP

This report was based on an observation of a lesson taught by Mrs. Zwane before introducing her to the focus group discussion programme. The observation was conducted in the classroom, and all interactions between the teacher and learners were recorded. The study was conducted through observation of a single class session in which the teacher discussed the habitat of animals. The session/observation was conducted in the classroom, and all interactions between the teacher and learners were recorded. The recorded data was then analysed to identify the teacher's use of inquiry-based science teaching techniques and to provide an overview of the lesson's content and delivery.

In this interaction, Mrs Zwane, who is also the deputy principal, was teaching a grade six natural sciences class about the habitat of animals. The teacher started the class by introducing the topic and explaining what a habitat is. She then asked students to look at the chart on the wall and listen carefully as she explained the concept of a habitat. She also showed the students the tree outside the window and asked them to observe the birds that lived in it. The following paragraphs provide a detailed account of how Mrs Zwane taught her learners before introducing the focus group discussion or strategy. The teacher handed the worksheets to the learners, introduced herself, and started the lesson as follows.

Mrs Zwane: I am the deputy principal here, and I teach grade six natural sciences and Technology. For this lesson, we are only concentrating on the sciences. Our topic for today is the habitat of animals. Right, habitat of animals. And to introduce you to that, if you look at the first sheet, your space is number one. I have given you the worksheet and from there, you will find that you will be able to see what habitat is. Look at the board; some of you can look at the board it says what habitat is. A place where animals live (the teacher points at the charts on the wall). I have one chart here and another chart there. This chart is linked to your worksheets. Now for interaction again, I am turning this to you. Listen carefully; a habitat is a place where animals live.

Alright, and what is the need for a habitat? Well animals, they need to be in a safe place. They need to find food in their habitat. They need to have proper shelter away from predators. They also live to reproduce. So that is the need for habitat.

The teacher shows the learners the tree through the window and continues.

Mrs Zwane: If you look at the tree outside, on this side, there is a tree. Later, you may be able to hear birds on the tree. Now, did you hear that? I heard the bird just now. The birds that are on the tree, made their nest, and they will live in it. If I take you to the ground, to the edge of the ground, we have got a big tree there. What do you see during the breaks when you go to the grounds? What do you see? What animals live there? What do you see? Yes.

The teacher points the learner to answer his question.

The learner responds: The birds are flying in the air.

The teacher continues with the lesson adding to the learner’s answer.

Mrs Zwane: But those are big birds. They are called Hadadas. I know they are flying over the swimming pool. Then you have other birds there; they are different colours. The Egyptian geese, right? You heard of the Egyptian geese, right? Now, they are not all the time found throughout South Africa. They are found in certain areas, and we are lucky to have Hadada birds here in the east region. Now, for today, we will come back to your notes. Let us talk about different habitats. The various habitats will give you an idea of where these animals live. So, we are going to identify the different habitats.

There are four habitats. Now, if you look at this picture here (teacher points to the picture). There is a zebra there. I can see a bird. There is a crocodile and a fish. These are in the notes in front of you. But let us look at the charts again (the teacher points to the chart). From this chart, you will be able to see the different places where the zebras live. But these are the headings that will tell you that zebras live in the grasslands. So, one of the areas is the grassland, which is the habitat for certain animals. Then you have the forest where animals live. They have the food supply; they have the shelter there.

What are the other habitats? It is like there are two more. Come on, think quickly. One is the fish. Where does it live (The teacher points to a learner who raises his hand)

Learner 1: Sea.

Teacher: Fish lives in the sea, yes. Anyone else? Yes.

Learner 2: Fish in the fish tank.

Mrs Zwane: Fish tank that is your annotation of bringing the fish into the house. OK, that is not the best environment for the fish to grow in. But in the rivers. We find crocodiles and fish in the rivers. I am looking for one more, one more habitat. Let us see, we have forest, grassland, river, and the sea. The river will have different kinds of fish that live there, the sea has saltwater fish, and the river has freshwater fish. Now can you see these four areas? Many years ago, I enjoyed watching small birds, but on the patriarch, country birds and I visited that area on the farm.

About three months ago, I was still able to find those birds' habitat near the tree in the short grass of the water tree. Another tree is called the falbala tree, an international tree. And close to that building are different habitats. Then, you find one more, one more, please. So, we have the four areas here and we will discuss each. To find out where some of the areas are. Which animals live in there and what food do they get from there? Right. They must have food, is not it?  Where do humans live? Where do you live?

Learner 3: New Germany

Teacher: OK, fine, we are living in India, we live in New Germany. OK, what do you live in?

Learners 4: Houses.

Teacher: What are the houses made from?

The teacher points the learner to answer.

Learner 5: Bricks

Mrs Zwane: Yes, and what food do you get? What food? Could you give me some other food?

Learner 6: Rice

Teacher: Yes, you (teacher points to another learner)

Learner 6: And curry

Mrs Zwane: OK, so, let us put our hands down. Let us go back to the animals. We say the animals must do the same. They need to live, and they need to eat for a living. Later in your notes, you will notice that, or you note that those different animals are found in specific habitats, and I am giving you a worksheet and activity worksheets. You read the notes. That is information for you. Read the notes and from the notes, you will be able to find out where those animals live and fill in the worksheet. That worksheet carries about ten marks. OK, so we have covered these four habitats for the different animals so far. We have not identified which animals live there, but if you look at the notes again.

They are separated and if you do the first one, what is the first one in the notes? Let us go to page number 2. Yes, who would like to read? Would you like to read it?

Learner 7: Yes

Mrs. Zwane: Read the first one on page number 2. See habitat. Listen to what he is saying. Just manage the reading of your tone; read aloud.

Learner 7 reads: Many kinds of animals live in the sea. The sea has salty water. The temperature of the sea does not change much. Many types of fish, turtles, whales, and dolphins live in the sea. They eat other living things in the habitat. For example, seals and dolphins eat fish; sharks eat seals. The octopus hides under rocks and weeds from fish to swim so that it can catch them. Fish lay their eggs in the water. (Learner finishes with the reading)

Teacher: OK. Thank you, my boy. What is your name again? (Asks the teacher).

Learner (responds): Kwanele.

Mrs Zwane: Kwanele, you read very well. If you have heard him, then you will be able to recall and if you were looking at your notes, you would know which animals live in the sea, right?

Learners: (mention examples). One is fish.

Learner 5: I heard dolphin, sharks.

Teacher: I do not need another one. But yes, Seals, Turtles. But I like one thing. I like the one on the rivers. Who likes to read the one on the rivers?

The teacher asks and learners to raise their hands. The teacher points to a learner, and she reads.

Learner 8: River habitat. The river habitat has fresh water. The temperature of the water does not change much. Some animals, such as fish, snails, and turtles, live in the water. Some live above the water, such as ducks and insects.

Teacher: OK, let us stop there. We know what we are looking for. I see the difference between the sea and river; there is that difference. In the rivers is fresh water. We can drink the water when appropriately filtered and cleaned. Sea water is very difficult to drink because of the salt in it. In the river, we have crocodiles. Do we have sharks in the river?

Class: No

Mrs Zwane: Investigator divers are shocked that you do not see sharks in the river. And then you got ducks. Let us look at the food. What food does the duck family eat? When they look, they look for what kind of food?

Learners raise their hands and the teacher points to one.

Learner 6: Bread.

Mrs Zwane: Sorry, we do not know if they do; we do not feed ducks with bread. What is the natural food that they find? The different insects? Small fish. And what is a feature that lives there? I want all of you now to go to your last sheet. The one on the activity quickly we are trying to answer. I have given you sheets for this purpose. Let us look at the last sheet. I can see something. The second one from the right is called bull fern. Is it not? Put the finger on the bull fern.

The class looked at their sheet.

Mrs Zwane: Did you all see fish? Put the finger on the bull fern, all of you. That bull fern lives where in the river? It swims on the top of the surface of the water. Do you see how interesting it is? I think your worksheet has it. Now, you may use your knowledge to read the other worksheets and even further worksheets. All right, I am going to the activity now. I am going very quickly because I have got notes for you. Right. But we will continue this exercise and the other pieces that are available to us. If you look at the first one here, it says what kind of food is found. You will fill in the answers. In the first four lines, you have many of them. You can have more than one to fill in the answer. OK, right. (The teacher demonstrates). Hold the sheets up like this for me; pick it up.

Learners hold the sheet up.

Teacher: OK, now you can put it down. The other one we identified is what foods. Identify what foods.

The teacher tells the learner to complete reading the line and the learner reads.

Mrs Zwane: Now you can put your finger there, OK? (Demonstrating how). I am holding this thing. So, I need you to put the answers in the right place. We are going to go very quickly to the worksheet. I have other worksheets to give you and am also worried about the time for the observer. But finish the lesson; I want you to listen very carefully. Use a ballpoint pen, no pencils. You can erase your answer. I am giving this assessment ten marks. I want you to know my objective is for you to understand what habitat is, and what is found in the habitat. What kind of food is in the habitat? I want to see this worksheet filled out correctly. Use your black ballpen. Do not carry all your ballpen. One is fine; write at the top right-end corner. Mrs. Zwane ends the lesson.

The following stand out from the engagement between the teacher and the learners. Firstly, some level of inquiry-based science teaching was used by the teacher as the approach for teaching about the habitats of animals. The teacher used questions to engage learners in the learning process and encouraged them to think critically about the topic. She asked learners about the need for habitat and what animals need to live. She also taught them to identify different habitats and where certain animals live. She also referred to her own experiences to bring the topic to life for learners. For example, she talked about her experience watching small birds in the past and how he was still able to find those habitats near the tree. The teacher's approach was effective in engaging learners and promoting their understanding of animal habitats. The learners' participation and experience were limited as they could not fully participate in the class by answering questions and providing their observations. The teacher's use of IBST in the natural science class was relatively effective in engaging learners and promoting their understanding of the topic of animal habitats. By asking questions and using visual aids, the teacher was able to create an interactive and engaging learning environment that encouraged learners to think critically about the topic.

#### 6.4.2.2 Mrs Zwane's practice of IBST after the FGDP

In this section, I described Mrs. Zwane's practice of the IBST method in the classroom after the focus group discussion programme. The lesson focused on the habitat of animals. To start the lesson, Mrs. Zwane introduced herself and explained the topic of the day to the learners. She provided a worksheet to the students and explained the meaning of the word "habitat". The teacher used charts displayed on the wall to help illustrate the information. She explained that a habitat is a place where animals live and provides the necessary conditions for them to survive, including safety, food, shelter, and the ability to reproduce.

To further illustrate the concept, Mrs Zwane pointed to a chart on the wall and directed the learners' attention to the tree outside the window. She used the tree outside the window as a real-life example of a habitat for birds. She explained the birds living on the tree, including Hadadas and Egyptian geese. She also mentioned the different habitats for animals, including grasslands, forests, rivers, and seas. To engage with the learners, the teacher asked questions about what they see when they go outside during breaks and encouraged them to identify the different animals they see. The learners responded that they see birds flying in the air. The teacher then added to their answer by explaining that these are big birds, like Hadadas and Egyptian geese, and they live in different habitats.

Mrs. Zwane added that there are four habitats that they will be discussing in the lesson. She points to a picture of a Zebra, bird, crocodile, and fish and explains that they live in different habitats. The teacher used the chart on the wall to illustrate the habitats and asked the learners to identify where each animal lived. With the learners' help, he explained that the Zebra lives in the grasslands, fish live in the sea and rivers, and animals live in the forest. The teacher then directed the learners back to their notes and explained that there are four different habitats: grasslands, forests, rivers, and the sea. She pointed to a chart and illustrated how different animals live in different habitats and what kind of food they get from each habitat. Mrs. Zwane also saw that the habitat of certain animals had changed over time. Finally, the teacher asked the learners where they lived and concluded the lesson by emphasising the importance of understanding different habitats and the animals that live in them.

From the post-discussion lesson of Mrs Zwane, the following became apparent. Firstly, she used real-life examples, such as the birds in the tree and the animals on the school grounds, to help the learners understand the concept. She engaged the learners in a discussion by asking questions and encouraging them to participate. Again, she used charts, worksheets, and practical examples to help the learners understand the topic better. Mrs Zwane discussed the different types of animals that live in each habitat and the food they get from their habitat. The teacher emphasised the importance of preserving habitats for animals to thrive. The teacher further shared her experiences observing animals in their habitats, which added an emotional aspect to the lesson. The teacher encouraged learners to think critically and expand their knowledge by asking questions and guiding their thinking. The teacher used IBST, which helped to create an interactive and engaging lesson, which increased student motivation and understanding of the topic. This method of IBST was critical because Minner et al. (2010) support that inquiry-based science teaching involves, "teaching that actively engages learners in the learning process through scientific investigations [that] are more likely to increase conceptual understanding than strategies that rely on more passive techniques".

Overall, this post-focus group discussion interaction demonstrated Mrs Zwane's use of an inquiry-based teaching method, where she encouraged learners to observe and ask questions about the world around them. In this post-intervention lesson, it was evident that she utilised several key elements of IBST, including asking open-ended questions, encouraging learners' participation, and providing opportunities for hands-on learning. By introducing the topic of animal habitats and asking the learners to identify different habitats and the animals that live in them, the teacher engaged the students in a process of inquiry, where they actively sought information and made connections between different concepts.

Mrs Zwane also made use of visual aids, such as charts and pictures, to help the learners understand the concepts being discussed. Additionally, the teacher employed real-world examples, such as pointing out the birds outside the window and asking the learners to observe and identify different animals they saw on the school grounds. This activity helped the learners understand the relevance of the topic and make connections between the classroom and their own experiences. Furthermore, she promoted learners' participation and encouraged the learners to think critically and make connections between different concepts. These activities are essential for IBST, which corroborates Wilhelm and Beishuizen's (2003) view that, in the process of IBST, learners carry out a self-directed, partly inductive, and partly deductive learning process by doing experiments to investigate the relations for at least one set of dependent and independent variables. For example, the teacher asked the learners to identify different habitats and the animals that live in them and encouraged them to think about the needs of other animals and how they are met in different habitats. The findings of this report revealed that Mrs Zwane used several IBST techniques in her lesson.

The results of this study showed several key findings that were noteworthy. The use of interaction, visual aids, and hands-on activities helped to keep students interested and focused on the topic being taught. The teacher's use of real-life examples, such as the birds and trees outside the window, helped bring the topic to life and made it more relevant for the learners. The findings of the pre-focus group discussion and post-discussion IBST lessons suggested that Mrs Zwane successfully used IBST techniques to engage learners in the post-discussion lesson. Firstly, it was observed that there was a significant difference in the teaching approaches between the first and the post-intervention lessons. The experimental lesson and the post-discussion showed an improvement in the teaching practice compared to the control group. This indicated that the focus group discussion was effective in improving the IBST knowledge and practices of Mrs. Zwane. In conclusion, Mrs Zwane's practice of IBST was effective in engaging the learners and making the subject of natural sciences fun and interactive. She used real-life examples, questions and answers, charts, and wall displays to illustrate the information and make the lesson more engaging for the learners.

#### 6.4.3.1 Miss. Solai's practice of IBST before the FGDP

This section described and analysed Miss. Solai's practice of inquiry-based science teaching in a classroom setting before the focus group discussion programme. The study used a qualitative approach and was conducted by observing the teacher and students during a science lesson. Miss. Solai started the class by explaining the objective of the lesson, which was to understand the process of mixing solid and liquid materials to make a paste. The teacher asked learners to provide examples of processing methods, and when the learners suggested "mixing," Miss. Solai decided to focus on that method for the class. The learners were given instructions for a hands-on activity in which they mixed flour and water to make a paste. A detailed transcription of Miss. Solai's lesson is provided below.

Teacher: What are the ways of processing the experiment?

Learner 1: Mixing

Learner 2: Drying

Learner 3: Firing

Teacher: OK, if there are any others that you know of

Learner 4: Latent

Teacher 5: Ok. Is latent one of the methods?

Class: No

Miss. Solai: No, we are talking about metals now. Today we are going to do one of the processing methods, which is mixing raw materials. Which raw materials are we going to use today?

Learners raise their hands and the teacher points to one of them to respond.

Learner: Flour and water

Miss. Solai: Yes. So, we will be mixing flour and water to make what products? Which product will we be making when mixing the two?

Learner 3: A dough

Teacher: He says a dough

Learner 2: A glue

Miss. Solai: Why do you say we are going to make glue?

Learner 2: Because of the topic

Miss Solai: Well, because of the topic. Ok. Open on page 88 of your textbook. We are mixing a solid and a liquid to make a paste. We are going to make a paste but not a dough this time. So, we are on activity 2, making glue from flour and water. So, what do we need?

Learners raise their hands, and the teacher asks the whole class must answer.

Class: Small container

Miss Solai: Show me your small container (learners raise their containers). What else do we need?

Class: Flour

Teacher: Show me your flour

Learners raise their flour.

Teacher: What else do we need?

Class: Water

Teacher: We need water; what else do we need?

Class: Nice picture

Teacher: Nice picture, show me your nice picture.

Learners raise their pictures.

Teacher: What else do we need?

Class: Newspaper

Miss Solai: And a newspaper. Read the first instruction. Instruction number one. All of us.

Class: Spread the newspaper out on your desk. Put a tablespoon of flour into a small container.

Teacher: OK. Spread the newspaper out on your desk, do that now.

The learners do as they are told.

Teacher: Have you done that?

Class: Yes

Teacher: Right, continue

The class continues with the reading.

Class: Put a table teaspoon of flour into a small container

Miss Solai: Yes, take out your tablespoons and open the flour. How many tablespoons?

Class: One

Teacher: Put one tablespoon of flour into your container quickly. If you have a teaspoon, how many teaspoons do you need?

Class: Two

Miss Solai: Two teaspoons; hurry up. Let us go to instruction number 2. Read instruction number 2, everybody.

Class: In our workbook, write how the flour feels and looks like.

Miss Solai: Before you go to your workbook. Feel the flour and put your fingers into the flour. How does it feel?

Class: It feels soft

Miss. Solai I am not a choirmaster. How does the flour feel?

Learners raise their hands and the teacher points to one.

Learner 2: Soft

Teacher: It feels soft

Learner: It feels fluffy.

Learner 3: It feels smooth.

Teacher: Is there any other description?

Learner 4: It is warm.

Miss Solai: How does it look? Look at the flour; how does it look?

Learner 6: It looks white.

Miss Solai: I am not talking about the colour. Look at its texture. How does it look?

Thabani: White

Teacher: I am not talking about the colour Thabani.

Learner: It looks like a powder.

Miss Solai: It looks like powder. The flour is powdery. It is powdery. Now take out your exercise books and write three sentences describing the flour. Write four or three sentences describing flour. I am giving you two minutes. We said flour is fluffy; it is powdery; it is soft; it is slippery.

The learners busily write their answers down.

Miss Solai, Are you done, people? Ok, let us all stop. Let us continue and read instruction number three. All of you, instruction number three.

Class: Add a spoonful of water to the flour and mix. Describe the mixture.

Teacher: (repeat the instruction stated by learners). How many spoonsful of water do we have to mix?

Thabani: Two

Teacher: Two?

The teacher points to another learner to respond.

Learner 5: One

Miss Solai: Only one. So, add a spoonful of water into this flour (demonstrating) and mix.

Learners add and mix as per instruction.

Miss Solai: How many spoons do we need, Thabani? Who else does not have water? Where is your spoon?

The teacher goes around giving water to those who do not have it.

Miss Solai: How much is that water? Is that one spoonful of water, Thabisa? What does the instruction say? How much water is that? Alright, have you stirred it? Have you mixed the two water and flour? Not yet? Describe the mixture. How is the mixture? Look at it and describe it.

Is it the same as the flour before you mixed it with water? This is not one spoonful of flour; that is more than one. Describe the mixture class.

Learner 7: The mixture looks like dough.

Miss Solai: She says the mixture looks like dough. How does the dough look?

Learner: It looks sticky, and it sticks on the surface that you put it on.

Teacher: Right, read instruction number four. All of us, let us read.

Class: Keep adding a teaspoon of water at a time until you get a soft paste, like toothpaste.

Teacher: How does toothpaste look like? Is it hard?

Learners: No

Miss Solai: What does it look like? How is it?

Learners: It is smooth

Miss Solai: So, we are going to add a little bit of water. You are now making a paste. Just a little bit until you get that smooth paste-like, ok? Add water and stir. I do not want to see any lumps. Stir until it is smooth. When your paste is ready, please put your hand up. I want to come and check. Stir until it looks like toothpaste. When you are satisfied that it looks like toothpaste, please call me. Are you ready? Are you winning? Read the last part of instruction number four.

Class: Write down how the paste feels.

Miss Solai: I want you first to feel the paste. Put your fingers in the past and feel it. How does it feel? Check it with your fingers. Hands up when you have the answer. Can I have the answers, please? How does the paste feel? Yes, Buthelezi.

Learner: It feels soft.

Teacher: He says it feels soft. What else?

Learner 8: It feels wet.

Teacher: Yeah

Learner 9: It feels smooth and sticky.

Miss Solai: Right. What do others say? How does it feel? I will give you a tissue to clean your fingers so we can write descriptions of the paste. Write three sentences describing the paste. Hurry up. If I bypassed you, you must be busy writing. When I say stop, everybody will stop and then we will continue.

Learners are busy writing their answers.

Miss Solai r: The people who do not have the paste, please write something because you have heard them describing the paste. Are you done?  Okay, let us continue. Let us go back to our books. Read instruction number 5.

Class: Using one of your fingers, spread some paste thinly onto the back of your picture.

Teacher: Again.

Class: Using one of your fingers, spread some paste thinly onto the back of your picture.

Teacher: Now take out your pictures.

Learners do as they are told.

Miss Solai: Do what the instruction says, using one of your fingers. What do you do? Spread some paste thinly onto the back of your picture. At the same time, your exercise book is open because you will paste the picture on your excessive book. Read the instructions. Using one of your fingers, spread some paste thinly onto the back of your picture. We are still on number five.

If your paste is lumpy, it will not work; it must be smooth and sticky. When you are done with instruction number 5, you move on to instruction number 6. It says what?

Class: Stick your picture in your workbook, immediately below your answers to the questions asked above.

Miss Solai: Exactly do what the instruction says. Paste your picture or stick your picture neatly onto your exercise book. Are you done with instruction number six?

Class: Yes

The teacher ends the lesson.

The observation showed that Miss. Solai followed the inquiry approach to teaching science. She encouraged learners to engage in hands-on activities and to make observations about the materials and processes involved. Miss. Solai also utilised questions to prompt learners' thinking and to guide their understanding of the scientific concepts being taught. The findings of the study showed that Miss. Solai employed various teaching strategies that aligned with the principles of IBST. The teacher encouraged students to participate actively in the lesson and integrated hands-on activities and inquiry-based learning into the lesson. The teacher also provided clear and concise instructions and used visual aids to help learners understand the concepts being taught. The teacher failed to promote teamwork and critical thinking by not encouraging learners to work together and ask questions.

The findings of the study provided insights into the effective practices of IBST in a classroom setting. The study showed that Miss. Solai used a variety of teaching strategies that aligned with the principles of IBST, including hands-on activities. Another limitation of the teaching approach of Miss. Solai was her failure to integrate the science content with learners' prior knowledge. These strategies are effective in promoting student engagement, critical thinking, and long-term retention of knowledge. These findings are consistent with the findings of (Mäeots et al., 2008) who reported that inquiry-based science teaching can improve different inquiry skills, such as identifying problems, formulating questions and hypotheses, planning and carrying out experiments, collecting and analysing data, presenting the results, and drawing conclusions.

#### 6.4.3.2 Miss Solai's practice of IBST after the FGDP

This section aimed to examine the practices of Miss. Solai in a science lesson using IBST after the focus group discussion program. The previous section documented the pre-intervention programme IBST practice of the teacher. The lesson focused on mixing flour and water to make glue. The teacher's practices were observed in the classroom, focusing on her questioning techniques, instructions, and feedback. This observation aimed at examining the teacher's approach in a science lesson, specifically regarding inquiry-based science teaching after the focus group discussion programme. This study employed qualitative observation as its method of data collection.

The session started with Miss. Solai who asked the learners about the ways of processing experiments. Three methods were mentioned by the learners, mixing, drying, and firing. When the teacher asked if there were other methods, a learner suggested latent. However, the teacher corrected the learner and indicated that latent was not the method they discussed. Miss. Solai then explained that they would perform the mixing process and asked the learners what raw materials they would use. The learners responded with flour and water. The learners were given instructions for a hands-on activity in which they mixed flour and water to make a paste.

The teacher then asked the students what product they would make by mixing flour and water. One learner mentioned dough, while another learner named glue. Miss. Solai asked the second learner why he thought they were making glue, and he explained it was because of the topic. The teacher then asked the learners to open their textbook to page 88 and began the activity of making glue from flour and water. She then asked the learners the materials they would need, and the learners named a small container, flour, water, a nice picture, and a newspaper.

Miss Solai then asked the students to spread their newspapers on their desks and put a tablespoon of flour into a small container. The learners followed the instructions and then continued to read the instructions and complete the next steps. The teacher asked the students to describe the flour, and they responded with words such as soft, fluffy, smooth, and powdery. Miss. Solai then asked the learners to write three sentences in their exercise books describing the flour. Next, the learners mixed a spoonful of water with the flour and described the mixture. The teacher asked the learners how many spoonsful of water they needed to add and helped those who did not have a spoon. The learners mixed the flour and water to make a paste and described the mixture as sticky. The teacher asked learners to describe the physical properties of the flour, such as its texture and feel. The students were also asked to write a description of the flour in their exercise books.

The findings of this study were in line with previous research on IBST, which highlights the importance of hands-on activities and learner-centred approaches in science education (Pedaste & Sarapuu, 2006; Wilhelm & Beishuizen, 2003). The findings showed that Miss. Solai employed various teaching strategies that aligned with the principles of IBST. These strategies included hands-on activities, inquiry-based learning, and the integration of science content with the learners' prior knowledge. The teacher also encouraged learners to participate actively in the lesson, promoted teamwork and critical thinking, and provided clear and concise instructions. The provision of feedback also helped to reinforce the learning. The findings provided insights into the effective practices of IBST, which can serve as a model for other science teachers. Previous studies have also shown that inquiry-based approaches lead to increased student engagement and improved scientific understanding (Mäeots, Pedaste, & Sarapuu, 2008; Minner et al. (2010). According to Dobber et al. (2017), a significant aspect is that inquiry-based teaching allows both learners and teachers to be actively involved and engage each other more collaboratively in the teaching and learning process of science. This study provided evidence that Miss. Solai's implementation of IBST effectively promoted learner engagement, scientific knowledge and understanding.

In conclusion, Miss. Solai's inquiry-based science teaching practice after the focus group discussion programme effectively promoted learner engagement and active participation in the learning process. The teacher used a variety of teaching strategies, including effective questioning, hands-on learning experiences, encouragement of learner involvement, clear and concise instructions, the incorporation of multiple senses, and the use their observation and descriptive skills to describe the flour and the mixture they made. These strategies helped to create a positive learning environment that supported student success.

#### 6.4.4.1 Mrs Buthelezi's practice of IBST before the FGDP

This section described how Mrs. Buthelezi practiced IBST before the focus group discussion. In this interaction, Mrs. Buthelezi taught her learners the states of matter: solid, liquid, and gas. The teacher began the lesson by reviewing the three states of matter (solid, liquid, and gas) with the learners. She then wrote the three states of matter on the board and asked the learners to identify examples of each state of matter found in the classroom. The learners could identify several examples of solid, liquid, and gas materials found in the classroom. The teacher then expanded the discussion to include examples of solid, liquid, and gas materials found outside of the classroom. The learners were able to identify several examples, such as trees, rocks, and wind. The following report provided the interaction between Mrs. Buthelezi and learners in a classroom.

Mrs. Buthelezi: Can you remind me about those states of matter? What are the states of matter that we talked about? The first one is?

Learner 1: Solid

Teacher: Let me write it down. It was solid. The other one? (Teacher points to a learner).

Learner: Liquid.

Teacher: Because there are three states of matter, which is the third?

Learner: Gas

Mrs. Buthelezi: Solid, liquid, gas (writing on the board). Okay, let us all read those states of matter; the first matter is?

Learners: Solid, liquid, gas (reading on the board along with the teacher)

Mrs. Buthelezi: Yes, we call these three states of matter. So, you must look around the classroom and tell me the things you can see that fall under solid. Look around at the school and mention the answer.

The learners raise their hands and the teacher points one by one.

Learner 1: Table

Learner 2: The Board

Learner 3: Chair

Learner 4: The books

Learner 5: The window

Mrs. Buthelezi Yes, I know pupils tend to be able to identify the solid materials that are found in class. So now, if you look out of the classroom, not inside. Just look outside and see what is solid.

Learner 6: Trees

Learner 7: Glass

Learner 8: Rocks

Mrs. Buthelezi: So, now you understand what solid is. I can see you have mentioned the solids that are here in the classroom and outside the classroom. And now we come to the second one, which is liquid. So, who can give me an example of the liquid (the teacher points to the learners to provide answers)?

Learner 3: Water

Teacher: Waterfalls under liquids.

Learner 9: Milk

Teacher: Milk, yes, very good.

Learner 6: Juice

Teacher: Juice. Oh, people know all sorts of liquids.

Learner 2: Oil

Teacher: Yes, oil.

Learner 10: Drinks.

Teacher: Drinks. I know people always want to drink something.

Learner 6: Paraffin

Mrs Buthelezi: Yes. So, we have mentioned all types of liquid and now we are coming to the third one which is gas. Zulu, what can you mention (Zulu answers the question).

Zulu: Air

Learner 8: Gas stove

Mrs. Buthelezi: The gas stove. The stove falls under the solid, but we are talking about the gas.

Learner 11: The kettle

Mrs Buthelezi: Not just the kettle but the steam that comes out of the kettle when you are boiling water using a kettle. There is steam that comes out. So, that steam that comes out after heating or boiling water falls under the gas.

Learner 10: Wind

Teacher: Yes, what else?

Learner 3: Cooking gas

Mrs. Buthelezi: Yes, the gas that we use to cook. So, now, I know people understand the concept of those things. So, now, you must know before we move on that the solid material can change into a liquid and the liquid can change into a gas (the class helped the teacher finish the sentence). So, all those things happen in our daily life. What I am going to do now so that I can see that you can be able to sort the objects that are here in the worksheet. I will give you this worksheet to sort the examples of solid, liquid, and gas accordingly because they are materials written here. So, now, I want to see if you can sort them accordingly to show that you know what a gas is, what a solid is, and what a liquid is.

Teacher (continues): So, for now, since you have identified the solid, liquid, and gas that are found inside and outside the classroom. Now, the following is for you to identify the solids, liquids, and gases. We know that we have moved around in the room. We have mentioned all those materials that are found in the classroom. You also mentioned the materials that are not here. But the materials that you know from home. So, now, there are three columns. As you can see, the first column is for solid materials, the second is for liquid materials, and the third is for gases. Now you look at picture A. You decide if each example is a solid, a liquid, or a gas and then you are going to write it down in the correct column in your table. So, now, look at those objects that are found in your worksheet. Can you read the names of those objects? You will look at the object and read the name orderly. You raise your hand then I will point at you. Yeah, what object (pointing at a learner)?

Learner 6: Cooking oil

Mrs Buthelezi: Yes, there is cooking oil. What else?

Learner 1: Wood.

Mrs. Buthelezi: Wood. Can you all see wood?

Class: Yes

Teacher: Good. What is it that you also see?

Learner 9: Cooking gas

Mrs. Buthelezi: Cooking gas. Yes, Zulu

Learner 12: Rock

Teacher: Yeah, Mpilonhle

Learner 13: Cotton shirt

Mrs. Buthelezi: Cotton shirt, very good. Nkamva

Learner 14: Water

Mrs. Buthelezi: Water. So, now, since you have mentioned and written all the names of those materials. Yes, let us start reading all the names starting with cooking oil. Read.

Learners: Cooking oil, orange juice, wood, plastic bags, cooking gas, rock, tea, steam, water.

Mrs. Buthelezi: OK. Since you have read all those materials, we will start now with the first column for solid material. Look at those materials. Raise your hand if you have seen anything that fits under solid. We are now trying to identify those materials. We will sort them out accordingly. So, look at those materials; which ones fall under solid?

Learners raise their hands while shouting miss and the teacher points to one to respond.

Learner 4: Wood

Teacher: Wood is correct. Which one else? (Teacher points to another learner)

Learner 14: Rock

Teacher: Rock. We know that rock falls under solid.

Learner 3: Cotton shirt

Teacher: Yes, cotton shirt (teacher points to another learner).

Learner 8: Cooking gas

Teacher: Cooking gas.

Learner 1: Plastic pockets

Mrs. Buthelezi: Yes, plastic pockets. So, now, let us move to liquids. (Teacher points at one learner)

Learner 4: Cooking oil

Teacher: Cooking oil. Yes, it falls under the liquid. (Teacher points at another learner)

Learner 14: Water

Teacher: Water is liquid. Good. (Teacher points at another learner)

Learner 11: Tea

Teacher: Yes, there is tea. (Teacher points at another learner)

Learner 5: Orange juice

Mrs. Buthelezi: Orange juice, yes. Now we move to the third column, which is the gas. (Teacher points at another learner).

Learner: Cooking gas

Teacher: Cooking gas, yes.

Learner: Steam

Mrs. Buthelezi: Steam. You see, now they are boiling this water. We know that water is a liquid. Then they boil the water. So now the steam comes out when the water is heated. So, now, look at that worksheet. Every one of us now must fill in that table to show an understanding. You must sort these out accordingly. What you are going to do, are you going to take out your pen? Under solid materials, you look at those materials. You only write the names in the row. Just write below those materials by sorting them accordingly. Write the correct spelling of each material. Look at all those materials; look at the names that are written underneath them and write in every column. You sort them accordingly. So, you must start doing that activity now. Make sure that when you write the material, you check the spelling correctly so that you can be able to write the correct words because it is very important. You read the word; you write it correctly (Learners are busy writing their activity, after which the teacher ends the lesson).

The following analysis can be made from the pre-focus group discussion IBST of Mrs Buthelezi. The teacher conducted a lesson on the states of matter, which included solid, liquid, and gas. The lesson analysis suggested that the teacher used the IBST approach to engage learners in learning about the different states of matter. This was evident as the teacher used a variety of teaching methods, including questioning, and writing on the board, to engage learners in the process of scientific discovery. The teacher also encouraged learners to participate in the lesson by asking questions and calling on individual learners to answer.

The questioning and writing on the board helped learners construct their understanding of the topic and provided opportunities for them to engage with the material in meaningful ways. Mrs. Buthelezi's use of questioning encouraged learners to participate in the lesson, which helped to foster a sense of community and collaboration in the classroom. However, the teacher failed to implement an important aspect of IBST, hands-on activities. Given that this topic is practical, and most students could relate to it, the teacher should have performed some experiments on the various state of matter. This could have encouraged the students to participate in the lesson excitingly.

The findings of this study have several implications for the teaching of science. Firstly, the teacher demonstrated IBST approach can be used to teach a variety of scientific concepts. Secondly, the IBST highlights the importance of hands-on activities, questioning, and writing on the board in engaging learners and helping them construct their understanding of scientific concepts.

#### 6.4.4.2 Mrs Buthelezi's practice of IBST after the FGDP

The previous section reported and analysed how Mrs. Buthelezi practiced IBST in a primary school classroom setting before the focus group discussion program. This section reported and discussed the teacher's practice of inquiry-based science teaching after the focus group discussion programme. The finding described the teaching process and the teacher's use of IBST to engage the learners and assess their understanding of the topic. The report also discussed the findings and the impact of IBST on the learners' understanding of the concept.

The teacher was observed in a science lesson where she taught the three states of matter and asked the learners to identify the different states of matter. The teacher also conducted a group activity where the learners sorted out objects found in a worksheet into solid, liquid, and gas categories. The research was conducted by observing a science classroom in which Mrs. Buthelezi was teaching the concept of the three states of matter. The observation was done during a single session, and the teacher's use of IBST was recorded and analysed. The learners' engagement and understanding of the concept were also assessed during the observation.

In the classroom, Mrs. Buthelezi started by asking the learners about the states of matter that were previously discussed. The teacher then wrote s down the answers (solid, liquid, gas) on the board for the learners to read. The teacher then asked the learners to look around the classroom and mention examples of solid objects. The learners could identify solid objects such as tables, boards, chairs, books, and windows. The teacher then asked the learners to look outside the classroom and identify solid objects such as trees, rocks, and glass. The teacher then encouraged students to look around the classroom and identify things that were solid and later things that were liquid and gas. The learners raised their hands, and the teacher asked them to respond. The teacher acknowledged the learners' responses and added additional information to clarify their understanding of the different states of matter.

The teacher gave the learners worksheets and asked them to sort the examples of solid, liquid, and gas. The learners were asked to identify the objects in the worksheet and decide if each example was a solid, a liquid, or a gas and then write it down in the correct column. The teacher facilitated this process by pointing learners to read the names of the objects and asking for their categorisation as solid, liquid, or gas. The teacher then moved on to the second state of matter, liquid. The teacher asked the learners to give examples of liquids and the learners mentioned water, milk, juice, oil, and drinks. The teacher then explained the concept of the third state of matter, gas, and asked the learners to give examples of gases. The learners mentioned air, the steam from boiling water, and cooking gas. The teacher performed certain experiments, including boiling water, and defrosting ice to demonstrate to the students how one state of matter changes to another state.

The engagement between the teacher and the learners demonstrated that the teacher provided a hands-on approach to learning and ensured that students were actively involved in the learning process. The teacher used the IBST approach to make the lesson more interactive and engaging for students. The teacher's approach allowed learners to learn about the different states of matter by looking around the classroom and outside the classroom and identifying aspects that fall into each category.

The findings of the observation further showed that Mrs. Buthelezi effectively used IBST in the second lesson to engage the learners and assess their understanding of the three states of matter. The teacher used different techniques, such as pointing and questioning, to engage the learners and assess their understanding. The learners could also identify and classify solid, liquid, and gas materials found inside and outside the classroom. The use of IBST by Mrs Buthelezi in the science classroom was found to be engaging and effective in improving the learners' learning and understanding of the concept and helped the learners to better understand the concept of the three states of matter. These findings confirm those of some authors (Capps & Crawford, 2013; Furtak et al., 2012) who showed that inquiry-based science teaching enhances motivation, critical thinking, understanding of a concept, positive attitudes during learning, and science content comprehension.

In conclusion, the teacher's use of the IBST approach was effective in engaging learners in learning about the different states of matter. The hands-on approach allowed learners to understand the concept concretely and encouraged active participation in the learning process. The teacher's use of questioning and acknowledging learners' responses showed that they valued the students' input and were interested in their understanding of the subject. Using the worksheet and inquiry-based science teaching method helped the learners to actively participate in the class and retain the information. This method can be applied to other subjects and topics to make learning more interactive and engaging for the learners. It is recommended that teachers should use IBST in their teaching to engage the learners and improve their understanding of the topics taught in the classroom.

#### 6.4.5.1 Miss Basi’s practice of IBST before the FGDP

This section describes Miss. Basi’s practice of IBST before an intervention programme which was the focus group discussion. The section provided insight into Miss Basi's method of teaching IBST and the effectiveness of the approach in facilitating learning. The study was conducted in a classroom setting. She demonstrated the experiment, and the learners participated in the experiment. Data were collected through observation and video recording. They were analysed qualitatively to determine Miss. Basi’s teaching methods and the effectiveness of the approach in facilitating learning. The paragraphs below provide a comprehensive and detailed description of how Miss. Basi taught her learners before introducing the focus group programme or strategy.

Miss. Basi (talking while writing on the chalkboard): This is a recap to see what we have done. So, tell me, what is a mixture?

Learner 1: Mixtures are two substances that are mixed.

Miss. Basi (talking while demonstrating to the learners): Right. To recap, I am going to take a salt and put it into this beaker, and we will see what happens to it. What is happening to the salt, children?

Learners: Dissolving

Miss. Basi (talking while stirring the mixture in the beaker): Right. Can somebody pick that up and tell me what is happening to the salt? Yes, my girl.

Learners raise their hands and the teacher points to one learner.

Learner 2: The salt is still there, but it will dissolve in the water.

Teacher (talking while carrying the beaker): OK, we can see the salt is still there, but it will dissolve in the water. Now, what else can you say about this salt? If I want to take this salt out, what can I do?

Learners raise their hands and the teacher points to a learner.

Learner 3: We need to place the water in the sun.

Miss. Basi: Yes. Why do we need to place it in the sun?

The teacher points out another learner.

Learner 4: So that it can evaporate.

Miss. Basi: Good. The water is going to evaporate and what will be left there?

Learners: Salt

Teacher (talking while moving around): So now we are together, and we will look at how we purify water. The different ways in which we can purify water to drink. Why is it important for us to drink clean water?

The teacher points out to a learner.

Learner 5: So that we do not get diseases or get sick.

Miss. Basi: Right. So that we do not get diseases and do not get sick. To prevent cramping and dirty water. We are going to try and keep the water clean. Is that not so? So, we have to find ways of investigating how we can clean the water.

Miss. Basi moves around the classroom while talking and calls one learner to stand up and demonstrate to the class.

Miss. Basi: You must look at sieving. So, what are you going to do? We have a small little silk here which I have brought, and we have some dirt. Come, who is going to do this for me? Come stand my boy; let us see what you are going to do.

The boy stands up and demonstrates to the class.

Miss. Basi shows the learner where to stand so that everyone can see the demonstration.

Teacher: You need to stand this way so that everybody can see you. What are we going to do now? Mix. What did you mix in here?

Learner 6: Sand and water.

Miss. Basi: So, now, what are we doing now? You are going to pour. Come to this side and let everyone see. I know it is a bit difficult to see whilst you are sitting, but now let us see what he is doing.

Learner (talking while demonstrating): I am going to pour this water into the sieve.

Miss. Basi (asks questions while the learner is demonstrating): What is happening? Everyone, tell me what you can see happening. But the water, is the water clean?

Learners: No

Miss. Basi: So, it is so dirty. So, we will have to do more. Why does the sand appear to be white? What can you see there? You can see the sand (the teacher picks up the beaker and shows it to the class). It is still inside this water and there is still some dirt. So, would you like to drink this water? (The teacher asks questions while moving around, pointing out learners to respond).

Learners: No

Miss. Basi: Why? Can you tell me why you are not drinking this water? Yes (the teacher points to the learner).

Learner 7: Because it is full of germs.

Miss. Basi: OK, it is full of germs. Next, we will look at another way to clean water, which will be filtering. Who is doing the filtering? Can you show us what you are going to do? Let us take this spoon (the teacher takes the spoon from the beaker) and mix your water and sand. Show us what you have; pick it up and show us.

The learner stands up.

Miss. Basi: What is this (the teacher picks up a filter paper from the beaker)? A filter paper, right?  And what is this (picking up a funnel)? A funnel. Let us see if you can do it now and tell me what happens.

The learner stirs the solution.

Learner: I am stirring the sand and water (demonstrating to other learners the entire process).

Teacher: Yes, Thabiso, what can you say now about this water?

Learner: It is now clean water.

Teacher: But most of the dirt will stay in the filter paper. Is it not?

Learners: Yes

Teacher: So, is that water drinkable?

Learners: No

Miss. Basi: Right, you still cannot drink that water. Let us move to the next one. We have settled. What happens in the beaker?

Leaner: The sand will settle in the water

Teacher: What can you tell me about that water?

Learner: It is clean

Teacher: Is it cleaner than this one here (as the teacher points to another water)?

Learners: No

Teacher: Come on, put your hands up and tell me.

Learners raise their hands and the teacher points to one.

Learner 8: No, it is not clean.

Miss. Basi: Yes, so now, I want you to do this. Let us read what it says. Let us see if you can understand it. What is settling?

Learners take their books to read, and one learner reads out loud.

Teacher: OK, now what experiment are you going to do?

Learner 9: We are going to stir the water.

Teacher: So, we are going to settle; we do not have to stir again. Maybe we can go to the next group that is going to do the decanting. Right, let us look at theirs. Can you explain what you are doing?

Learner 10: I am going to decant the sand and the water.

Teacher: OK, what did we do first?

Learner 10: We settled the water, so now we are going to decant the water.

Teacher: OK, but then did we not mix it first? So now let us see. Take that water, pour it on the other side, and let us see what happens. We are going to do the last task; we are going to decant. Please stand, my girl.

The learner stands up and starts her demonstration while the teacher continues with the lesson.

Teacher: We are now pouring the water and leaving the sand particles at the bottom. Now, let us look at that water. What else can we do? What else can we do to this water so that it can be clean for you to use?

Learner: We can boil the water.

Teacher: OK. You can boil it, good. Why do you want to boil it? Why is it important to boil this water?

Learner: To kill germs

Teacher: Good, to kill germs. Why do you want to kill the germs?

Learner: To not get sick.

Teacher (talks while moving around): Very good. Let us look at this water. If you look at this water and need to use it, can we use it?

Learners: No

Teacher: No, we must make sure that it is clear and clean. So, the next step is to make a sand filter. Then you will see how we can purify the water. Let us write down in our books the activity that follows there and let us see what we have done.

The teacher takes the book and starts reading.

Miss. Basi: It says to answer the group work. You are supposed to answer in groups. Unfortunately, we do not have the time. Now let us look at the activity on page 104. Let us describe what we found in the water now. Let us write it down on page 104, everybody. Investigate different methods to purify water. Let us write that down. It says what did you use? Two glasses, a teaspoon, dirt. Is that what we have done already? So, let us write that down in our books on page 104. The teacher moves around while talking and the learners are busy writing in their books. The lesson ends after the learners finish writing.

Overally, the finding demonstrated the effective use of IBST in teaching learners about the process of purifying water. The hands-on approach and the teacher's role as a facilitator encouraged the students to engage in the scientific process and develop a deeper understanding of the subject matter. From the observation, the following analyses were made. Miss. Basi used hands-on and interactive activities to engage the students in learning the process of purifying water. She used real-life examples and demonstrations to make the concept more relevant and understandable to the students. Miss. Basi used questions to encourage students to think critically and reflect on their learning. The learners were highly engaged and showed enthusiasm during the lesson. The learners were able to apply the concepts they learnt in the lesson to practical tasks and answer questions accurately.

This teaching approach of Miss. Basi was effective in promoting active learning and engagement among learners and developing their scientific inquiry skills. The major concern about the teaching process of Miss. Basi was its inability to exhaust the lesson and the process of purifying water, which left a gap in the learners' understanding. For instance, the concept of stirring was not fully explained and experimented with. In this way, the learners may not have understood the need for stirring in the water purification process. Nonetheless, the findings indicated that Miss. Basi's teaching method was effective in promoting learners' understanding of the concept discussed. Based on the findings of this study, it was recommended that science teachers should continue to receive professional development opportunities to further develop their understanding of IBST and its application in the classroom.

#### 6.4.5.2 Miss Basi’s practice of IBST after the FGDP

This section reported and analysed the post-intervention inquiry-based science teaching session about purifying water of Miss. Basi. She and her learners engaged in a hands-on learning experience involving various methods of purifying water, including dissolving, sieving, filtering, and settling. The session underlined how crucial clean water is and how it can be purified. The inquiry-based teaching method was used during the session. Miss. Basi used a combination of lectures, demonstrations, and hands-on activities to engage the learners in the learning process.

Miss. Basi started the lesson by introducing the concept of mixtures to the learners and engaged them in an inquiry-based science teaching method. She asked questions and guided the learners to understand the process of purifying water. Miss. Basi asked the learners to define a ‘mixture’ and later demonstrated it by putting salt in water. She continued by recapping what a mixture is and demonstrated the process of dissolving salt in water. The learners were then asked to think about what could be done to take the salt out of the water. After that, she explained the importance of drinking clean water and demonstrated different methods of purifying water, including sieving, filtering, and settling. Miss. Basi asked questions to engage the learners and had them explain what was happening to the salt as it dissolved in water. Later, she moved on to the topic of purifying water and asked the learners why it was important to drink clean water. She then demonstrated the different methods of purifying water, including sieving, filtering, and settling.

The learners also demonstrated the process of purifying water using filter paper and a funnel. Finally, the Miss. Basi concluded the demonstration by asking the learners if the water was drinkable. Miss. Basi also ensured that the learners understood the importance of clean water and the dangers of drinking water contaminated with germs. Throughout the lesson, she engaged the learners by asking questions and pointing out one learner at a time to demonstrate each process. Miss. Basi also provided guidance and clarification when necessary and asked questions to encourage the learners to think critically about their observations. The learners actively participated in the demonstration by answering the teacher's questions and demonstrating each process. This teaching approach encouraged the learners to think critically and understand the concepts.

The findings of the inquiry-based science teaching approach of Miss. Basi were analysed and discussed in detail as follows. The learners were able to learn about mixtures, purifying water, and different methods of cleaning water, such as sieving, filtering, and settling. The students were able to see the results of each method and understood the importance of clean water for avoiding diseases and sickness. The demonstration of each method allowed the learners to understand the process and observe the outcome. The learners learnt about mixtures, dissolving, filtering, and settling as techniques for purifying water. For example, sieving showed the learners that not all dirt could be removed from the water while filtering showed them that the water could be cleaned to a certain extent but still had some impurities. The settling method showed the learners that by leaving the water still, the dirt and impurities would settle at the bottom of the beaker, leaving clean water on top. This approach by Miss. Basi demonstrated her ability to implement IBST, which aligned with the view of Minner et al. (2010) that inquiry-based science teaching involves teaching that actively engages learners in the learning process through scientific investigations that are more likely to increase conceptual understanding than strategies that rely on more passive techniques.

Moreover, the learners were able to identify that mixtures are two substances that are mixed and that a mixture of salt and water could be separated through evaporation. The learners understood the importance of drinking clean water and the dangers of consuming contaminated water. In the demonstration of sieving, the learners observed that the water was unclean, and the sand was still visible in the water, indicating that it was not yet safe to drink. The demonstration of the filtering process showed the learners that the water became cleaner by filtering the sand and water mixture, but it was still unsafe to drink.

From the IBST method adopted by Miss. Basi, the learners also understood the importance of clean water and why it is necessary to drink clean water. They saw the results of drinking dirty water, which could be full of germs and cause diseases and sickness. The learners could connect the practical demonstration with real-life scenarios and see the importance of clean water for their health. The inquiry-based teaching approach was effective in helping the learners understand the concepts and encouraged critical thinking and problem-solving skills. By asking questions and encouraging students to participate in the demonstration, she was able to engage the learners and make the learning process more interactive. The hands-on activities encouraged students to engage with the material and think about the presented concepts. The observations demonstrated that the teacher effectively practiced IBST because according to Wilhelm and Beishuize (2003), in the process of IBST, learners carry out a self-directed, partly inductive, and partly deductive learning process by doing experiments to investigate the relations for the least one set of dependent and independent variables. Miss. Basi also used questions to encourage learners to think critically and make connections between their prior knowledge and the new information. This observation was consistent with that of Mäeots et al. (2008) who stressed that inquiry-based science teaching can improve different inquiry skills, such as identifying problems, formulating questions and hypotheses, planning and carrying out experiments, collecting and analysing data, presenting the results, and drawing conclusions. It was evident that the inquiry-based teaching method allowed learners to explore and experiment with different techniques for purifying water.

In conclusion, the inquiry-based science teaching was successful in helping the learners understand the concepts of mixtures, purifying water, and the different methods of cleaning water. The practical demonstration allowed the learners to observe the outcome and understand the importance of clean water for their health. The inquiry-based approach to teaching science is effective in promoting learner learning and provides learners with hands-on experience in problem-solving and critical thinking. It is recommended that inquiry-based science teaching sessions continue to be used to educate learners about important issues such as access to clean water. The inquiry-based teaching method used in the session can be applied to other science topics to engage learners in learning and promote critical thinking and problem-solving skills.

### 6.5 Chapter summary

In Chapter 6, the focus is on synthesising the findings related to how natural science teachers understand and practice IBST in grades 6 and 7. The chapter highlights the diverse interpretations of IBST among teachers, emphasizing the significance of their pedagogical beliefs and prior experiences in shaping their instructional practices. Through qualitative analysis of interviews and classroom observations, key themes emerged, including the challenges teachers face in fostering a learner-centered learning environment and the strategies they employ to engage learners in inquiry. Additionally, the chapter discusses the role of professional development in enhancing teachers' understanding and implementation of IBST, as well as the impact of institutional support on their teaching efficacy. Ultimately, this chapter underscores the necessity for ongoing training and resources to empower teachers to effectively adopt IBST approaches, thereby enriching the educational experiences of their students in natural science.

# CHAPTER SEVEN
# FACTORS INFLUENCING TEACHERS' IBST PRACTICE

## 7.1 Introduction

Inquiry-based science teaching is an approach that promotes active learner engagement and exploration, where learners develop their understanding through questioning, investigation, and reflection. The previous chapter presented the results and discussions on how teachers practised IBST in a classroom setting before the focus group discussion intervention programme. In addition, the chapter presented the teachers' practice of IBST in a classroom after an intervention strategy or programme through a focus group discussion and training. This chapter analysed and evaluated the factors influencing natural science teachers' practice of IBST. This was achieved through a questionnaire response from selected natural sciences teachers. Five teachers were interviewed to offer an in-depth understanding of the factors that affected how they practised IBST.

## 7.2 Questionnaire and interview results on the factors that affect teachers' IBST practice

This section describes the teacher's view on the factors that affect how teachers teach natural sciences in class. The results were based on the analysis of the data obtained from the questionnaire. To do this, a set of assertions was presented to the participants, asking them to explain how each affected or limited the way they taught natural science in the classroom. The exact question posed was: How much do you think the following influences or restricts the way you teach science classes? Participants were asked to score how each of the twelve assertions in this question affected the way they teach natural sciences. A three-point rating system, with 1 meaning not at all, 2 signifying quite a bit, and 3 signifying rather substantially, was to be used to rate the statements. Table 7.1 presents the findings of the variables influencing natural sciences teachers' methods of teaching.

**Table 7.1 Factors that affect the teaching methods of NST**

| Learner actions | Mr. G | Mrs. Z | Miss. S | Mrs. B | Miss. B |
|---|---|---|---|---|---|
| Academic abilities of learners | 2 | 2 | 2 | 2 | 2 |
| Background of learners | 1 | 1 | 1 | 1 | 1 |
| Interested of learners | 1 | 2 | 3 | 2 | 2 |
| Needs of learners | 3 | 3 | 3 | 3 | 3 |
| Disruptive learners | 2 | 2 | 3 | 3 | 2 |
| Other instructional equipment for learners' use | 3 | 3 | 3 | 2 | 3 |
| Equipment for demonstrations and other exercises | 2 | 3 | 2 | 3 | 3 |
| Learner/teacher ratio | 1 | 3 | 2 | 1 | 2 |
| Performance of learners in projects or laboratory exercises | 2 | 3 | 2 | 3 | 2 |

The participants were first asked to indicate whether learners' academic abilities affect how they teach natural sciences. This result suggested that learners' academic abilities moderately affect how the participants teach natural sciences. Table 7.1 further showed the results concerning whether learners' backgrounds affect how the teachers teach natural sciences. The outcome suggested that the background of the learners did not affect the way the teachers teach natural science at all. There was agreement among the participants on the extent to which the interest of learners affects the way they teach natural science. This result showed that most of the participants indicated that learners' interests somehow affected how they taught natural sciences.

Teachers also need an organised and disciplined class to discharge their teaching responsibilities efficiently. As a result, the teachers were asked to indicate whether disruptive learners affect how they teach natural sciences. As expected, this result indicated that disruptive learners sometimes affect how they teach natural sciences. In addition, the result showed that the availability of other instructional equipment for learners' use influences the way they teach natural sciences. This response item suggested that the availability of equipment for demonstrations and other exercises greatly affects how they teach natural sciences.

The study further ascertained whether the learner/teacher ratio affects the way they teach natural sciences. The result, as shown in Table 7.1, indicated a general disagreement among the participants that the learner/teacher ratio affected the way they taught natural sciences. This result was unsurprising because a large class size would affect the teachers' ability to attend to the needs of each learner. On the other hand, small class sizes would positively influence how teachers teach natural sciences because they can attend to the idiosyncratic needs of the learners. There was agreement among the participants on the extent to which learners' performance in projects or laboratory exercises affects how they teach natural sciences. This result showed that many of the participants indicated that learners' performance in projects or laboratory exercises affects the way they teach natural sciences quite a bit.

In addition, the participants suggested that learners' responses in class affect how they teach natural sciences. Here, the result suggests that learners' responses in the class affect the way the teachers teach natural sciences quite a bit. The study further found a general agreement among the participants that the observations of learners in the class somehow affected how they taught natural sciences. Finally, Table 7.1 revealed that the availability of physical facilities in class affected how they teach natural science. The availability of physical facilities in class has had a great influence on how they taught natural sciences.

The results of this research had several implications for science teachers and education policymakers. Firstly, teachers should consider the importance of learner motivation and engagement when designing and implementing inquiry-based science teaching. They should strive to create lessons that capture learners' interests and encourage active participation. Secondly, teachers should ensure that they have access to adequate instructional equipment and physical facilities to support inquiry-based science teaching. Policymakers should also invest in ensuring that schools have the necessary resources to support effective science teaching. Thirdly, teachers should receive training on managing disruptive behaviour in the classroom and strategies to optimise teaching methods in the context of the learner/teacher ratio.

This research interview was aimed at exploring the impact of learner characteristics on the way natural sciences teachers practise inquiry-based science teaching. The insights shared by five teachers provided valuable perspectives on the various factors that shape teachers' IBST instructional strategies and approaches. The responses showed that teachers' practice of IBST is influenced by various factors, including the knowledge and experience of the teachers, the availability of classroom resources, the school culture, the characteristics of the learners, class size, school culture, professional development opportunities, learners' response, and performance of students. The following sections presented the factors that influence the way teachers practise IBST from the interview responses.

### 7.3 Teachers' knowledge and experience

This section focused on the impact of knowledge and experience on their IBST practice. The analysis and discussion of the teachers' responses shed light on how their knowledge and experience influenced their practice of inquiry-based science teaching. Mr. Govender emphasised the significance of an extensive background in science, which allowed him to develop a deep understanding of the material. He responded that this knowledge formed the foundation for designing inquiry-based lessons that were engaging and effective. The following was the quotation from Mr. Govender:

> *My extensive background in science has allowed me to develop a deep understanding of the material, which in turn allows me to design inquiry-based lessons that are engaging and effective.*

As for Mrs. Zwane, drawing from her experience with inquiry-based teaching helped her recognise the importance of active learner engagement in the learning process. This understanding influenced the way she designed lessons and interacted with her learners. In her words, Mrs Zwane stated:

> *My experience with inquiry-based science teaching has taught me that learners learn best when they are actively engaged in the learning process. This knowledge has influenced the way I design my lessons and interact with my learners.*

Similarly, Miss. Solai highlighted the impact of experience in inquiry-based science teaching on her lesson structure and feedback provision. Through experience, she indicated that she had learnt the importance of scaffolding and supporting learners as they navigate through the material. This knowledge guided her instructional decisions, ensuring that learners received the necessary guidance to succeed in inquiry-based learning. The following quotation was attributed to Miss. Solai about the subject matter:

*My experience with inquiry-based science teaching has taught me the importance of scaffolding and providing support for learners as they work through the material. This knowledge has influenced the way I structure my lessons and provide feedback to my learners.*

Mrs. Buthelezi brought attention to the influence of knowledge of different learning styles and learners' information processing on instructional design. She responded that she incorporated various modalities of learning into her lessons, which catered to her learners' diverse needs. In responding to this item, Mrs Buthelezi stated:

*My knowledge of different learning styles and how learners process information has influenced the way I design inquiry-based lessons. I try to incorporate different modalities of learning into my lessons to cater to the diverse needs of my learners.*

Miss Basi also emphasised the role of reflection and self-evaluation in improving IBST practice. She responded that her experience with inquiry-based teaching has taught her the importance of seeking feedback from learners and colleagues, leading to continuous improvement in their instructional approaches. The following quotation is attributed to Miss. Basi:

*My experience with inquiry-based science teaching has taught me the importance of reflection and self-evaluation. I constantly seek feedback from my learners and colleagues to improve on my teaching practice.*

Overall, the analysis revealed that teachers' knowledge and experience influence their practice of IBST by guiding instructional design, promoting active engagement, providing support and scaffolding, considering learning styles, and fostering reflection and self-improvement. The findings from the teachers' responses provided valuable insights into the impact of knowledge and experience on IBST. The teachers' extensive background in science, as highlighted by Mr Govender, equips them with a deep understanding of the subject matter. This knowledge allows them to design inquiry-based lessons that are engaging and effective, providing learners with meaningful learning experiences. Mrs Zwane's recognition of the importance of active learner engagement aligns with research findings that suggest that learners learn best when they are actively involved in the learning process (Wenning, 2005). Teachers can enhance learner understanding and promote scientific inquiry by incorporating interactive and hands-on activities.

On the other hand, Miss. Solai's emphasis on scaffolding and support reflects the importance of guiding learners through the inquiry process. This is particularly important because teachers with experience in IBST recognise that learners may require varying levels of assistance as they navigate scientific concepts and investigations. Providing appropriate scaffolding helps learners develop their inquiry skills and gradually become more independent in their learning. This aligned with research indicating that well-structured and supportive learning environments promote learner achievement and engagement (Wenning, 2005). Similarly, Mrs. Buthelezi's consideration of different learning styles and information processing reflects the recognition that learners have diverse needs and preferences in how they learn. By incorporating multiple modalities of learning, teachers can create inclusive learning environments that cater to the varied learning styles of their learners. This approach promotes equity and ensures that all learners have opportunities to engage meaningfully with the content. It is also interesting to note that Miss Basi focused on reflection and self-evaluation, which highlighted the importance of continuous improvement in IBST. By seeking feedback from learners and colleagues, teachers can identify areas for growth and refine their instructional practices. This reflective approach could foster professional development and enhance the quality of teaching. The discussion of these findings underscores the multifaceted nature of IBST. It requires a deep understanding of the subject matter and the ability to design engaging lessons, promote active learner engagement, provide the necessary support, consider diverse learning styles, and engage in reflective practice. The teachers' knowledge and experience are crucial factors in shaping their instructional approaches and contributing to the effectiveness of inquiry-based science teaching.

The implications of the teachers' responses are significant for both current and future practitioners of IBST. Firstly, it highlights the importance of professional development and continuous learning for teachers. Building a strong foundation of subject knowledge and staying updated with current scientific advancements are vital for designing effective inquiry-based lessons. Teachers should actively seek opportunities to expand their knowledge through professional development programmes, workshops, and collaborations with colleagues. Additionally, the teachers' emphasis on active learner engagement, scaffolding, and support underscores the need for educators to adopt a learner-centred approach. Teachers should provide guidance, resources, and scaffolds to facilitate learner inquiry and investigation. Creating a supportive learning environment allows learners to develop critical thinking skills, problem-solving abilities, and a deeper understanding of scientific concepts.

The consideration of diverse learning styles and learning modalities is another crucial implication of the teachers' responses. In a diverse classroom, teachers should ensure that their instructional approaches cater to learners' varied needs and preferences. This may involve incorporating visual aids, hands-on activities, technology, group work, and other strategies to create a rich and inclusive learning experience for all learners. Moreover, the importance of reflection and self-evaluation highlighted by Miss. Basi suggested that teachers should continuously reflect and seek feedback from learners and colleagues. This reflective practice would enable teachers to identify areas of improvement, refine their instructional strategies, and enhance their overall teaching effectiveness. In this case, professional learning communities, mentoring relationships, and collaboration with colleagues can provide valuable opportunities for teachers to engage in reflective discussions and receive constructive feedback.

### 7.4 Classroom resources availability and its effect on IBST

The responses from the teachers highlighted the significant role of classroom resources in shaping their practice of IBST. The teachers emphasised that well-equipped laboratories, technology, and relevant teaching materials are crucial in designing lessons that incorporate hands-on experiments and investigations. They indicated that these resources encourage active learner participation, as learners are encouraged to ask questions and actively pursue answers. For instance, Mrs. Buthlezi shared:

> *Classroom resources play a significant role in shaping my inquiry-based science teaching practices. When I have access to well-equipped laboratories, technology, and relevant teaching materials, I can design lessons that incorporate hands-on experiments and investigation, which encourage learners to ask questions and pursue answers actively. For example, when I have access to microscopes, learners can explore microscopic organisms and conduct experiments to understand the differences between various cell types.*

The teachers further emphasised the importance of a diverse collection of plants and animals and materials such as magnets, circuits, and lenses in providing inquiry-based learning opportunities. These resources allow learners to observe and learn about the diversity of life, its evolution, and its adaptations to the environment. Additionally, they enable learners to design their experiments and investigate the properties of various materials, fostering hands-on exploration and scientific inquiry. Mrs. Zwane explained:

*Resources are essential for me to provide inquiry-based learning opportunities to my learners. For instance, when I have a diverse collection of plants and animals, learners can observe and learn about the diversity of life, its evolution, and its adaptations to the environment. Similarly, when I have access to a range of materials such as magnets, circuits, and lenses, students can design their experiments and investigate the properties of these materials.*

Mr Govender also acknowledged the motivational and engaging aspects of classroom resources in inquiry-based science teaching. He highlighted using simulation software, which provides learners with opportunities to conduct virtual experiments. This enables them to test hypotheses and enhance their understanding of scientific concepts without the associated risks of conducting experiments in a physical laboratory. According to Mr Govender, these resources provide a safe and interactive learning environment, promoting learner engagement and exploration. He stated that:

*Classroom resources are an essential tool for IBST. They can motivate and engage learners in learning scientific concepts and ideas. For instance, when I have access to simulation software, learners can conduct virtual experiments, which allows them to test their hypotheses and develop their understanding of scientific concepts without any risks involved.*

The teachers further emphasised the significance of classroom resources in inquiry-based science teaching. He stressed that resources such as lab equipment, books, computer software, and science kits are essential for learners to actively explore scientific ideas and concepts. The teachers highlighted those learners can learn science by doing science, and actively engaging in experiments and investigations when they have access to adequate resources. These resources would foster hands-on learning experiences and support learners in developing their understanding of scientific phenomena. In addition to this point, Miss. Solai stated:

"*Classroom resources are a vital element of inquiry-based science teaching. They provide the materials and tools necessary for learners to explore scientific ideas and concepts. When I have access to adequate resources, such as lab equipment, books, and computer software, learners can learn science by doing science. For instance, when I have access to science kits, learners can use them to perform experiments, which allows them to develop their understanding of scientific phenomena.*

The teachers' responses underscored the crucial role of classroom resources in facilitating IBST. This suggests that the availability of well-equipped laboratories, technology, and relevant teaching materials empowers teachers to design lessons that encourage active learner engagement and inquiry. Using resources such as microscopes, diverse plant and animal collections, and materials like magnets, circuits, and lenses allows learners to explore scientific concepts through first-hand experiences. Similarly, the responses highlight that access to appropriate resources enables teachers to create a learning environment that fosters scientific inquiry, critical thinking, and problem-solving skills. Teachers can facilitate hands-on experiments, investigations, and discovery by providing students with the necessary tools and materials. These experiences would not only enhance learners' understanding of scientific concepts but also promote a deeper appreciation of the scientific process and the importance of evidence-based reasoning.

The insights gained from the teachers' responses have several implications for practice. Firstly, they highlight the importance of adequate funding and resources for schools and educational institutions in South Africa. Ensuring that classrooms are equipped with the resources required for inquiry-based science teaching is essential. Additionally, schools, SGBs, and policymakers should prioritise allocating sufficient funds to provide well-equipped laboratories, technology, and relevant teaching materials. This will enable teachers to create engaging and interactive learning experiences that promote scientific inquiry and learner-centred learning.

Additionally, professional development programmes should include training on using and maximising the potential of classroom resources in IBST. Teachers should be provided with opportunities to learn about new technologies, instructional materials, and strategies for incorporating hands-on experiences into their lessons. Teachers can enhance their teaching approaches and create dynamic learning environments by staying informed about the latest resources and best practices.

Another implication is the need for collaboration and resource sharing among educators. Teachers can benefit from sharing their expertise, experiences, and available resources with colleagues. Collaboration can occur within schools, across schools, or even through online platforms. By fostering a culture of collaboration, teachers can expand their resource pool, access a broader range of materials, and learn from each other's successful practices. This collective effort can improve IBST practices and enhance learner-learning outcomes.

## 7.5 School culture and its effects on the way teachers practice IBST

The teachers' responses suggested that the schools' culture affects how they practise IBST. The section analysed the perspectives the teachers shared regarding school culture's impact on their teaching approaches. Teacher responses emphasised the role of school culture in providing the freedom and support necessary for innovative teaching practices. The responses highlighted that teachers are empowered to try new teaching techniques and develop inquiry-based science lessons when the school culture encourages experimentation and collaboration. This suggests that a positive and supportive school culture can facilitate the implementation of inquiry-based teaching practices. This impact of school culture on teachers' practice of IBST was emphasised by Mrs Zwane in the following statements:

> *School culture has a significant impact on the way I practise inquiry-based science teaching. If the school culture is supportive of innovation and experimentation in teaching practices, it provides me with the freedom to try new teaching techniques and explore new methods of IBST. For instance, my school encourages collaboration among teachers. In this way, I can work with my colleagues to develop and refine our inquiry-based science lessons.*

From a different perspective, Miss. Basi highlighted the relationship between school culture and the availability of resources. She added that, if the school values and supports inquiry-based science teaching, it is likely to invest in providing teachers with the necessary resources such as laboratory equipment, technology, and professional development opportunities. This connection between school culture and resources suggests that a school's commitment to inquiry-based teaching extends beyond philosophical alignment and encompasses tangible support. Miss. Basi expounded:

> *School culture can also impact the resources that are available to me as a science teacher. If the school values inquiry-based science teaching, it may invest in providing me with the necessary resources such as laboratory equipment, technology, and professional development opportunities. This would allow me to better facilitate inquiry-based learning experiences for my learners.*

Mrs Buthelezi also drew attention to the challenges a school culture poses by focusing on standardised testing and rote memorisation. The teacher maintained that it may be difficult for teachers to fully incorporate IBST in such a culture. However, the teacher acknowledged the need for creativity and adaptation to provide meaningful learning experiences for learners while navigating the demands of the school culture. This suggests that even in less supportive school cultures, teachers can find ways to integrate inquiry-based approaches, albeit with additional effort and adaptation. The following quotation is linked to Mrs Buthlezi on this subject:

> *On the other hand, if the school culture is focused solely on standardized test scores and rote memorisation, it may be challenging to incorporate inquiry-based teaching practices. In such situations, I would need to be creative and find ways to adapt inquiry-based teaching techniques to meet the demands of the school culture while still providing meaningful learning experiences for my learners.*

Miss. Solai brought attention to the influence of school culture on student attitudes and expectations towards IBST. She spelt out that a school culture that values and promotes inquiry-based learning can nurture curiosity and excitement among learners. This positive attitude towards inquiry-based approaches can lead to more engaged and motivated learners willing to take risks and explore new ideas. Therefore, the teacher underscored that school culture is crucial in shaping students' receptiveness to inquiry-based teaching methods through the following quotation.

> *The school culture can also influence the attitudes and expectations of learners towards inquiry-based science teaching. If the school culture values and encourages inquiry-based learning, it can foster a sense of curiosity and excitement among students, making them more receptive to the teaching approach. This can lead to more engaged and motivated learners who are willing to take risks and explore new ideas.*

Lastly, the teachers highlighted the importance of administrative and colleague support within the school culture. Their point was that when the school culture values and supports IBST, administrators, and colleagues are likely to provide feedback, encouragement, and collaboration opportunities. They stressed that this support could help teachers refine their teaching techniques and improve learner outcomes. Thus, a positive school culture that fosters collaboration and support can contribute to the success of inquiry-based teaching practices.

The responses from the teachers highlight the significant influence of school culture on the way they practise IBST. The consensus among the teachers was that a positive school culture that supports innovation, collaboration, and the allocation of resources can create an environment conducive to the successful implementation of inquiry-based teaching practices. Such a culture empowers teachers, fosters their professional growth, and provides the necessary tools and support to engage students in meaningful scientific inquiry. Conversely, the responses suggested that a school culture focused on standardised testing and memorisation can challenge teachers aiming to incorporate inquiry-based approaches. In such cases, teachers need to adapt their teaching techniques to meet the demands of the school culture while still providing authentic and meaningful learning experiences. This underscores the importance of teacher creativity and resilience in overcoming obstacles and promoting inquiry-based science teaching within less supportive school cultures.

The implications of these findings are significant for various stakeholders in the education system in South Africa. Firstly, it shows that school administrators and policymakers should recognise the critical role of school culture in shaping teaching practices and learner outcomes. They should strive to foster a positive school culture that values inquiry-based learning and provide teachers with the necessary resources and support to implement such practices effectively. Similarly, the Provincial Department of Education, school leaders, and administrators can promote a supportive school culture by recognising and celebrating teachers' efforts in implementing IBST. Providing platforms for teachers to share their successes, challenges, and best practices can inspire and motivate others to adopt similar approaches. Additionally, creating opportunities for interdisciplinary collaboration and project-based learning can further foster a culture of IBST within the school.

### 7.6 Background and characteristics of learners and the way they affect IBST

The interview response further showed that the learners' background and related characteristics affected how the natural sciences teachers practise IBST. The paragraphs below presented and discussed the insights shared by five teachers; it provided valuable perspectives on how learner characteristics shape teachers' IBST instructional strategies and approaches.

The teachers emphasised the importance of considering learners' curiosity and exploration tendencies when designing inquiry-based activities. The teachers reported that tailoring learners' learning experiences to match their natural inclinations could enhance learner engagement and foster independent investigation. However, Mr. Govender also acknowledged the need to provide additional support for learners who struggle with science, highlighting the importance of scaffolding and step-by-step guidance in the inquiry process. Mr Govender elucidated:

*Learner characteristics play a significant role in shaping my inquiry-based science teaching practices. For instance, if I have a class that consists of learners who are highly curious and enjoy exploring, I would structure the activities to give them ample opportunities to ask questions, design experiments, and investigate concepts independently. However, if I have learners who struggle with science, I would need to take a more scaffolding approach to inquiry-based science teaching, breaking down the content into smaller chunks and guiding them through the inquiry process step by step.*

Mrs Zwane also highlighted the significance of learner diversity in shaping inquiry-based science teaching practices. The teacher stressed that by recognising and accommodating different learning styles and abilities, teachers can create inclusive learning environments where all learners can access meaningful inquiry experiences. Accordingly, the teacher elucidated as follows:

*The characteristics of my learners are critical in shaping my inquiry-based science teaching practices. For example, if my class has learners with diverse learning styles and abilities, I would need to provide multiple entry points and differentiation in the inquiry activities to accommodate their varied needs. I might incorporate visual aids, group work, and hands-on activities to cater to visual and auditory learners.*

The teachers further highlighted the impact of language proficiency on IBST. They reported that learners who are not good at the English Language require additional support in comprehending scientific concepts. Providing visuals, hands-on activities, and real-world examples can enhance their understanding and help bridge the language barrier. Furthermore, Miss. Solai indicated that encouraging collaborative work among learners allows them to develop their language skills while engaging in scientific inquiry. She responded as follows:

*When it comes to inquiry-based science teaching, the characteristics of my learners play a vital role. For instance, if I am teaching a class with a high number of English Language Learners, I would need to provide more visuals, hands-on activities, and real-world examples to support their understanding. Additionally, I would encourage learners to work in pairs or small groups to help them build their language skills and collaborate with their peers.*

Furthermore, the teachers acknowledged the influence of learner attention and focus on inquiry-based teaching. Miss. Solai retorted that learners who struggle with attention might require specific strategies to maintain their engagement throughout the inquiry process. Miss. Solai emphasised as follows:

> *Learner characteristics play a crucial role in shaping my inquiry-based science teaching practices. For example, if my class has learners who struggle with attention and focus, I would need to structure the inquiry activities in a way that maintains their engagement and motivation. I might include opportunities for movement and exploration and frequent check-ins to ensure they are following the inquiry.*

The teachers further stressed that understanding the backgrounds and characteristics of their learners is essential for effective inquiry-based science teaching. Mr. Govender illustrated:

*When teaching learners with special needs, I make adaptations and modifications to ensure their full participation and engagement in the inquiry process. I may provide additional support, modify the materials or activities, or use assistive technology to accommodate their individual needs.*

The insights provided by the teachers highlight the intricate relationship between learner background and characteristics and IBST. The backgrounds encompass various aspects such as cultural, linguistic, socio-economic, and special needs considerations. Each teacher recognised the importance of addressing these factors to create an inclusive and effective learning environment. The teachers' responses suggest that effective implementation of IBST requires teachers to be responsive to their learners' diverse needs, abilities, and interests. Teachers can tailor their instructional strategies to optimise learner engagement and learning outcomes by understanding and considering these characteristics. One key aspect that emerges from the teachers' responses is the importance of differentiation in inquiry-based science teaching. Recognising and accommodating different learning styles, abilities, and language proficiency levels is crucial in ensuring equitable access to inquiry experiences. In addition, the responses demonstrate that providing multiple entry points, incorporating various instructional approaches, and offering support systems can help address the diverse characteristics of the learners in the classroom.

The teachers’ responses also highlighted the need for flexibility and adaptability in IBST. This point is crucial because learner characteristics are not fixed but can vary from one class to another and even within the same class. Therefore, teachers must be prepared to modify their instructional strategies based on the learners' specific needs. This requires ongoing assessment, reflection, and adjustment to ensure that inquiry-based teaching remains effective and responsive to the evolving characteristics of the learner population.

The findings from the interview response have several implications for IBST. Firstly, teacher professional development programmes should include training on learner-centred approaches that address diverse learner characteristics. Teachers need support in developing strategies for differentiation, scaffolding, and creating inclusive learning environments that foster inquiry and exploration. Secondly, the curriculum design should consider the diverse characteristics of learners to ensure that IBST aligns with their needs and abilities. This may involve providing various resources, materials, and instructional approaches that cater to different learning styles, language proficiency levels, and attention spans.

Furthermore, the findings emphasise the importance of learner engagement and motivation in inquiry-based science teaching. Teachers should design activities that align with learners' interests, curiosity, and exploration tendencies. Creating a positive and stimulating learning environment makes learners more likely to participate actively in the inquiry process and develop a deeper understanding of scientific concepts. The responses suggest that the socio-economic backgrounds of learners impact the availability of resources and materials for inquiry-based science teaching. Given this, teachers should adapt their practices to ensure that all learners have access to hands-on learning experiences regardless of their economic circumstances. This may involve using low-cost materials, household items, or alternative approaches that utilise readily available resources. By considering the socio-economic backgrounds of learners, teachers promote equity and inclusion in science education.

The implications also extend to assessment practices. Inquiry-based science teaching requires teachers to assess learner learning in a manner that reflects the process-oriented nature of the inquiry. Assessments should focus on the outcomes and the learner's ability to ask questions, design, and conduct experiments, analyse data, and communicate their findings. Teachers need training and support in developing authentic and meaningful assessment strategies that align with the goals of inquiry-based teaching.

## 7.7 Teacher professional development and its effect on IBST practice

The responses from the five teachers provided valuable insights into the impact of teacher professional development on IBST practices. Several key themes emerged from their responses, including staying current with research and trends, refining teaching strategies, gaining new perspectives, collaborating with peers, and self-reflection for continuous improvement.

Mr. Govender highlighted the importance of professional development in keeping up with the latest research and trends. This demonstrates a commitment to ongoing learning and professional growth. The teacher asserted that he could integrate new approaches into their IBST practice by attending workshops and staying informed. This reflects a proactive approach to enhancing instructional strategies. Mr Govender remarked:

> *Professional development opportunities help me stay current with the latest research and trends in inquiry-based science teaching. For example, I recently attended a workshop on using modelling in science education, and I have since incorporated modelling activities into my lessons.*

Similarly, Mrs. Zwane emphasised the role of professional development in refining IBST techniques. The following statement from Mrs Zwane supports his assertion:

> *Professional development helps me refine my inquiry-based teaching strategies and techniques. For instance, I recently attended a training on the 5E model of instruction, which helped me structure my lessons more effectively and engagingly.*

The *t*eachers further highlighted the value of professional development in expanding perspectives and incorporating diversity into IBST. They asserted that attending conferences, workshops, and seminars helps create an inclusive learning environment. By incorporating diverse perspectives and experiences, teachers could make science education relevant and meaningful for all learners. Miss Solai explained:

> *Professional development provides me with new ideas and perspectives on inquiry-based teaching. For example, I recently attended a conference on culturally responsive teaching, which inspired me to incorporate more diverse perspectives and experiences into my lessons.*

Apart from the highlighted points, the teachers emphasised the collaborative aspect of professional development. They suggested that participation in a teacher-led professional learning community allows them to share ideas, lesson plans, and feedback. This collaborative approach fosters a supportive environment where teachers can learn from one another's successes and challenges. For instance, Mrs. Buthlezi asserted that collaboration promotes professional growth and the exchange of best practices for IBST by sharing that:

> *Professional development allows me to collaborate with other teachers and share best practices for inquiry-based teaching. For instance, I recently participated in a teacher-led professional learning community where we shared lesson plans, feedback, and ideas for inquiry-based teaching.*

The responses from the teachers indicate that professional development plays a significant role in shaping their inquiry-based science teaching practices. Teachers gain the knowledge, skills, and resources necessary to effectively implement inquiry-based teaching methods by engaging in professional development opportunities. Professional development is a significant factor that could influence the teachers' practice of IBST because it helps teachers stay current with research and trends in inquiry-based science teaching. Science education is a dynamic field, with discoveries and pedagogical approaches emerging regularly. Hence, teachers can update their knowledge and incorporate evidence-based practices into their teaching by attending workshops, conferences, and training sessions. This ensures that learners receive instruction that aligns with current understandings of scientific inquiry.

The implications of teacher professional development for inquiry-based science teaching are significant. Firstly, professional development allows teachers to refine their inquiry-based teaching strategies and techniques. Through training and learning opportunities, teachers can deepen their understanding of effective instructional models and methods. They can learn how to structure inquiry-based lessons, design meaningful assessments, and facilitate learner engagement. This professional growth enhances the quality of IBST and improves learner-learning outcomes. Furthermore, professional development provides teachers with new ideas and perspectives on inquiry-based teaching. By exposing teachers to diverse teaching philosophies, approaches, and cultural perspectives, professional development fosters creativity and innovation. With professional development opportunities, teachers would be encouraged to explore alternative strategies and adapt their teaching to meet the needs of diverse student populations. This would broaden the scope of inquiry-based teaching and promote inclusive and culturally responsive science education.

Collaboration with peers is another significant benefit of professional development. Through collaborative professional learning communities, teachers can share experiences, exchange ideas, and receive feedback from fellow teachers. This collaborative environment can nurture a culture of continuous improvement and encourages teachers to learn from one another's successes and challenges. Collaborative professional development provides a supportive network of educators who can inspire and support one another in implementing IBST.

When teachers actively participate in professional development opportunities, they enhance their knowledge, skills, and confidence in implementing inquiry-based teaching methods. This, in turn, positively impacts learner learning experiences and outcomes. Teachers create a classroom environment that fosters curiosity, critical thinking, and scientific inquiry by staying current with research and trends, refining teaching strategies, incorporating diverse perspectives, collaborating with peers, and engaging in self-reflection.

## 7.8 Learner/teacher ratio and its influence on teachers' practice of IBST

One significant factor explored in this study was the learner/teacher ratio, which refers to the number of learners per teacher in a classroom setting. By examining the perspectives of five teachers, this section provided insights into the impact of the learner/teacher ratio on how teachers practised IBST. Firstly, Mr. Govender emphasised the significant impact of the learner/teacher ratio on their ability to provide individualised attention and guidance during inquiry-based science activities. He stated,

> *The learner/teacher ratio has a significant impact on my ability to provide individualized attention and guidance to learners during inquiry-based science activities. When I have a larger class size, I often must rely more heavily on group work and collaborative learning, which can limit opportunities for independent exploration and discovery.*

This statement highlights the challenge of catering to learners' individual needs in larger classes. The teacher further explained his approach, stating:

> *For instance, when teaching a class of 40 learners, I divide them into groups of 5 to ensure they get enough attention.*

This strategy demonstrated the teacher’s efforts to ensure that the learners received adequate support despite the limitations imposed by a higher learner/teacher ratio.

Mrs Zwane also considered the learner/teacher ratio as a critical factor for successful IBST. She asserted that:

> *The learner/teacher ratio is a critical factor in the success of IBST. In my experience, smaller class sizes allow for more hands-on experimentation, one-on-one discussions, and personalised instruction.*

This statement emphasises the advantages of smaller class sizes in facilitating deeper engagement and personalised interactions. The teacher provided an example of his instructional approach, explaining.

*For example, when I teach a class of less than twenty learners, I encourage them to bring their questions to me for further guidance.*

This approach highlights the opportunities that a reduced learner/teacher ratio provides to address individual questions and provide tailored support.

Miss Solai presented a perspective that acknowledged the positive and negative effects of the learner/teacher ratio on IBST. The teacher opined:

> *The learner/teacher ratio can have both positive and negative effects on inquiry-based science teaching.*

The teacher elaborated:

> *While smaller class sizes can provide more individualised attention, larger class sizes can also facilitate more group discussions and collaboration.*

This statement recognised the potential benefits of both smaller and larger class sizes. The teacher further explained her approach to addressing the challenges of larger class sizes, claiming:

> *When teaching larger classes, I often use technology and project work to supplement my instruction and provide additional support. For example, I have created for learners where learners meet, ask, and answer each other's questions.*

This strategy demonstrated their effort to foster learner collaboration to compensate for the limitations of larger learner/teacher ratios.

Mrs. Buthlezi also recognised the significance of the learner/teacher ratio, noting*:*

*The learner/teacher ratio plays a significant role in the way I practise inquiry-based science teaching. With a low ratio, I can provide more personalised attention to learners and have more meaningful interactions with them.*

This response suggested that the teacher valued the benefits of a low ratio, such as the ability to engage learners through thought-provoking questions and encourage deeper exploration. The teacher found that learners are likely to engage in inquiry-based learning and develop a deeper understanding of science concepts in such circumstances.

Moreover, Miss. Basi focused on the impact of the learner-to-teacher ratio on the accurate assessment of learner learning, expressing:

> *The learner/teacher ratio affects my ability to assess learner learning accurately in inquiry-based science teaching. With a high ratio, it becomes more difficult to monitor each learner's progress and understanding of scientific concepts. As a result, I may not be able to provide sufficient feedback to help students improve their inquiry-based skills, leading to lower personalization.*

The teacher’s response highlights the challenges of assessing individual student progress and providing targeted feedback when facing a high learner/teacher ratio.

The perspectives shared by the five teachers provided valuable insights into the influence of the learner/teacher ratio on the practice of inquiry-based science teaching. The teachers’ experiences demonstrate that larger class sizes can limit individual attention and the opportunity for independent exploration. In such cases, group work becomes a necessary alternative. However, it is essential to strike a balance between collaborative learning and independent inquiry to ensure students' holistic development and engagement in the scientific process. In addition, the views expressed by the teachers highlight the advantages of smaller class sizes in facilitating hands-on experimentation, one-on-one discussions, and personalised instruction. This enables deeper engagement and encourages students to ask questions that demand more attention. It is evident from the responses that smaller class sizes foster an environment conducive to meaningful interactions, allowing teachers to provide tailored guidance and support to individual learners, ultimately enhancing the quality of IBST.

On the other hand, Miss. Solai's perspective recognises the potential benefits of both smaller and larger class sizes. While smaller classes offer advantages in terms of individual attention, larger classes can harness the power of group discussions and collaboration. Technology and online resources can significantly support instruction and bridge the gap created by larger learner/teacher ratios.

The insights provided by the teachers have several implications for inquiry-based science teaching in South Africa. Firstly, it is crucial to address the issue of large class sizes, as they can hinder the effective implementation of this teaching approach. Policy interventions and resource allocation should be directed towards reducing learner/teacher ratios to enable greater individual attention and personalised instruction. Smaller class sizes should be prioritised to create an optimal learning environment that fosters inquiry, critical thinking, and scientific exploration.

Additionally, professional development programmes should be implemented to effectively equip teachers with strategies and techniques for managing larger class sizes. Teachers must be trained in utilising technology and online resources to supplement instruction and provide additional support in larger classrooms. This can help maintain learner engagement, facilitate collaborative learning, and address individual needs even in resource-constrained environments. Furthermore, policymakers and educational institutions should consider the importance of allocating sufficient resources to support inquiry-based science teaching. This includes providing adequate laboratory equipment, materials, and technology infrastructure to enhance hands-on experimentation and access to online resources. By investing in the necessary resources, educators can overcome the challenges of larger learner/teacher ratios and create a conducive environment for inquiry-based learning.

### 7.9 Learners' responses and teachers' practice of IBST

This section analysed and evaluated how learners' responses affected the practice of IBST among natural science teachers in South Africa. Firstly, Mr Govender highlighted the importance of learner responses in shaping their practice of IBST. The teacher indicated that:

> *The responses of learners in the class are an important factor that influences how I practice inquiry-based science teaching. If I notice that learners are struggling with a particular concept, I may modify my teaching approach to make it more accessible to them.*

This statement demonstrates the teacher's attentiveness to learner understanding and their willingness to adapt instruction based on the observed responses. The teacher further provided an example, revealing:

> *For example, if I notice that learners are struggling with the concept of density, I might incorporate a hands-on activity that involves measuring the density of different objects to help them better understand the concept.*

This example illustrated the teacher's proactive approach to addressing learner difficulties through relevant and engaging activities.

Mrs. Zwane also emphasised the significance of learner responses in tailoring instruction to meet individual needs. He stated:

> *The responses of learners in the class play a significant role in how I practice inquiry-based science teaching. I believe that every learner has a unique learning style, and by observing their responses, I can tailor my teaching to meet their individual needs.*

This statement reflected the teacher's recognition of the diversity of learning styles and the value of incorporating instructional strategies that align with learners' preferences. The teacher further illustrated his approach, claiming:

*For instance, if I notice that a learner is more visual, I might incorporate more diagrams and pictures into my teaching.*

The teacher’s approach demonstrates his responsiveness to learner preferences and their commitment to creating an inclusive and engaging learning environment.

Miss. Solai also highlighted the critical role of learner responses in assessing the effectiveness of their teaching approach. The teacher argued: *The responses of learners in the class are a* *critical factor in how I practise inquiry-based science teaching. By observing their responses, I can assess whether my teaching approach is effective or not.*

This statement reflected the teacher's commitment to continuous improvement and her willingness to adjust her instructional strategies based on student feedback. The teacher further provided an example:

*For example, if I notice that learners are not engaged during a particular lesson, I might incorporate more interactive activities to increase their engagement.*

The teacher’s approach showcased her responsiveness to learner engagement levels and her proactive approach to enhancing student involvement in the learning process.

Mrs Buthelezi stressed the importance of observing learners' observations in adapting IBST to meet their needs better. She stated:

*The observations of learners in the class are essential in helping me to adapt my inquiry-based science teaching to better meet their needs*.

This statement reflects the teacher's commitment to personalised instruction and recognising the importance of aligning teaching strategies with student requirements. She further explained her approach, uttering:

*For example, if I observe that learners are struggling with the concept of photosynthesis, I might incorporate a virtual lab activity to help them better understand the process*.

This illustrated the teacher's proactive use of technology and virtual resources to enhance learner understanding and engagement.

Miss Solai also underscored the significance of learner responses in shaping inquiry-based science teaching. She said:

*The responses of learners in the class are an important factor in how I practise inquiry-based science teaching. By observing their responses, I can modify my teaching approach to make it more engaging and effective.*

Similarly, Miss. Solai’s response reflected her responsiveness to learner engagement and commitment to enhancing learner experiences in the classroom. The teacher further explained her approach:

*For example, if I notice that learners are struggling with a particular lab activity, I might incorporate more scaffolding to help them complete the task successfully.*

This strategy demonstrated the teacher's dedication to providing the necessary support and guidance based on learner responses, ensuring learners can actively participate and achieve the desired learning outcomes.

The perspectives shared by the five teachers shed light on the significant influence of learner responses on the practice of inquiry-based science teaching. These teachers recognised the importance of observing and analysing how learners engaged with the subject matter and adapted their instructional strategies accordingly. The analysis revealed several common themes and implications for effective teaching practices. Firstly, the responses emphasise the need to tailor instruction to meet individual student needs. By observing learner responses, teachers can identify various learning styles, preferences, and areas of difficulty. This understanding would allow teachers to employ diverse instructional approaches, such as hands-on activities, visual aids, interactive tasks, and scaffolding, to support learner learning and engagement.

Similarly, by closely monitoring how learners interact with the content and activities, teachers can identify gaps in understanding, disengagement, or misconceptions. They can then make timely adjustments to their teaching strategies to address these issues and optimise the learning experience. The responses further highlight that learner responses serve as a valuable indicator of learner engagement. Teachers must recognise the importance of creating interactive learning environments to stimulate curiosity and active participation. By incorporating interactive activities, technology, and varied resources, teachers can enhance learner engagement, foster critical thinking, and deepen scientific inquiry. The findings further demonstrate a flexible and adaptive approach to inquiry-based science teaching. Teachers must recognise that each learner is unique and may require different levels of support and guidance. By observing and responding to learner responses, teachers can adapt their teaching methods, pacing, and instructional materials to create a supportive and inclusive learning environment that accommodates diverse learner needs.

### 7.10 The effect of learners' performance on IBST practice

The teachers' responses highlight the significance of learner performance in projects and laboratory exercises as a key factor influencing the practice of inquiry-based science teaching. Mr. Govender emphasised the importance of learner performance as an indicator of the effectiveness of inquiry-based teaching, stating:

*If the learners perform well, it reinforces my belief in the effectiveness of inquiry-based teaching, and I am motivated to continue using this approach.*

This response demonstrates that the learners' success directly influences the teacher's motivation to continue using inquiry-based teaching. On the other hand, when learners struggle or fail, Mr Govender responded that he reflected on his teaching methods and sought ways to modify their approach to support learner learning better.

Mrs Zwane also shared a similar perspective, expressing:

*If the learners perform well, it confirms that they are grasping the concepts and skills I am trying to teach them. This encourages me to continue using inquiry-based teaching to help them deepen their understanding.*

The response also stressed that the teacher's confidence in inquiry-based teaching was reinforced when learners demonstrated proficiency in projects and laboratory exercises. However, if learners encountered challenges, she recognised the need to adjust her teaching approach and provided additional practice and skill development opportunities.

On her part, Miss. Solai highlighted the link between learner performance and engagement, indicating:

*If the learners perform well, it shows that they are engaged and motivated by the inquiry process.*

Her response shows that she perceived learner performance as an indication of their interest and motivation in the inquiry-based approach. However, when learners struggle, Miss. Solai reflected on her teaching methods and made the necessary adjustments to enhance learner understanding and participation.

Mrs. Buthelezi also emphasised the practical application of scientific concepts through learner performance, indicating:

*If the learners perform well, it demonstrates that they can apply the scientific concepts they have learnt to real-world situations.*

Here, it is apparent that the teacher views learner performance as evidence of the effectiveness of IBST in equipping learners with transferable skills. However, when learners face difficulties, Mrs Buthelezi indicated that she takes it as an opportunity to assess her teaching methods and adapt her approach to providing additional guidance and feedback. The teachers' perspectives highlight the interplay between learner performance and the use of IBST. Several common themes emerged from the analysis. Firstly, the teachers find learner performance to be an essential validation of the effectiveness of inquiry-based teaching. This suggests that when learners perform well and demonstrate a solid understanding of scientific concepts, it reinforces the teachers' confidence in their instructional approach. This encourages them to continue using inquiry-based teaching to help them deepen their understanding. In addition, the responses demonstrate that learner performance prompts the teachers to reflect and modify their teaching methods. When learners struggle or fail, the teachers critically evaluate their instructional strategies and seek ways to support learner learning better. The insights from teachers' perspectives on learner performance have several implications for the practice of inquiry-based science teaching in South Africa.

Firstly, teachers need to continually assess learner performance in projects and laboratory exercises to gauge the effectiveness of their instruction. Regular feedback and evaluation of learner work can help identify areas where learners may be struggling or excelling, allowing teachers to make timely adjustments to their teaching methods. Secondly, learner performance provides valuable information about individual learners' needs and learning styles. Teachers can use this information to differentiate their instruction and tailor their teaching methods to meet the diverse needs of their learners. By observing learner responses and adjusting their approach, teachers can provide targeted support and create a more inclusive learning environment.

### 7.11 Chapter summary

The teachers’ responses highlighted that various factors influence IBST. Firstly, the teachers' responses revealed the significant influence of teachers’ knowledge and experience on IBST.

This demonstrates that teachers' extensive background in science, coupled with their experiences in inquiry-based teaching, shape their instructional approaches by guiding lesson design, promoting active engagement, providing support and scaffolding, considering diverse learning styles, and fostering reflection and self-improvement. The study further found that learners' backgrounds and characteristics influence teachers' practices of IBST. The insights shared by the teachers shed light on the significance of considering learners' curiosity, learning styles, language proficiency, and attention levels when designing and implementing inquiry-based practices. These findings highlight the importance of ongoing professional development, learner-centred approaches, inclusivity, and reflective practice in the effective implementation of IBST. By considering these factors, teachers can create engaging and impactful learning experiences that promote scientific inquiry, critical thinking, and a deeper understanding of the natural world among their learners. The analyses further shed light on the significance of resources in creating engaging and effective learning experiences. Well-equipped laboratories, technology, and relevant teaching materials provide hands-on experiments, investigations, and scientific inquiry opportunities. Other factors that affect how teachers practise IBST include school culture on IBST practices, professional development, class size, learner responses, and learner performance.

# CHAPTER EIGHT
# SUMMARY, RECOMMENDATIONS AND CONCLUSION

## 8.1 Introduction

Science teachers play a critical part in a learner's academic journey because they provide the foundational information and skills needed to understand and engage with the world around them. In the field of science education, IBST is a suggested pedagogical strategy that can improve learners' understanding of scientific ideas. IBST is an educational approach that emphasises the importance of learner-driven inquiry and the integration of scientific material with prior knowledge. This teaching approach is based on the educational theory that learners learn best when they are actively involved in the process of creating links between their academic goals and real-world experiences.

In Chapter 6, the focus is on synthesizing the findings related to how natural science teachers comprehend and implement Inquiry-Based Science Teaching (IBST) in grades 6 and 7. The chapter highlights the diverse interpretations of IBST among educators, emphasizing the significance of their pedagogical beliefs and prior experiences in shaping their instructional practices. Through qualitative analysis of interviews and classroom observations, key themes emerged, including the challenges teachers face in fostering a student-centered learning environment and the strategies they employ to engage students in inquiry. Importantly, the chapter discusses that while IBST is a valuable approach, it should not be the sole strategy in teaching; rather, it should be integrated with other instructional methods to create a more comprehensive learning experience. Additionally, the role of professional development in enhancing teachers' understanding and implementation of IBST is addressed, as well as the impact of institutional support on their teaching efficacy. Ultimately, this chapter underscores the necessity for ongoing training and resources to empower teachers to effectively adopt IBST alongside other teaching strategies, thereby enriching the educational experiences of their students in natural science.

## 8.2 Teachers' understanding and practice of IBST

The study's first objective focused on documenting and exploring how natural science teachers understood and practised IBST in a primary school. The findings of this objective included the results from questionnaires and structured interviews conducted with 5 grades 6 and 7 natural sciences teachers. The study began by discussing the participants' attendance at workshops and training on teaching natural sciences. All the participants confirmed attending such training, with various workshops mentioned, although most focused-on assessments rather than teaching. Next, the participants' understanding of IBST was explored. The analysis of responses from the questionnaires and interviews revealed that the teachers had different understandings of how natural sciences should be taught. However, there was a consensus among the teachers that teaching natural sciences involves both practical and theoretical lessons, including experiments, demonstrations, and worksheets.

The sources of understanding of IBST for the teachers were also explored. It was found that their understanding of how natural sciences should be taught is primarily informed by their professional studies. Additionally, interactions with colleagues and support from school management, including workshops provided by the Department of Education, also contribute to their understandings. Furthermore, the study assessed the teachers' understandings of the natural sciences subject itself. Participants were asked to rate their level of agreement with statements about natural sciences. The findings showed that most teachers agreed that science is primarily a formal way of representing the real world and a practical and structured guide for addressing real situations. However, there were mixed responses regarding whether science is primarily an abstract subject, and participants generally disagreed with the idea that science focused on rules that lead to memorisation.

The participants unanimously indicated that they involved learners in teaching natural sciences by giving them practical or experimental work. The teachers emphasised the importance of engaging learners in self-discovery, group work, experiments, observations, discussions, and question-and-answer sessions. The study also assessed the teachers' understanding of teaching natural sciences using six statements. The results showed that all the teachers demonstrated a high level of understanding and implementation of teaching strategies, including using appropriate tools and materials, facilitating tentative explanations, guiding learners in investigations, using content terminology and scientific language, and interacting with learners.

The participants were further asked about their teaching methods' effects on the learners' learning outcomes. All participants expressed optimism that their teaching methods positively impacted learning outcomes. They provided various reasons such as improved understanding, active participation, better recall, critical thinking, and application of knowledge. However, it was noted that their teaching methods were limited in their ability to address all the diverse learning outcomes of natural science.

Next, the participants' understanding of IBST was explored. All participants were aware of this teaching approach. However, their descriptions of IBST varied, indicating different levels of understanding. Some participants emphasised learning through inquiry and problem-solving, while others highlighted the role of the teacher as a facilitator and the importance of logical thinking based on scientific evidence. Overall, the participants had some knowledge of IBST, but there were variations in their understanding.

Furthermore, the participants were asked to identify activities and processes they considered IBST. There was consensus among participants that projects, practical tasks, experiments, demonstrations, and class activities constituted IBST. Lastly, the participants' familiarity with documents related to IBST was assessed. Most participants reported being familiar with the CAPS document, which is an essential resource for guiding IBST

**8.3 Teachers' application of IBST**

The study's second objective was explored through observations of how teachers practised IBST in a classroom setting before an intervention programme. In addition, the second objective assessed the teachers' practice of IBST in a classroom after an intervention strategy or programme through a focus group discussion. The steps the teachers took during the lesson, including demonstration, explanation, and questioning, were recorded, and analysed to determine the elements of IBST in the lesson. The following is a summary of the major findings for this objective. The results of this study showed several key findings that are noteworthy. Firstly, the findings showed a significant difference between teachers' understandings and practices of IBST before and after the focus group intervention programme. After the teacher had received the intervention, they showed an improvement in their IBST understanding and practice. This indicated that the intervention was effective in improving teachers' understanding and practices of IBST. This finding was important because it highlights the potential for the intervention to be a valuable resource for individuals looking to enhance their understanding and practices of IBST.

Moreover, we found that the level of improvement was consistent across different demographic groups, including age, gender, and education level. This suggested that the intervention may be equally effective for individuals of diverse backgrounds and that it has the potential to be widely applicable. The study's findings also showed that the participants who received the intervention reported a high level of satisfaction with the programme. This suggests that the intervention was well-received and that participants found it a positive experience. This was important because it indicates that individuals are more likely to use the intervention if they feel that it is a positive experience. Overall, the findings of this study indicated that the intervention was effective in improving the teachers' construction and practice of IBST and that it was well-received by participants. These results have important implications for the potential use of the intervention in the future and highlight the need for further research in this area.

### 8.4 Factors that influence how NST practice IBST

The study's third objective was to analyse and evaluate the factors influencing natural sciences teachers' practice of IBST. This was achieved through a questionnaire response. Five teachers were interviewed to offer an in-depth understanding of the factors that affected how they practised IBST. The research findings highlighted the influence of learner characteristics and classroom resources on the practice of IBST among natural sciences teachers. The analysis of the interview responses revealed that teachers' knowledge and experience play a significant role in shaping their instructional strategies and approaches, suggesting teachers with extensive backgrounds in science can design engaging and effective inquiry-based lessons. Experience in IBST focuses on active learner engagement, scaffolding and support, consideration of diverse learning styles, and reflection for continuous improvement. Additionally, the study found that the availability of classroom resources is crucial in facilitating IBST. Well-equipped laboratories, technology, and relevant teaching materials allow hands-on experiments and investigations. The responses demonstrated that adequate resources foster active learning experiences, support learner understanding, and promote scientific inquiry.

School culture was also found to influence the way teachers practice IBST. The analyses of the teachers' responses showed that a positive and supportive school culture encourages experimentation, and collaboration, and provides resources, which allow teachers to try new techniques and develop inquiry-based lessons. The reasoning behind this view is that school culture can impact the availability of resources for IBST. A school that values and supports inquiry-based teaching is more likely to invest in providing teachers with necessary resources such as laboratory equipment, technology, and professional development opportunities. Similarly, it was found that school culture influences learner attitudes and expectations towards IBST. A culture that values and promotes IBST nurtures curiosity and excitement among learners, leading to more engaged and motivated learners. Regarding teacher professional development, the teachers emphasised the importance of staying current with research and trends in IBST.

Regarding the learner/teacher ratio, the teachers recognised its influence on their ability to provide individualised attention and guidance during IBST activities. Larger class sizes were found to limit independent exploration and discovery opportunities, leading to a reliance on group work and collaborative learning. On the other hand, smaller class sizes were seen as advantageous, facilitating hands-on experimentation, one-on-one discussions, and personalised instruction. Teachers acknowledged the benefits of smaller and larger class sizes, with larger classes fostering more group discussions and collaboration. The findings highlighted the need to strike a balance between collaborative learning and independent inquiry in larger classes.

Five teachers' perspectives were presented, highlighting the importance of learner responses in shaping their instructional strategies. The teachers emphasised the need to tailor instruction to meet individual learner needs, recognise diverse learning styles, and adjust teaching methods accordingly. They also stress the importance of observing learner engagement, addressing gaps in understanding, and fostering interactive learning environments. The findings further emphasised the significance of learner performance as an indicator of the effectiveness of IBST. Teachers' motivation to continue using inquiry-based teaching is reinforced when learners perform well, while challenges prompt reflection and adjustments in teaching methods. Learner performance is seen as validation of the instructional approach and prompts teachers to make necessary modifications to support learning.

## 8.5 Summary of findings

The conclusions of the findings of the study are presented below. In conclusion, this research study reveals that natural sciences teachers in grades 6 and 7 have different understandings of IBST. Their understandings are influenced by their professional studies, interactions with colleagues, and support from school management. The participants generally agree that teaching natural sciences should involve practical and theoretical lessons. The findings emphasise the importance of providing teachers with relevant and effective training, promoting collaboration among teachers, and aligning teaching approaches within the natural science curriculum.

The research findings demonstrate that the natural sciences teachers in grades 6 and 7 understand teaching methods and strategies. They involve learners in teaching and employ various techniques such as group work, experiments, discussions, and question-and-answer sessions. The teachers showed competence in using appropriate tools, materials, and scientific language in their instruction. These findings also highlight the importance of promoting inquiry-based teaching approaches and supporting teachers to enhance their pedagogical skills.

By fostering active engagement and learner-centred learning experiences, teachers can promote scientific inquiry and nurture learners' interest and understanding of natural sciences.

The research findings highlight the positive beliefs of natural sciences teachers regarding the impact of their teaching methods on learning outcomes. However, the study also reveals the need for a broader range of teaching methods to effectively address the diverse learning outcomes of natural sciences. The participants' varied understanding of inquiry-based science teaching suggests the importance of professional development programmes to enhance teachers' knowledge and implementation of this approach. While teachers demonstrated an understanding of the approach, there are areas for improvement regarding allocating sufficient time to natural sciences, promoting open-ended problem-solving and technology integration, and facilitating more collaborative learning experiences for learners. Additionally, the inclusion of modern tools and equipment in the teaching process could enhance learners' engagement and exposure to current scientific practices. These findings provide insights for educators and policymakers to strengthen IBST practices to improve learners' learning outcomes in natural science.

According to the research findings, IBST is practised by most natural sciences teachers. Teachers cited various reasons for adopting this approach, such as enhancing student understanding, evaluating learning, and promoting critical thinking. However, the teachers differed in the extent and nature of inquiry-based practices. Traditional teaching methods still prevailed; even inquiry-related activities often lacked learner-generated questions and independent exploration opportunities. Despite these challenges, the study concludes that teachers have the motivation to incorporate more inquiry into their teaching. Efforts should be made to provide professional development and resources to support teachers in implementing effective inquiry-based science teaching strategies. The participants' familiarity with documents related to inquiry-based science teaching indicates access to relevant guidelines and resources that can support their instructional practices. Overall, these findings contribute to understanding teaching methods and IBST in the context of natural sciences education.

### 8.6 Teachers' application of IBST

The research findings indicated that teachers could implement IBST but faced challenges that limited the full realisation of its potential. The study highlights the need for support and resources to overcome these challenges and further enhance the practice of IBST. The effectiveness of the intervention strategy/programme in improving the teacher's practice was evident in the follow-up lesson, where the teachers effectively engaged learners in hands-on learning and promoted critical thinking. The findings emphasise the significance of inquiry-based teaching strategies and learner-centred approaches in science education. Using real-life materials and interactive methods helped learners relate scientific concepts to their everyday experiences, enhancing their understanding and application.

The research findings suggest that Mr Govender and Mrs Zwane's practice of inquiry-based science teaching before the intervention programme successfully engaged learners and promoted their understanding of science concepts. The teachers effectively used questions, visual aids, and personal experiences to stimulate critical thinking and encourage learner participation. By emphasising the importance of habitats and their relevance to animals' lives, Mr Govender fostered a more profound understanding among the learners. However, it is essential to note that the learners' participation and experience were somewhat limited, as they were not given extensive opportunities to answer questions or share their observations. To enhance the effectiveness of IBST, it would be beneficial for the teacher to incorporate more interactive activities and encourage greater learner involvement in future lessons. The findings of the study demonstrate that Mr Govender and Mrs Zwane effectively implemented IBST techniques after the intervention. Their use of interaction, visual aids, and hands-on activities kept learners interested and focused. Real-life examples and connections to the learners' experiences made the topic more relevant and engaging.

The study's findings suggest that Miss Solai and Mrs. Buthelezi's implementation of IBST after the intervention programme effectively promoted learner engagement and active participation. The teachers used various teaching strategies aligned with the principles of IBST, such as hands-on activities, inquiry-based learning, and learner involvement. Clear and concise instructions, effective questioning, and incorporation of multiple senses enhanced the learning experience. For example, Miss Basi effectively implemented IBST in the classroom through an experiment that tested the absorbency and strength of different materials. She promoted critical thinking and scientific inquiry by actively engaging the learners in predicting and observing the outcomes. The experiment showed that different materials have distinct properties such as absorbency, strength, and waterproofing. The use of questioning and demonstrations fostered a deeper understanding of these material properties among the learners. This study highlighted the importance of questioning techniques, clear instructions, and feedback in promoting learner engagement and understanding in a science lesson using

IBST. The findings suggested that science teachers can effectively use these practices to enhance the learning experience for their learners.

The focus group intervention the researcher carried out as part of the research project made a big difference in the participating teachers' understanding and practices of IBST. The intervention created a collaborative learning environment through organised group discussions, which enabled teachers to share ideas, and experiences, and collectively work through the implementation issues of IBST. There was a discernible improvement in the teachers' understanding and application of IBST concepts because of the focus groups' interactive format, which also increased teacher involvement and promoted the adoption of creative teaching techniques. In addition to enhancing the knowledge of individual teachers, the focus group sessions' exchanged ideas and reflections promoted a positive community of practice, which in turn promoted a transformative and long-lasting effect on scientific teaching methods in primary school settings.

## 8.7 Factors that influence how NST practice IBST

The research findings emphasise the importance of teachers' knowledge, experience, and classroom resources in shaping the practice of IBST. Teachers' deep understanding of science, gained through extensive backgrounds and experience, enables them to design effective inquiry-based lessons. Active learner engagement, scaffolding and support, consideration of diverse learning styles, and reflective practice are vital elements influenced by teachers' knowledge and experience. Furthermore, the availability of well-equipped laboratories, technology, and relevant teaching materials facilitates IBST. Access to resources allows hands-on experiments, investigations, and virtual simulations, promoting learner engagement, understanding, and scientific inquiry. The findings demonstrate that school culture and learner characteristics impact how teachers practice IBST. A positive school culture that supports innovation, collaboration, and resource allocation creates an environment conducive to the successful implementation of inquiry-based teaching practices. On the other hand, school cultures focused on standardised testing and memorisation present challenges requiring teachers to adapt their techniques while providing authentic and meaningful learning experiences.

Similarly, learners' characteristics, curiosity, exploration tendencies, diversity, language proficiency, and attention levels also shape teachers' IBST instructional strategies. Teachers must consider and address these factors to create inclusive and effective learning environments.

Differentiation, scaffolding, and multiple entry points are crucial in ensuring equitable access to inquiry experiences. Flexibility and adaptability in IBST are necessary to cater to the evolving characteristics of learners. The findings emphasise the significance of teacher professional development and student/teacher ratio in IBST practices. Professional development enables teachers to stay updated, refine their strategies, gain new perspectives, and collaborate with peers. It enhances teachers' knowledge and skills, positively impacting learner-learning outcomes. On the other hand, the learner/teacher ratio influences teachers' ability to provide individualised attention and facilitate independent exploration. Smaller class sizes offer advantages in terms of personalised instruction, while larger class sizes can foster collaboration and group discussions. Striking a balance between collaborative learning and independent inquiry is essential.

The findings emphasise the crucial role of learner responses and performance in shaping the practice of IBST. Teachers must be attentive to student understanding, adapt instruction based on observed responses, and tailor teaching methods to meet individual learner needs. By incorporating diverse instructional approaches and resources, teachers can enhance engagement, foster critical thinking, and deepen scientific inquiry. Learner performance validates the effectiveness of inquiry-based teaching, reinforcing teachers' confidence and motivation. Challenges prompt reflection and adjustments in teaching methods to better support learner learning. Regular assessment and feedback enable teachers to identify areas of struggle or excellence and make timely adjustments to instructional strategies.

### 8.8 Teachers' understandings and practices of IBST

The findings related to this study have implications for teacher training and professional development in natural sciences education. The results suggest a need for workshops and training programmes that focus on teaching methods and strategies rather than solely on assessments. Emphasising the practical aspects of natural science teaching, such as experiments and hands-on activities, can help improve learner engagement and understanding. The study also highlights the importance of teacher interactions and school management support. Promoting collaboration and creating opportunities for teachers to share their experiences and learn from each other can enhance their understanding and implementation of inquiry-based science teaching. The participants' diverse understandings of how natural sciences should be taught indicate a need for clarifying and aligning teaching approaches within the natural science curriculum.

Providing clear guidelines and resources for inquiry-based teaching methods can help standardise practices and improve the quality of science education. The findings suggest that natural sciences teachers believe their teaching methods positively affect learning outcomes. However, the limited scope of their teaching methods may hinder the attainment of all learning outcomes. This highlights the importance of diversifying instructional strategies to address the various learning outcomes of natural sciences. The variations in participants' understanding of inquiry-based science teaching indicate a need for further professional development and support in implementing this approach effectively. Teachers could benefit from additional training and resources to enhance their understanding and implementation of inquiry-based science teaching. The consensus among participants regarding the activities and processes associated with inquiry-based science teaching provides valuable insights for curriculum development and teacher training. Emphasising projects, practical tasks, experiments, demonstrations, and class activities in instructional practices can promote inquiry-based learning in natural sciences classrooms.

In terms of learners' classroom activities, the findings indicate that learners often worked individually, both with and without assistance from the teacher. However, collaborative activities, such as working together as a class or in pairs/small groups, are less common. Increasing opportunities for collaborative learning can enhance learners' communication, teamwork, and problem-solving skills. Regarding tools, equipment, and materials, the participants utilised various resources, including practical equipment, investigative booklets, charts, textbooks, posters, science kits, and apparatus. However, there is a lack of modern equipment and technology, such as computers and software, which could enhance learners' learning experiences and expose them to current scientific practices.

The findings of the study also indicate room for improvement in the implementation of IBST. Many teachers still rely on traditional teaching methods, and even activities labelled as inquiry-based often limit learners' freedom to ask questions and find answers based on available data. This suggests a need for professional development and support to help teachers fully embrace and effectively implement IBST, which the focus group intervention sought to offer. The findings of this study have several implications for science education. In the case of the teachers' practice of IBST, the implications are significant in several ways. Firstly, the study's findings can help teachers understand the importance of incorporating interactive activities and hands-on learning in their teaching practices. This can encourage teachers to use similar classroom techniques and activities to help learners better understand abstract concepts and engage in their learning. Using IBST in the classroom can help foster learner curiosity, encourage hands-on learning, and promote scientific literacy.

The findings of the study may have implications for teacher training and professional development. By highlighting the effectiveness of IBST in promoting student learning and understanding, the results may be used to support the development of new teaching techniques and methods in teacher training programmes. This could help to improve the quality of education provided to learners and result in better learner outcomes. The findings may also have implications for educational policy and curriculum design. The study's results can provide valuable insights into how interactive and hands-on learning activities can help learners better understand abstract concepts and ideas. These insights can inform the development of educational policies and curriculum design and help to create more effective and engaging learning experiences for learners.

Finally, the implications of the study extend beyond the classroom and potentially impact society by improving the quality of education and learner learning outcomes, the study can help to produce well-informed and knowledgeable citizens who can contribute to the advancement of society. In conclusion, the implications of the research on the teacher's practice of IBST are far-reaching and have the potential to impact the education sector and society positively. By highlighting the importance of incorporating interactive and hands-on learning activities, the study can help to improve the quality of education provided to learners and result in better student outcomes.

**8.9 Factors that influence how NST construct and practice IBST**

The implications of the teachers' responses are significant for both current and future practitioners of IBST. Firstly, it highlights the importance of professional development and continuous learning for teachers. Building a strong foundation of subject knowledge and staying updated with current scientific advancements are vital for designing effective inquiry-based lessons. Teachers should actively seek opportunities to expand their knowledge through professional development programmes, workshops, and collaborations with colleagues. Additionally, the teachers' emphasis on active student engagement, scaffolding, and support underscores the need for educators to adopt a learner-centred approach.

Considering diverse learning styles and modalities is another crucial implication of the teachers' responses. In a diverse classroom, teachers should ensure that their instructional approaches cater to learners' varied needs and preferences. This may involve incorporating visual aids, hands-on activities, technology, group work, and other strategies to create a rich and inclusive learning experience for all learners. Moreover, the importance of reflection and self-evaluation highlighted by the teachers suggests that they should engage in ongoing reflection and seek feedback from learners and colleagues. This reflective practice would enable teachers to identify areas of improvement, refine their instructional strategies, and enhance their overall teaching effectiveness. In this case, professional learning communities, mentoring relationships, and collaboration with colleagues can provide valuable opportunities for teachers to engage in reflective discussions and receive constructive feedback.

The findings of the study also highlight the importance of adequate funding and resources for schools and educational institutions in South Africa. Ensuring that classrooms are equipped with the resources required for IBST is essential. Additionally, school leaders, SGBs, and policymakers should prioritise allocating sufficient funds to provide well-equipped laboratories, technology, and relevant teaching materials. This will enable teachers to create engaging and interactive learning experiences that promote scientific inquiry and learner-centred learning. Another implication is the need for collaboration and resource sharing among teachers. Teachers can benefit from sharing their expertise, experiences, and available resources with colleagues. Collaboration can occur within schools, across schools, or even through online platforms. By fostering a culture of collaboration, teachers can expand their resource pool, access a broader range of materials, and learn from each other's successful practices. This collective effort can improve IBST practices and enhance student learning outcomes. Furthermore, the findings emphasise the importance of learner engagement and motivation in inquiry-based science teaching. Teachers should design activities that align with learners' interests, curiosity, and exploration tendencies. Creating a positive and stimulating learning environment makes learners more likely to participate actively in the inquiry process and develop a deeper understanding of scientific concepts. The responses suggest that the socio-economic backgrounds of learners impact the availability of resources and materials for inquiry-based science teaching. Given this, teachers should adapt their practices to ensure that all learners have access to hands-on learning experiences regardless of their economic circumstances. This may involve using low-cost materials, household items, or alternative approaches that utilise readily available resources. By considering the socio-economic backgrounds of learners, teachers promote equity and inclusion in science education.

### 8.10 Limitations

The findings of the study have some limitations, which inhibit its generalisability. Firstly, the research involved a small number of participants. Having a larger sample size would increase the generalizability of the findings and provide a more comprehensive understanding of the practices of inquiry-based science teaching. There is also a possibility of self-reporting bias from the teachers. The study mostly relied on self-reporting from the participants, which may introduce bias. Participants might provide socially desirable responses or overestimate their adoption of inquiry-based science teaching. Additional methods, such as learner assessments, could provide a more objective evaluation of the teachers' practices. Including learners' perspectives and experiences in future studies would provide valuable insights into their perceptions of IBST. Understanding how learners perceive and engage with inquiry-based approaches can inform instructional strategies and support the design of more learner-centred learning experiences.

The research considered the specific contexts in which the teachers were practising IBST, but not in the specific exploration, only through teacher responses. Factors such as school resources, curriculum requirements, and classroom dynamics can influence the implementation and effectiveness of inquiry-based approaches. Considering these contextual factors would provide a more nuanced understanding of the challenges and opportunities associated with inquiry-based teaching. In addition, conducting studies across different cultural and educational contexts would contribute to our understanding of the transferability and adaptability of inquiry-based science teaching. Comparing practices and outcomes across diverse settings can shed light on the cultural and contextual factors that influence the implementation and effectiveness of inquiry-based approaches. The study was also conducted within a limited time. Conducting longitudinal studies that follow teachers' adoption of IBST over an extended period would provide insights into the long-term impact of this approach on learner-learning outcomes. It would also help identify factors that facilitate or hinder the sustained implementation of inquiry-based practices. Additionally, investigating the impact of professional development programmes focused on inquiry-based science teaching would help identify effective strategies for supporting teachers in adopting and implementing inquiry-based practices. Research could explore the specific components and duration of professional development that could lead to sustainable changes in teaching practices. Addressing these limitations and exploring these suggested research areas can further enhance our understanding of IBST and its impact on learner learning in various educational contexts.

## 8.11 Recommendations

Based on the findings of this study, it is recommended that teachers incorporate IBST into their science lessons as a way of engaging learners in the process of scientific discovery. This approach can help foster learner curiosity, encourage hands-on learning, and promote scientific literacy. Additionally, teachers should incorporate demonstration, explanation, and questioning into their lessons to engage learners and promote critical thinking. Furthermore, it is recommended that teachers provide learners with worksheets to record their observations, which can help reinforce scientific concepts, promote scientific literacy, and construct their understanding of scientific concepts. Finally, teachers should work to foster a sense of community and collaboration in the classroom, which can be beneficial for learners' overall understanding.

# REFERENCES


Abrahams, F. (2004). The *application* of *critical theory to a sixth grade general music class. Visions of research in music education.* In: Princeton, NJ: Rider University.

Adhami, N., & Taghizadeh, M. (2022). Integrating inquiry-based learning and computer supported collaborative learning into flipped classroom: effects on academic writing performance and perceptions of students of railway engineering. *Computer Assisted Language Learning*, 1-37.

Adhemar, P. (2006). *International Public Sector Accounting Standards Board (IPSASB). PowerPoint Presentation at the Sixth Annual* OECD Public Sector Accruals Symposium, Paris,

Adisendjaja, Y., Rustaman, N., Redjeki, S., & Satori, D. (2017). Science teachers' understanding of scientific inquiry in teacher professional development. *Journal of Physics: Conference Series*,

Ainley, M., & Ainley, J. (2011). Student engagement with science in early adolescence: The contribution of enjoyment to students' continuing interest in learning about science. *Contemporary Educational Psychology*, *36*(1), 4-12.

Alake-Tuenter, E., Biemans, H. J. A., Tobi, H., Wals, A. E. J., Oosterheert, I., & Mulder, M. (2012). Inquiry-based science education competencies of primary school teachers: A literature study and critical review of the American perspective. *International Journal of Science Education, 34*(17), 2609-2640.

Ali, S. S. (2019). Problem based learning: A student-centered approach. *English Language Teaching*, *12*(5), 73-78.

Alzahrani, I., & Woollard, J. (2013). The Role of the Constructivist Learning Theory and Collaborative Learning Environment on Wiki Classroom, and the Relationship between Them. *Online Submission*.

Anderson, R. D. (2002). Reforming science teaching: What research says about inquiry. *13*(1), 1-12.

Anderson, R. D. (2013). Reforming science teaching: What research says about inquiry. *Journal of Science Teacher Education, 13*(1), 1-12.

Asay, L. D., & Orgill, M. (2010). Analysis of essential features of inquiry found in articles published in The Science Teacher, 1998–2007. *Journal of Science Teacher Education*, *21*(1), 57-79.

Atar, H. Y., & Gallard, A. (2011). Investigating the relationship between teachers' nature of science conceptions and their practice of inquiry science. Asia-Pacific Forum on Science Learning and Teaching,

Banilower, E. R., Heck, D. J., & Weiss, I. R. (2013). Can professional development make the vision of the standards a reality? The impact of the national science foundation's local systemic change through teacher enhancement initiative. *Journal of Research in Science Teaching, 44*(3), 375-395.

Bansal, G., & Ramnarain, U. (2023). *Inquiry-Based Science in the Primary Classroom*. Taylor & Francis.

Barrow, L. H. (2006). A brief history of inquiry: From Dewey to standards. *Journal of Science Teacher Education*, *17*(3), 265-278.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, *13*(4), 544-559.

Bell, R. L., Smetana, L., & Binns, I. (2005). Simplifying inquiry instruction. *The Science Teacher, 72*(7), 30-33.

Bertram, C., & Christiansen, I. (2014). *Understanding research: An introduction to reading research*. Van Schaik Publishers.

Bin Ahmad, Z., Sulaiman, N. L. B., Salleh, N. F. B., & Ibrahim, N. B. (2023). Advantages and Positive Impacts of Inquiry-Based Learning on Student Psychology Achievement: A Review. *Journal for ReAttach Therapy and Developmental Diversities*, *6*(4s), 193-200.

Blanchard, M. R., Southerland, S. A., & Granger, E. M. (2010). No silver bullet for inquiry: Making sense of teacher change following an inquiry-based research experience for teachers. *Science Education, 93*(2), 322-360.

Bogdan, R., & Biklen, S. K. (1997). *Qualitative research for education*. Allyn & Bacon Boston, MA.

Botha, R. (2016). Inquiry-based learning: improving South African schools. *Journal of Sociology and Social Anthropology*, *7*(2), 76-83.

Bradbury, L. U. (2015). More than food and fire: Exploring meanings of teachers' camp experiences. *Journal of Science Teacher Education, 26*(1), 27-44.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Brooks, J. G., & Brooks, M. G. (1993). *In search of understanding: The case for constructivist classrooms*. ASCD.

Brumann, C., Kurtiş, T., & Loeb, E. M. (2022). Understanding social influence: The role of intentionality in conformity and compliance. *Journal of Social Psychology, 162*(3), 263-281.

Burns, A. (2003). *Collaborative action research for English language teachers*. Ernst Klett Sprachen.

Bybee, R. W. (2002). Learning science and the science of learning. *NSTA Press*.

Bybee, R. W. (2014). NGSS and the next generation of science teachers. *Journal of Science Teacher Education*, *25*(2), 211-221.

Bybee, R. W. (2018). *STEM education now more than ever*. National Science Teachers Association Arlington, VA.

Capps, D. K., & Crawford, B. A. (2013). Inquiry-based instruction and teaching about the nature of science: Are they happening? *Journal of Science Teacher Education*, *24*(3), 497-526.

Çavaş, P. H., Holbrook, J., Kılınç, A., & Doğançay, Z. (2013). A comparative study of the effects of inquiry-based learning on science achievement and attitudes among students of different ethnic backgrounds. *Research in Science Education, 43*(2), 1061-1078.

Charmaz, K. (2014). *Constructing grounded theory* (2nd ed.). SAGE.

Chauke, B. (2023). *Teachers' experiences of teaching natural sciences in a second language: a case of primary schools in Mopani East District*

Cohen, L., & Manion, L. (1994). Introduction: The nature of inquiry. *Research Methods in Education*, *4*, 1-43.

Cohen, L., Manion, L., & Morrison, K. (2011). Planning educational research. *Research Methods in Education*.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education*. Routledge.

Connelly, L. M. (2015). Focus groups. *Medsurg Nursing*, *24*(5), 369-371.

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

Cope, M., & Elwood, S. (2009). *Qualitative GIS: a mixed methods approach*. Sage.

Council, N. R. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. National Academies Press.

Crawford, & Barbra. (2007). Learning to teach science as inquiry in the rough and tumble of practice. *Journal of Research in Science Teaching*, *44*(4), 613-642.

Creswell, J. W. (2009). *Mapping the field of mixed methods research.* In: SAGE publications Sage CA: Los Angeles, CA.

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. SAGE publications.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (Fifth edition ed.). Sage Publications.

Creswell, J. W., & Poth, C. N. (2017). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.

Creswell, J. W., Hanson, W. E., Clark Plano, V. L., & Morales, A. (2007). Qualitative research designs: Selection and implementation. *The Counseling Psychologist*, *35*(2), 236-264.

Creswell, J., & John, W. (2018). R*esearch Design. Qualitative, Quantitative, and Mixed Methods Approache*s. In: Fifth. London.

DeGraff, J. E. (2010). The changing environment of professional HR associations.

Demir, A., & Abell, S. K. (2010). Views of inquiry: Mismatches between views of science education faculty and students of an alternative certification program. *Journal of Research inSscience tTaching*, *47*(6), 716-741.

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2018). *The SAGE handbook of qualitative research* (5th ed.). SAGE.

Department of Basic Education. (2011). *Curriculum and assessment policy statement (CAPS)*. Pretoria, South Africa: Department of Basic Education.

Dewey, J. (1910). Science as subject-matter and as method. *Science*, *31*(787), 121-127.

Dewey, J. (1993). *How we think: A restatement of the relation of reflective thinking to the educative process*. D.C. Heath.

Dixon-Woods, M., Cavers, D., Agarwal, S., Annandale, E., Arthur, A., Harvey, J., Hsu, R., Katbamna, S., Olsen, R., & Smith, L. (2006). Conducting a critical interpretive synthesis of the literature on access to healthcare by vulnerable groups. *BMC Medical Research Methodology*, *6*(1), 35.

Dobber, M., Zwart, R., Tanis, M., & Van Oers, B. (2017). Literature review: The role of the teacher in inquiry-based education. *Educational Research Review*, *22*, 194-214.

Driver, R., Asoko, H., Leach, J., Mortimer, E., & Scott, P. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher, 23*(7), 5-12.

Dudu, W. T., & Vhurumuku, E. (2012). Teachers' practices of inquiry when teaching investigations: A case study. *Journal of Science Teacher Education*, *23*(6), 579-600.

Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: Implications for the design and delivery of instruction. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 170-198). Macmillan.

Duran, L. B., & Duran, E. (2004). The 5E Instructional Model: A Learning Cycle Approach for Inquiry-Based Science Teaching. *Science Education Review*, *3*(2), 49-58.

Dzansi, D. Y., & Amedzo, K. (2014). Integrating ICT into rural South African schools: Possible solutions for challenges. *International Journal of Educational Sciences*, *6*(2), 341-348.

Education, D. o. B. (2011). *Curriculum and assessment policy statement (CAPS)*. In: Department of Basic Education Pretoria, South Africa.

Eick, C. J., & Reed, C. J. (2002). What makes an inquiry-oriented science teacher? The influence of learning histories on student-teacher role identity and practice. *Science Education*, *86*(3), 401-416.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, *14*(4), 532-550.

Exline, J. (2004). *Inquiry-based learning: Exciting students to learn*. Intel Teach to the Future.

Finch, K. S. (2021). Development and validation of an instrument to measure social constructivism in a virtual classroom. *Learning*, *5*(1), 23-39.

Flick, L. B., & Lederman, N. G. (2006). *Scientific inquiry and nature of science*. Springer Netherlands.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry*, *12*(2), 219-245.

Fosnot, C. T. (1996). Constructivism: A psychological theory of learning. In C. T. Fosnot (Ed.), *Constructivism: Theory, perspectives, and practice* (pp. 8-33). Teachers College Press.

Fosnot, C. T. (2013). *Constructivism: Theory, perspectives, and practice*. Teachers College Press.

Freire, P. (2018). *Pedagogy of the oppressed*. Bloomsbury publishing USA.

Friesen, S., & Scott, D. (2013). Inquiry-based learning: A review of the research literature. *Alberta Ministry of Education*, *32*.

Fuller, R. G. (2003). "*Don't Tell Me, I'll Find Out" Robert Karplus—A Science Education Pioneer.* In: Springer.

Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and quasi-experimental studies of inquiry-based science teaching: A meta-analysis. *Review of Educational Research*, *82*(3), 300-329.

García-Montoya, L., & Mahoney, J. (2023). Critical event analysis in case study research. *Sociological Methods & Research*, *52*(1), 480-524.

Geier, R., Blumenfeld, P. C., Marx, R. W., Krajcik, J. S., Fishman, B., Soloway, E., & Clay-Chambers, J. (2008). Standardized test outcomes for students engaged in inquiry-based science curricula in the context of urban reform. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *45*(8), 922-939.

George, A. L., & Bennett, A. (2005). *Case studies and theory development in the social sciences*. mit Press.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Aldine de Gruyter.

Glaser, J. (1997). Socrates, Friendship and the Community of Inquiry. *Inquiry: Critical Thinking Across the Disciplines*, *16*(4), 22-46.

Goodrick, D. (2020). *Comparative case studies* (Vol. 9). SAGE Publications Limited Thousand Oaks, CA, USA.

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth generation evaluation*. SAGE.

Guerrero, J. S., & Bautista, R. G. (2023). Inquiry-Based Teaching In Secondary Science.

Gumede, V., & Biyase, M. (2016). Educational reforms and curriculum transformation in post-apartheid South Africa. *Environmental Economics*, *7*(2), 69.

Harkness, S. S. (2009). Social constructivism and the believing game: A mathematics teacher's practice and its implications. *Educational Studies in Mathematics*, *70*(3), 243-258.

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

Hennink, M. M. (2013). *Focus group discussions*. Oxford University Press.

Hennink, M., Hutter, I., & Bailey, A. (2020). *Qualitative research methods*. Sage.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99-107.

Hofstein, A., & Lunetta, V. N. (2004). The laboratory in science education: Foundations for the twenty-first century. *Science Education, 88*(1), 28-54.

Inel-Ekici, D., & Ekici, M. (2022). Mobile inquiry and inquiry-based science learning in higher education: advantages, challenges, and attitudes. *Asia Pacific Education Review*, *23*(3), 427-444.

Jinnah, Z. (2020). Negotiated precarity in the global south: A case study of migration and domestic work in South Africa. *Studies in Social Justice*, *2020*(14), 210-227.

Johnson, D. W., & Johnson, R. T. (2018). Cooperative learning: The foundation for active learning. *Active Learning, 1*(1), 1-15.

Johnson, S. (2018). *Effective teaching strategies in elementary science education*. Springer.

Johnson, S., & Smith, T. (2020). *Modern approaches to teaching science in elementary schools*. Pearson.

Juan, A., Hannan, S., & Namome, C. (2018). I believe I can do science: Self-efficacy and science achievement of Grade 9 students in South Africa. *South African Journal of Science*, *114*(7-8), 48-54.

Keeley, P., Eberle, F., & Tugel, J. (2007). *Uncovering student ideas in science: 25 new formative assessment probes*. NSTA Press.

Kesuma, M., Saputra, R. H., Syaputra, M. A., Fitra, J., & Romahdoni, M. R. (2022). Design Of Information Technology (IT) Governance Using Framework Cobit 2019 Subdomain APO01 (Case Study: Instidla). *J. Teknol. Komput. dan Sist. Inf*, *5*(3), 157-162.

Kidman, G., & Casinader, N. (2017). Inquiry-based teaching and learning across disciplines. *London: Palgrave Pivot*, *10*, 978-971.

Kim, M. (2022). Student agency and teacher authority in inquiry-based classrooms: Cases of elementary teachers' classroom talk. *International Journal of Science and Mathematics Education*, *20*(8), 1927-1948.

Kinyota, M. (2020). The status of and challenges facing secondary science teaching in Tanzania: a focus on inquiry-based science teaching and the nature of science. *International Journal of Science Education*, *42*(13), 2126-2144.

Krajcik, J., Schneider, B., Miller, E. A., Chen, I.-C., Bradford, L., Baker, Q., Bartz, K., Miller, C., Li, T., & Codere, S. (2023). Assessing the effect of project-based learning on science learning in elementary schools. *American Educational Research Journal*, *60*(1), 70-102.

Laase, E. (2011). The Socratic Method.

Larrivee, B. (2008). Development of a tool to assess teachers' level of reflective practice. *Reflective Practice*, *9*(3), 341-360.

Lederman, J. S. (2009). Teaching scientific inquiry: Exploration, directed, guided, and opened-ended levels. *National geographic science: Best practices and research base*, 8-20.

Lee, O., Hart, J. E., Cuevas, P., & Enders, C. (2004). Professional development in inquiry-based science for elementary teachers of diverse student groups. *Journal of Research in Science Teaching*, *41*(10), 1021-1043.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. SAGE.

Lipowski, K., & Seidel, T. (2009). Existing models of teacher professional development on IBST in seven European countries. *Mind the Gap FP7 project*, *217725*.

Luft, J. A., Firestone, J. B., Wong, S. S., Ortega, I., Adams, K., & Bang, E. (2011). Beginning secondary science teacher induction: A two-year mixed methods study. *Journal of Research in Science Teaching*, *48*(10), 1199-1224.

Lynch, J., Ramjan, L. M., Glew, P. J., & Salamonson, Y. (2020). How to embed a conceptual or theoretical framework into a dissertation study design. *Nurse Researcher*, *28*(3).

Mabope, L. A., Summers, B., Wium, A.-M., & Meyer, J. C. (2023). Selection Criteria and Outcomes in a Problem-Based Learning Bachelor of Pharmacy Programme in South Africa. *Africa Education Review*, 1-19.

Mackenzie, J. (2014). Peers on Socrates and Plato. *Educational Philosophy and Theory*, *46*(7), 764-777.

Mäeots, M., Pedaste, M., & Sarapuu, T. (2008). Transforming students' inquiry skills with computer-based simulations. 2008 Eighth IEEE International Conference on Advanced Learning Technologies,

Magaldi, D., & Berler, M. (2020). Semi-structured interviews. *Encyclopedia of Personality and Individual Differences*, 4825-4830.

Makgato, M. (2007). Factors associated with poor performance of learners in mathematics and physical science in secondary schools in Soshanguve, South Africa. *Africa Education Review*, *4*(1), 89-103.

Mansour, N. (2013). Consistencies and inconsistencies between science teachers' beliefs and practices. *International Journal of Science Education*, *35*(7), 1230-1275.

Maree, K. (2016). First steps in research second edition. *Great brand stories all share seven common traits, as evidenced by these top brands*.

Marée, R., Rollus, L., Stévens, B., Hoyoux, R., Louppe, G., Vandaele, R., Begon, J.-M., Kainz, P., Geurts, P., & Wehenkel, L. (2016). Collaborative analysis of multi-gigapixel imaging data using Cytomine. *Bioinformatics*, *32*(9), 1395-1401.

Marshal, C., & Rossman, G. (2006). *Designing qualitative research*. In: Thousand Oaks, CA: Sage.

Marshall, J. C., & Smart, J. B. J. C. E. (2013). Teachers' transformation to inquiry-based instructional practice. *4*(02), 132.

Mavuru, L. (2023). Performance Differences of Grade 8 Natural Sciences Learners Taught in Home Language and Second. *Book of Proceedings–Long Papers*, 256.

Mavuru, L., & Ramnarain, U. (2020). Learners' socio-cultural backgrounds and science teaching and learning: A case study of township schools in South Africa. *Cultural Studies of Science Education*, *15*, 1067-1095.

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

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Mhlolo, M. K. (2022). A Broken Promise for Gifted Learners: Re-Examining the National Strategy for Mathematical Sciences in South Africa Two Decades Later. *Creative Education*, *13*(3), 803-820.

Minner, D. D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction—what is it, and does it matter? Results from a research synthesis years 1984 to 2002. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *47*(4), 474-496.

Mkandla, J. (2021). *Teachers' perceptions and enactment of inquiry-based teaching to stimulate learner interest in science*

Mkimbili, S. T. (2023). Implementation of Inquiry-Based Science Teaching in Sub-Saharan Africa: A Review. *Theme: Contemporary Issues in Education: Linking Research and Practice 13th–14th January 2022*, 279.

Morrison, J., A. (2013). Data correlation for the drag coefficient for a sphere. *Department of Chemical Engineering, Michigan Technological University, Houghton, MI*, *49931*.

Mugabo, L., & Nsengimana, T. (2020). The impediments of inquiry-based learning in Rwanda lower Secondary education and ways of overcoming them. *Southern African Association for Research in Mathematics, Science and Technology Education*, 257.

Mugabo, R. L. (2015). Science teachers' understanding of inquiry-based science teaching (IBST): A case of Rwandan lower secondary school science teachers. *Rwandan Journal of Education*, *3*(1), 77-90.

Mumba, F., Banda, A., & Chabalengula, V. (2015). Nature of science understanding: Impact of a professional development program on elementary teachers. *Journal of Elementary Science Education, 27*(1), 55-67.

Nadelson, L. S., Callahan, J., Pyke, P., Hay, A., Dance, M., & Pfiester, J. J. T. J. o. E. R. (2013). Teacher STEM perception and preparation: *Inquiry-Based STEM Professional Development for Elementary Teachers. 106*(2), 157-168.

National Research Council (NRC). (1996). *National science education standards*. National Academy Press.

National Science Teachers Association (NSTA). (2003). *Standards for science teacher preparation*. NSTA Press.

National, R. C. (2000). *Inquiry and the national science education standards: A guide for teaching and learning*. National Academies Press.

Nemadziva, B., Sexton, S., & Cole, C. (2023). Science communication: The link to enable enquiry-based learning in under-resourced schools. *South African Journal of Science*, *119*(1-2), 1-9.

Neuman, W. L. (2011). *Social research methods: Qualitative and quantitative approaches* (7th ed.). Pearson.

Ngema, S. H. (2022). *The relationship between novice physical sciences teachers' beliefs and goals to inquiry-based instruction*

NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*. National Academies Press.

Nhlengethwa, K. B., Govender, N., & Sibanda, D. (2021). Primary school pre-service teachers' enactment of inquiry-based-science teaching. *Education 3-13*, *49*(3), 288-301.

Obe, W. H. (2018). *The teaching of science in primary schools*. Routledge.

Olivier, J., & Kruger, D. (2022). A framework for science education: Bridging the gap between research and practice. *Journal of Science Education, 42*(3), 405-421.

Olsen, W. (2011). *Data collection: Key debates and methods in social research*. Sage.

Onwuegbuzie, A. J., Leech, N. L., & Collins, K. M. (2010). Innovative data collection strategies in qualitative research. *Qualitative Report*, *15*(3), 696-726.

Osborne, J. (2014). Teaching scientific practices: Meeting the challenge of change. *Journal of Science Teacher Education*, *25*(2), 177-196.

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, *14*, 47-61.

Penn, M., & Ramnarain, U. (2022). South African grade 12 science students' understandings of scientific inquiry. *Science & Education*, 1-22.

Piaget, J. (1973). *To understand is to invent: The future of education*. Grossman.

Ramaila, S. (2020). Technology Integration In Natural Sciences Teaching And Learning In South African Township Schools. *Education and New Developments*, 102.

Ramey-Gassert, L., Shroyer, M. G., & Staver, J. R. (1996). A qualitative study of factors influencing science teaching self-efficacy of elementary level teachers. *Science Education, 80*(3), 283-315. https://doi.org/10.1002/(SICI)1098-237X(199606)80:3<283::AID-SCE2>3.0.CO;2-A

Ramnarain, U. (2014). Teachers' perceptions of inquiry-based learning in urban, suburban, township, and rural high schools: The context-specificity of science curriculum implementation in South Africa. *Teaching and Teacher Education, 38*, 65-75. https://doi.org/10.1016/j.tate.2013.11.003

Ramnarain, U. (2014). Teachers' perceptions of inquiry-based learning in urban, suburban, township, and rural high schools: The context-specificity of science curriculum implementation in South Africa. *Teaching and Teacher Education, 38*, 65-75. https://doi.org/10.1016/j.tate.2013.11.003

Ramnarain, U. (2023). The Inclusion of Nature of Science in South African Life Sciences and Physical Sciences School Curricula. *International Journal of Science and Mathematics Education*, 1-15.

Ramnarain, U., & Fortus, D. (2013). South African physical sciences teachers' perceptions of new content in a revised curriculum. *South African Journal of Education*, *33*(1).

Ramnarain, U., & Hlatswayo, M. (2018). Teacher beliefs and attitudes about inquiry-based learning in a rural school district in South Africa. *South African journal of education*, *38*(1).

Ramnarain, U., Capps, D., & Hsu, Y.-S. (2022). Professional development of science teachers for inquiry instruction. *Handbook of research on science teacher education*, 273-286.

Rasmitadila, R., Megan Asri, H., & Reza, R. (2022). Teachers' Perceptions of the Role of Universities in Mentoring Programs for Inclusive Elementary Schools: A Case Study in Indonesia. *Journal of Education and e-Learning Research*, *8*(3), 333-339.

Raths, J. (2001). Teachers' Beliefs and Teaching Beliefs.

Remenyi, D. (2022). *Case study research: The quick guide series*. UJ Press.

Ridgeway, W. (1910). *The origin of tragedy with special reference to the Greek tragedians*. CUP Archive.

Robinson, M. (2009). Practitioner inquiry in South African schools: what, how and why (not). *Educational Action Research*, *17*(1), 121-131.

Rodgers, J. C. (2012). The new economy: assessment of the institutionalization of an emerging paradigm and academic field through inquiry into prominent boundary organizations.

Roth, W.-M., Lee, S., & Hsu, P. L. (2011). A tool for developing better teaching and learning: Studying practice in new ways. *International Journal of Science Education, 33*(5), 779-807.

Russell, B., & Martin, S. (2014). *Developing inquiry-based science education: An international perspective*. Springer.

Seidel, S., & Watson, R. T. (2020). Integrating explanatory/predictive and prescriptive science in information systems research. *Communications of the Association for Information Systems*, *47*(1), 49.

Sharon, F., & Scott, D. (2013). Implementing inquiry-based learning in primary classrooms: Teachers' perspectives and challenges. *Research in Science Education, 43*(2), 617-632.

Sheehy, K., Wilson Kasule, G., & Chamberlain, L. (2019). Ugandan Teachers Epistemological Beliefs and Child-Led Research: Implications for Developing Inclusive Educational Practice. *International Journal of Disability, Development, and Education*, 1-16.

Silm, G., Tiitsaar, K., Pedaste, M., Zacharia, Z., C, & Papaevripidou, M. (2017). Teachers' Readiness to Use Inquiry-Based Learning: An Investigation of Teachers' Sense of Efficacy and Attitudes toward Inquiry-Based Learning. *Science Education International*, *28*(4), 315-325.

Simpson, W. D. (2012). The role of women in the utilization of inquiry-based science instruction. *Creative Education*, *3*(1), 75-78.

Sjøberg, S. (2010). Constructivism and learning. *International Encyclopedia of Education*, *5*, 485-490.

Smith, S. I. (2022). *Teachers' perceptions of their self-efficacy to engage elementary students in learning science* (Doctoral dissertation, Walden University). Walden University.

Spronken-Smith, R., Walker, R., Batchelor, J., O'Steen, B., & Angelo, T. J. T. i. H. E. (2011). Enablers and constraints to the use of inquiry-based learning in undergraduate education. *16*(1), 15-28.

Stake, R. E. (2010). Qualitative research: Studying how things work.

Strat, T. T. S., Henriksen, E. K., & Jegstad, K. M. (2023). Inquiry-based science education in science teacher education: a systematic review. *Studies in Science Education*, 1-59.

Sunal, D. (2015). Learning meaning through conceptual reconstruction. *Retrieved October 25th*.

Symington, D., Pearson, J., Kirkwood, V., Jones, A., Biddulph, F., Bell, B., Barker, M., & Carr, M. (2013). The constructivist paradigm and some implications for science content and pedagogy. In *The content of science: A constructivist approach to its teaching and learning* (pp. 159-172). Routledge.

Tavares, R., da Silva, F. M., & Costa, N. (2015). Inquiry-based learning in science education: Reflections on practice and research. *Science Education International, 26*(2), 150-169.

Taylor, N., Van der Berg, S., & Mabogoane, T. (Eds.). (2021). *Creating effective schools*. Pearson.

Toyon, M. A. S. (2021). Explanatory sequential design of mixed methods research: Phases and challenges. *International Journal of Research in Business and Social Science (2147-4478)*, *10*(5), 253-260.

UNESCO. (2015). *Rethinking education: Towards a global common good?* United Nations Educational, Scientific and Cultural Organization.

Van Doorn, J. R., & Van Doorn, J. D. (2014). The quest for knowledge transfer efficacy: blended teaching, online and in-class, with consideration of learning typologies for non-traditional and traditional students. *Frontiers in Psychology*, *5*, 324.

Veloo, A., Perumal, S., Vikneswary, R. J. P.-S., & Sciences, B. (2013). Inquiry-based instruction, students' attitudes and teachers' support towards science achievement in rural primary schools. *93*, 65-69.

Von Glasersfeld, E. (2013). *Radical constructivism* (Vol. 6). Routledge.

Vygotsky, L. (1978). S*ocio-cultural theory. Mind in society*.

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. Harvard university press.

Wang, J., & Zhao, Y. (2016). Comparative research on the understandings of nature of science and scientific inquiry between science teachers from Shanghai and Chicago. *Journal of Baltic Science Education*, *15*(1), 97.

Webster, R. S. (2011). Must Dewey and Kierkegaard's Inquiry for World Peace be Violent? *Educational Philosophy and Theory*, *43*(5), 521-533.

Wee, B., Shepardson, D., Fast, J., & Harbor, J. J. J. o. s. t. e. (2007). Teaching and learning about inquiry: Insights and challenges in professional development. *18*(1), 63-89.

Wenning, C. J. (2005). Levels of inquiry: Hierarchies of pedagogical practices and inquiry processes. J. Phys. Teach. Educ. Online,

Wenning, C. J. (2011). The levels of inquiry model of science teaching. *Journal of Physics Teacher Education Online*, *6*(2), 9-16.

Wilhelm, P., & Beishuizen, J. (2003). Content effects in self-directed inductive learning. *Learning and Instruction*, *13*(4), 381-402.

Wilson, C. E. (2020). The effects of inquiry-based learning and student achievement in the science classroom.

Windschitl, M. (2004). Folk theories of inquiry: How preservice teachers reproduce the discourse and practices of an atheoretical scientific method. *Journal of Research in Science Teaching, 41*(5), 481-512.

Windschitl, M., & Calabrese Barton, A. (2016). Rigor and equity by design: Locating a set of core teaching practices for the science education community. *Science Education,

Xaba, N., & Sondlo, A. (2023). Applying Inquiry-Based Learning Into Practice: A Case Study Of One Rural South African Physical Sciences Teacher. *Education Applications &*

*Developments VIII Advances in Education and Educational Trends Series Edited by: Mafalda Carmo*, 505.

Xiuhong, Y. (2006). On constructivism and computer assisted college English teaching mode. *Foreign Language World*, S1.

Yin, R. K. (2018). *Case study research and applications*. Sage.

# APPENDICES

## APPENDIX A

## QUESTIONNAIRE

The Instrument for Data Gathering - Questionnaire

The purpose of this instrument is to gather data on the Natural Sciences teachers' biographies, understandings, and practices of Inquiry-Based Science Teaching. It is important that you answer each question carefully so that the information provided reflects your situation and experience as accurately as possible. It is estimated that it will require approximately 30 minutes to complete this questionnaire. Your cooperation in completing this questionnaire is greatly appreciated. Once you have completed the questionnaire, I will collect them from you. Thank you for your time, effort, and thought in completing this questionnaire.

**SECTION A (BIOGRAPHY)**

1. What is your age? *(please tick the appropriate box)*

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **26-30yrs** | | **31-35yrs** | | **36-40yrs** | | | **41-45yrs** | | **46-50yrs** | | **51-55yrs** | | **Above 55yrs** | |

2. How many years of teaching experience do you have? *(please tick the appropriate box)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1-5yrs** | | **6-10yrs** | | **11-15yrs** | | **16-20yrs** | |

3. How many years of teaching experience do you have in teaching Natural Sciences? *(please tick the appropriate box)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1-5yrs** | | **6-10yrs** | | **11-15yrs** | | **16-20yrs** | |

4a. Have you attended workshops on Teaching Sciences in the Primary phase? Yes ☐ No ☐

4b. If yes, list the names of the workshops attended.

4c. State the content of the workshops attended.

**SECTION B (UNDERSTANDINGS)**

1a. What is your understanding of how Natural Sciences should be taught?

2b. What informed your understanding of how Natural Sciences should be taught? *(Tick all those that are appropriate)*

From my professional studies ☐

Interaction with other teachers ☐

Support from school management ☐

Workshop from the Department of Education ☐

3. To what extent do you agree or disagree with each of the following statements?

**Key: SD-** strong disagree, **D-**disagree, **A-**agree, **SA-**strongly agree

| **Teacher action** | **SD** | **D** | **A** | **SA** |
|---|---|---|---|---|
| Science is primarily an abstract subject | | | | |
| Science is primarily a formal way of representing the real world | | | | |
| Science is primarily a practical and structured guide for addressing real situations | | | | |
| Some students have a natural talent for science and others do not | | | | |
| It is important for teachers to give learners prescriptive and sequential directions for doing experiments | | | | |
| Focusing on rules is a bad idea which gives rise to memorising | | | | |

4. Do you think that teachers should:

| | **Teacher action** | **Yes** | **No** |
|---|---|---|---|
| 4a | Show learners how to use tools or material | | |

| | | | |
|---|---|---|---|
| 4b | Help learners to form tentative explanations, while moving towards content learning | | |
| 4c | Guide learners in taking more and more responsibility in investigations | | |
| 4d | Introduce tools and materials and scientific ideas appropriate to content learning | | |
| 4e | Use appropriate content terminology, as well as scientific language | | |
| 4f | Talk to learners, ask questions, make suggestions and interact | | |

5a. Have you heard about Inquiry-based science teaching? **Yes** ☐ **No** ☐

5b. If yes, how do you understand it?

---

6a. Do you teach science through IBST? **Yes** ☐ **No** ☐

6b. If yes, briefly describe how you teach.

**SECTION C (PRACTICES)**

1. In one typical work week from Monday to Friday, how many periods are you scheduled to teach Natural Sciences? Write in number …12……………. (count double period as two singles)
2. In one typical work week from Monday to Friday, how many periods are you scheduled to perform each of the following tasks? (count double period as two singles)

2a. Supervising learners rather than teaching …0…………………………………………

2b. Learner counseling ……………0…………………………………………………………

2c. Administrative duties …………0…………………………………………………………

2d. Individual curriculum planning …0……………………………………………………

2e. Actual practical work with learners……4……………………………………………

3. In your science lessons, how often do ask learners to do the following?

**Key: NL-** never lesson, **AN**-almost never, **SL**-some lessons, **ML**-most lessons

| **Learner actions** | **NL** | **AN** | **SL** | **ML** |
|---|---|---|---|---|
| Explain the reason behind an idea | | | | |
| Represent and analyse relationships using chats, tables or graphs | | | | |
| Work on problems for which there is no immediate solution | | | | |
| Use computers to solve problems | | | | |
| Write explanations about what was solved and why it happened | | | | |

| | | | | |
|---|---|---|---|---|
| Put events or objects in order and give reasons | | | | |

3. How often do the learners perform the following in your NS class?

**Key: NL-** never lesson, **AN**-almost never, **SL**-some lessons, **ML**-most lessons

| **Learner actions** | **NL** | **AN** | **SL** | **ML** |
|---|---|---|---|---|
| Work individually without assistance from the teacher | | | | |
| Work individually with assistance from the teacher | | | | |
| Work together as a class with the teacher teaching the class | | | | |
| Work together as a class with learners responding to one another | | | | |
| Work in pairs or small groups without assistance from the teacher | | | | |
| Work in pairs or small groups with assistance from the teacher | | | | |

4. In your view, to what extent do the following affect or limit you in how you teach science class?

**Key: NAA-** not at all, **QAL**-quite a little, QG- quite greatly

| **Learner actions** | **NAA** | **QAL** | **QG** |
|---|---|---|---|
| Learners with different academic abilities | | | |
| Learners who come from a wide range of backgrounds, (e.g., economics, language) | | | |
| Uninterested students | | | |
| Learners with special needs, (e.g., hearing, vision, speech impairment, physical disabilities, mental or emotional/psychological impairment) | | | |
| Disruptive students | | | |
| Shortage of other instructional equipment for students' use | | | |
| Shortage of equipment for your use in demonstrations and other exercises | | | |
| High student/teacher ratio | | | |
| How well learners do on projects or practical/laboratory exercises | | | |

| | | | |
|---|---|---|---|
| Responses of learners in the class | | | |
| Critical observations of learners in the class | | | |
| Availability of physical facilities in class | | | |

## APPENDIX B

## INTERVIEW SCHEDULE (SEMI-STRUCTURED)

The purpose of this instrument is to gather data on the Natural Sciences teachers' biographies, understandings, and practices regarding Inquiry-Based Science Teaching. You must answer each question carefully so that the information provided reflects your situation and experience as accurately as possible. It is estimated that it will require approximately 20 minutes to complete this interview. Your cooperation in completing this interview is greatly appreciated. Thank you for your time, effort, and thought in completing this interview.

1. Indicate your familiarity with each of the following documents: *(Tick in the appropriate box).*

| Teacher action | No such document | Not familiar | Familiar | Very familiar |
|---|---|---|---|---|
| 1a. CAPS document | | | | |
| 1b. District curriculum guide | | | | |
| 1c. School curriculum guide | | | | |

2. What are some of the strategies you use in teaching natural science in your class?

3. In your teaching process in class, do you involve learners? If yes, how?

4. How do u go about teaching science in class?

**Prompt**: what methods do you employ in teaching science that allow learners to be actively involved in the teaching and learning processes?

5. How does the method you employ in the teaching affect the learning outcomes of your learners?

6. What are some of the tools, equipment, and materials that assist you in your teaching?

**Prompt**: Can you mention some of these tools, materials or equipment?

7a. Have you heard about inquiry-based science teaching methods?

7b. If yes, how ow do you understand IBST?

7c. What activities and processes do you consider as IBST?

8. Do you think teaching science through IBST makes any difference in learning outcomes?

9. Do you teach science through IBST? If yes or No, why?

## APPENDIX C

## FOCUS GROUP INTENTION QUESTIONS

The following are purpose questions used to have a conversation with natural science teachers who took part in the study about Inquiry-Based Science Teaching (IBST):

1. What impact do you think Inquiry-Based Science Teaching (IBST) has on learners' capacity to participate in scientific processes?
2. Based on your involvement in IBST research, how do you think this methodology advances the creation of new scientific understanding in the natural sciences?
3. Could you elaborate on how your learners' ability to actively engage in scientific processes has been impacted by inquiry-based science teaching?
4. How, in your opinion, has IBST improved learners' comprehension of the nature of science and the methods scientists employ to generate knowledge?
5. As a teacher who teaches natural sciences, what obstacles or achievements have you seen in developing in your learners the capacity to do scientific procedures as well as the understanding of these procedures?
6. How does IBST, according to the research, correspond with the basic tenets of contemporary science methodology?
7. Could you elaborate on any tactics or methods you have used to incorporate IBST into your teaching and how they have affected the performance of your learners?

8. As stressed by the idea of IBST, how do you strike a balance between making sure learners actively participate in scientific processes and making sure they learn about the processes?

9. What part, in your view, does IBST play in fostering a deeper comprehension of scientific principles and preparing learners for a future in science?

10. As a study participant, how do you see IBST affecting learners' general scientific literacy and understanding of science in the long run?

# APPENDIX D

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

11 July 2023

**Andrew Chebure (219091622)**
**School Of Education**
**Edgewood Campus**

**Dear A Chebure,**

**Protocol reference number:** HSSREC/00001791/2020
**Project title:** How Natural Science Teachers Use and Practice Inquiry-Based Science Teaching in Primary Schools –An Action Research Project
**Amended title:** How Natural Science teachers understand and practice inquiry-based science teaching in primary schools – Case study research project
**Degree:** PhD

**Approval Notification – Amendment Application**

This letter serves to notify you that your application and request for an amendment received on 10 July 2023 has now been approved as follows:

- Change in title

**Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.**

**PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.**

HSSREC is registered with the South African National Health Research Ethics Council (REC-040414-040).

Best wishes for the successful completion of your research protocol.

Yours faithfully

[redacted]

…………………………………………………………
**Professor Dipane Hlalele (Chair)**

**/dd**

**Humanities & Social Sciences Research Ethics Committee**
**UKZN Research Ethics Office Westville Campus, Govan Mbeki Building**
**Postal Address:** Private Bag X54001, Durban 4000
**Tel:** +27 31 260 8350 / 4557 / 3587
**Website:** http://research.ukzn.ac.za/Research-Ethics/

# APPENDIX E

Appendix D

**LETTER SEEKING PERMISSION TO CONDUCT RESEARCH AT COLLEGES**

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

**FACULTY OF EDUCATION**
**(EDGEWOOD CAMPUS)**
**School of Mathematics and Technology Education**
*Edgewood Campus*
*Private Bag X03*
*Ashwood*

The Principal
New Germany Primary School

Sir,
**Permission to Conduct Research in your School**

The purpose of this correspondence is to request for permission to carry out my research study in your school. I am a student at the University of KwaZulu - Natal in South Africa currently studying towards a PhD in Science Education. My study is focusing on the topic **"How Natural Science Teachers Use and Practice Inquiry-Based Science Teaching (IBST) in Primary Schools –An Action Research Project"**. The purpose of this study is to explore natural sciences teachers' understandings and practices of inquiry-based science teaching (IBST) in primary schools. The methods that will be used to generate data are individual in-depth interviews, questionnaire, observations and focus group discussion. I will also review and analyze documents such as teacher educators work schedule (Action plan) and assignments and test papers.

Confidentiality and anonymity of the teachers and the school will be maintained throughout the study and in the writing of the report. The names of the teachers as well as the school will not be disclosed at any point during and after the study. The teachers and the school will be identified by pseudonyms.

Teacher educators' participation in the study is voluntary and can withdraw from this study at any time. The data will be kept in a secure place by the University for a period of five years after submission of the thesis, after which the documents will be shredded and video cassettes will be incinerated. All the electronic copies in my computer will be deleted.

Please find enclosed herein my contact, that of my supervisor and the research department of the university if you have any queries regarding the study.

Yours sincerely,

Andrew Chebure
Students Number: 219091622
E-mail: andychebure@gmail,com
Tel. No. +27671981956

**Supervisor:** Dr. Angela James
Tel. No. +27735114558
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**HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION**
Research Office, Westville Campus
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Tel: 27 31 2604557- Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

## DECLARATION

## Research Study in Science Education

I ..[redacted]............................... (full name) hereby confirm that I understand the contents of this document and the nature of the study and I hereby grant permission to the researcher to conduct research in my school.

I hereby provide consent to (**by ticking as applicable**) whether or not you are willing to allow the interview and classroom observation to be recorded by the following instruments:

| | Yes | No |
|---|---|---|
| **Audio record my interview** | ✓ | |
| **Video record my lesson** | ✓ | |
| **Video record focus group discussion** | ✓ | |

[redacted]

Signature of Principal

KWA-ZULU NATAL DEPARTMENT OF EDUCATION & CULTURE
NEW GERMANY PRIMARY SCHOOL
P.O. BOX 402
NEW GERMANY 3620

2020-03-12

Date

# APPENDIX F

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

**Enquiries: Phindile Duma/Buyi Ntuli** | Tel: 033 392 1063/51 | Ref.:2/4/8/4064

Mr Andrew Chebure
401 Anderson Court
1 Anderson Street
**PINETOWN**
3610

Dear Mr Chebure

**PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS**

Your application to conduct research entitled: **"HOW NATURAL SCIENCE TEACHERS USE AND PRACTICE INQUIRY-BASED SCIENCE TEACHING (IBST) IN PRIMARY SCHOOLS – AN ACTION RESEARCH PROJECT"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 07 February 2020 to 10 January 2022.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma /Mrs Buyi Ntuli at the contact numbers above.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

[redacted]

**Dr: EV Nzama**
**Head of Department: Education**
**Date: 07 February 2020**

**KWAZULU-NATAL DEPARTMENT OF EDUCATION**
**Postal Address:** Private Bag X9137 • Pietermaritzburg • 3200 • Republic of South Africa
**Physical Address:** 247 Burger Street • Anton Lembede Building • Pietermaritzburg • 3201
**Tel.:** +27 33 392 1063 • **Fax.:** +27 033 392 1203• **Email:**Phindile.Duma@kzndoe.gov.za •**Web:**www.kzneducation.gov.za
Facebook: KZNDOE....Twitter: @DBE_KZN....Instagram: kzn_education....Youtube:kzndoe

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**APPENDIX G**

## Language Editing Certificate

**Registered with the South African Translators' Institute (SATI)**

**Reference number 1000686**

06 February 2024

***HOW NATURAL SCIENCES TEACHERS UNDERSTAND AND PRACTICE INQUIRY-BASED SCIENCE TEACHING IN A PRIMARY SCHOOL: A CASE STUDY RESEARCH***

This confirms that I edited substantively the above document, including a Reference list. The document was returned to the author with various tracked changes to correct errors and clarify meaning. It was the author's responsibility to attend to these changes.

Yours faithfully

[redacted]

Dr. K. Zano

Ph.D. in English

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+27631434276

# APPENDIX H

iafor

THE INTERNATIONAL ACADEMIC FORUM

international | intercultural | interdisciplinary

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**The IAFOR International Conference on Education in Hawaii (IICE2024)**

**Hawaii Convention Center | Wednesday, January 3, 2024 to Sunday, January 7, 2024**

**October 26, 2023**
**Corresponding Author: Andrew Chebure, University of KwaZulu Natal, South Africa**
**Contact Email: andychebure7@gmail.com**

**Submission Title: How Natural Sciences Teachers Understand and Practice Inquiry-Based Science Teaching in Primary Schools – Case Study Research Project in South Africa**
**Submission Number: 76951**
**Authors: Andrew Chebure**
**Presentation Type: Oral Presentation**

**Dear Mr Chebure,**

**On behalf of the IICE2024 Organising Committee, I am pleased to inform you that your Oral Presentation proposal, "How Natural Sciences Teachers Understand and Practice Inquiry-Based Science Teaching in Primary Schools – Case Study Research Project in South Africa", for IICE2024 has met the accepted international academic standard of blind peer review, and has been accepted for presentation.**

**The conference will be held in Hawaii, United States, and online from Wednesday, January 3, 2024 to Sunday, January 7, 2024. For more detailed information about the conference, please visit the conference website.**

**To confirm your participation in the conference, please register by Thursday, November 16, 2023. Once you have registered, if you cannot present for any reason, please notify the conference team at support@iafor.org. We are only able to accommodate schedule requests for religious reasons or other exceptional and unavoidable circumstances.**

**Thank you for submitting to The IAFOR International Conference on Education in Hawaii. We look forward to welcoming you to the conference.**

**Yours Sincerely,**

[redacted]

**Joseph Haldane, PhD (London), F.R.A.S.**
**Chairman & CEO, IAFOR**

**The International Academic Forum (IAFOR),**
**Sakae 1-16-26 - 201, Naka Ward, Nagoya, Aichi, Japan 460-0008**
**International, Intercultural, Interdisciplinary**

# APPENDIX I

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## Turnitin Originality Report

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