Teachers' perceptions and enactment of inquiry- based teaching to stimulate learner interest in science

by

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I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the dissertation to originality-checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

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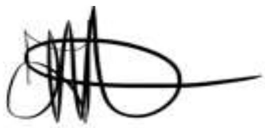

SIGNATURE

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ACRONYMS AND THEIR MEANING

ATP	Annual Teaching Plan
GDE	Gauteng Department of Education
DBE	Department of Basic Education
OBE	Outcomes Based Education
RNCS	Revised National Curriculum Statements
CAPS	Curriculum and Assessment Policy Statements
NS	Natural Sciences
GET	General Education and Training
FET	Further Education and Training
NRC	National Research Council
SMT	School management team
SACE	South African Council of Educators
IQMS	Integrated Quality Management Systems
REC	Research Ethics Committee
UNISA	University of South Africa
PCK	Pedagogical Content Knowledge
UK	United Kingdom
EU	European Union
IBST	Inquiry-Based Science Teaching
IBL	Inquiry-Based Learning
IBSE	Inquiry-Based Science Education
SQBI	Student Question-Based Instruction
NOSI	Nature of Science Instruction
NEPA	National Education Policy Act
COVID 19	Life-threatening disease caused by SARA-CoV-2 virus
P.G.C.E	Post Graduate Certificate in Education

P.G.D.E	Post Graduate Diploma in Education
H.Ed.D	Higher Educational Diploma
B.Sc	Bachelor of Sciences
B.Sc.Ed	Bachelor of Science Education
B.Sc. Hons	Bachelor of Science (Honours)
M.Sc.	Master of Sciences
H.O.D	Head of Department

Dedication

I dedicate this study to all the reflective Natural Sciences teachers who desire to stimulate learner interest in science subjects.

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I owe my heartfelt gratitude to:

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ABSTRACT

This qualitative, single high school case-study conveniently sampled eight natural sciences teachers and, after conducting lesson observations and document analysis, interviewed all participants to obtain their perceptions about the effectiveness of inquiry-based teaching in motivating learners to specialise in sciences. The major finding was that most participants were sceptical about inquiry-based teaching. Participants from a behaviourist epistemology did not believe that learner motivation resulted from inquiry-based teaching while those from an eclectic epistemology preferred a complementary use of both approaches. The few participants oriented towards inquiry acknowledged the link between learner motivation and inquiry-based teaching but faced the challenge of limited time to prepare all the apparatus and procedures required for inquiry-based teaching. This researcher recommends employing laboratory assistants to assist teachers with setting up apparatus for inquiry-based lessons, trimming some content to reduce overload in the Annual Teaching Plans (ATP), and in-service training on inquiry-based teaching to develop learner interest in sciences.

Science teaching, logical positivism, inquiry-based teaching, motivation, behaviourist teaching approach.

OPSOMMING

Hierdie kwalitatiewe gevallestudie het agt natuurwetenskap onderwysers betrek en na leswaarnemings en dokumentanalise, is onderhoude met die deelnemers gevoer om hul sienings te bekom oor die bydrae van die ondersoek-gebaseerde konstruktivistiese benadering as ’n strategie om leerders te motiveer om in wetenskap-verwante vakke te spesialiseer. Die belangrikste bevindings was dat die deelnemers logiese positivistiese en eklektiese benaderings verkies; dat hulle skepties is oor ondersoek-gebaseerde onderrig en dat hulle nie leerder motivering aan onderwysbenaderings koppel nie. Daar was egter enkele deelnemers wat wel ondersoekend onderrig het en wat leerder belangstelling in wetenskap aan ondersoek-gebaseerde onderrig gekoppel het. Op grond van die data wat verkry is, beveel hierdie navorser aan dat laboratoriumassistente aangestel moet word om onderwysers by te staan met die opstel van apparaat vir ondersoek-gebaseerde lesse; dat spesifieke modelle van ondersoek in die “CAPS”-dokument ingesluit word; dat inhoud afgeskaal moet word om oorlading in die jaarlikse onderrigplanne (ATP) te verminder, en dat voor- en indiensopleiding aan onderwysers

oor ondersoek-gebaseerde onderrig verskaf word as ‘n manier om die belangstelling van die leerders in die wetenskappe te prikkel.

Wetenskaponderrig, logiese positivisme, eklektisisme, epistemologie, ondersoek-gebaseerde konstruktivistiese onderrig, wetenskaplike motivering, onderrig benadering.

I Abstract yocwaningo

Lesisifundo socwaningo esenziwe esikoleni esisodwa samabanga aphakeme lwakhetha othisha beSayensi Yemvelo (NS) abayisishiyagalombili ukuze kwazakale ukuthi bayibona kanjani indlela yokufundisa iSayensi ngophenyo (inquiry-based teaching) ehlose ukukhuphula intshisekelo yabafundi kwiSayensi. Ngemuva kokubona othisha beSayensi befundisa, lomcwaningi wahlaziya incwadi eziphathelene nokufundiswa kohlelo lwe CAPS, waphinde wenza izingxoxo nabothisha. Okumqoka okutholakale kuloluphenyo kube ukuthi iningi lababambe iqhaza, abakhuthalela ukufundisa ngendlela egxile kuthisha (logical positivism) bangabaza ukuthi abafundi bafunde bephenya njalo abakubonanga ukuxhumana kwenzindlela zokufundisa nokunyuka kwentshiseko yabafundi ezifundweni ze Sayensi. Ababambiqhaza abahlanganisa indlela yokufundisa egxile kuthisha ne ndlela yokufundisa ngophenyo (eclectic) bakholelwa ukuthi indlela yokufundisa egxile kuthisa nendlela yokuthi abafundi bafunde bephenya, kuyomela zisetshenziswe zombili. Kwatholakala ingcosana yabothisha eyenelisa ukufundisa isayensi ngendlela yophenyo eyayisezingeni eliphansi njalo yaqinisekisa ukuthi bukhona ubudlelwano phakathi kwendlela zokufundisa nokunyusa intshiseko yabafundi kwi Sayensi. Ngokolwazi olutholakele, lolucwaningo luncome ukusebenzisa abasizi basemagunjini okusebenzela ososayensi ukusiza ukuhlela amalungiselelo okwenza uphenyo lwezifundo, nokuhlinzekwa kwezindlela eziqondile zokuphenya izincwadi zikaCAPS, kanye nokunciphisa okunye okuqukethwe, kwehliswe umthwalo kuhlelo lokufundisa lonyaka (i-ATP), ukuqeqeshwa kothisha kwi ndlela yokufundisa iSayensi ngokuphenya ukuze kuthuthukiswe intshiseko yabafundi.

Ukufundiswa kwesayensi, **Indlela yokufundisa egxile kuthisha, Indlela yokufundisa ehlanganisa ukugxila kuthisha ne ndlela yophenyo, Imfundo lwazi, intshiseko, Imibono ngendlela zokufundisa.**

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CHAPTER 1
ORIENTATION

1.1 INTRODUCTION

Inquiry-based science teaching (IBST) is gaining traction in contemporary science teaching pedagogy (Ramnarain & Hlatshwayo 2018:1) and it is important to seek teachers' perceptions about this relatively new curriculum innovation within the South African context. Luneta (2011:26), in tandem with Alabdukareem (2017:68) states that the investigation of teachers' epistemological perceptions and practices can provide pedagogical solutions that lead to their professional growth. Gunstone (2012:429) also states that research into teacher thinking offers potential insight into ways of promoting better teaching. The process of evaluating teachers' perceptions about inquiry-based teaching can assist in establishing better practices that promote improved learner motivation in science subjects.

1.2 INQUIRY BASED TEACHING

Williams (2018:22) states that numerous international science curriculum documents require teachers to teach through the inquiry-based approach. (Chen, Mineweaser, Acceta and Noonan (2018: 25) also state that inquiry-based teaching is a relatively new innovative practice that requires learners to carry out scientific investigations instead of cramming facts from a textbook. Draghicescu, Petrescu, Cristea, Gorghiu and Gorghiu (2014) propose that there is a relationship between learner interest in science and the use of inquiry-based teaching. Teachers, however, tend to have their own epistemological orientations that influence their perceptions.

1.3 TEACHERS' EPISTEMOLOGICAL ORIENTATIONS

Epistemology, according to the https://www.merriam-webster.com/dictionary refers to the theory of the nature of knowledge and how knowledge is acquired. Mahmood (2013:298) says that it is important to know each teacher's episteme to get useful insights to his or her perceptions about teaching and learning. Mansour (2009:31) states that teachers' perceptions about learning can become personal epistemologies or theories that guide their practices. It is therefore important to understand what teachers think about epistemological issues that guide science teaching. The two major epistemological orientations of science teachers discussed in this study are inquiry-based teaching and teacher-based behaviourist teaching. These two approaches are the crux of this study because they represent the two major dichotomies that influence educational practice.

1.3.1 Theoretical basis of behaviourist-oriented teaching

Llewellyn (2013:69) states that the epistemological base of behaviourism is founded on the didactic approach that positions learners as empty vessels that can be filled with knowledge. In other words, emphasis is placed on the teaching of scientific facts, laws, principles, and theories through the lecture-oriented approaches. The classical (teacher-centred) approach dates from the stimulus-response theory based on Thorndike (1913), who argued that learning was habit formation. It was believed that knowledge resulted from the repeated accumulation of the stimulus-response associations (Ornstein & Hunkins 2018:113). Thorndike's (1913) experiments proved that learning involved the formation of associations or connections between sensory experiences and neural impulses that manifested themselves in behaviours (Schunk, Meece & Pintrich 2014:21). Skinner's (1953) operant conditioning theory also supported the stimulus-response theory which was the genesis of teacher-centred pedagogy. He claimed that learners were blank slates that needed manipulation by the environment. Pollard (2014) suggests that behaviourism (logical positivism) is based on the 'deficit view' of learners. Teachers who believe that learners lack knowledge tend to control every part of the teaching/learning process. Behaviourist oriented teachers perceive memorisation techniques as efficient in transmitting knowledge within limited time frames. They also believe that learners can be motivated to learn when a teacher acts as the stimulus to initiate all learning activities (Schunk et al 2014:21).

1.3.2 The major limitations of behaviourist epistemology.

Research has found that teacher-centred lessons are detrimental to the learners' desire to learn (Campbell & Bohn 2008; Shah 2019:4; NRC 2005). In the case of science, the main limitation of behaviourism is that learners tend to be overly dependent on the teacher and this deprives them of the opportunity to explore scientific knowledge. This is because communication between teachers and learners tends to be a boring, mundane transfer of existing information from books and is demotivating (Asego & McNeil 2017:13). The other challenge associated with logical positivism is the assumption that all learners have the same background knowledge and therefore the one-size-fits-all approach is applied, usually in an expository style. Shah (2019:7) maintains that teachers cannot apply the one-size-fits-all when teaching science; instead, they should provide lessons that cater for a range of learner abilities to stimulate learning.

1.3.3 Theoretical basis of on inquiry-based teaching

There is a pedagogical shift in contemporary curriculum theory aiming at encouraging teachers to incorporate scientific inquiry in their practice as means to enhance learners' interest in science. (Dillon, 2009; Gudyanga & Jita 2019:715). The inquiry-oriented approach emanated from the appreciation of the fact that learner interest in science subjects develops through a process that allows them to obtain scientific knowledge by investigating phenomena, rather than listening to the teacher and summarising main ideas. Keller, Neumann, and Fischer (2016:586) believe that inquiry- based teaching is a major determinant and predictor of learner motivation and teachers' self-efficacy. Inquiry based teaching can be done in different phases that promote a hands-on approach to teaching and learning.

1.4 Phases of the inquiry-based teaching

Bybee's (2006) 5E model outlines various phases of inquiry-oriented, constructivist lessons. These 5Es are engagement, exploration, explanation, elaboration or extension, and evaluation. A brief discussion of each phase follows: The *engagement phase* begins with some activities set to create interest by using stimulating questions that seek to determine what learners already know about the topic. When prior knowledge has been obtained, the teacher proceeds to the next stage. The *exploration stage,* according to Chen, Mineweaser, Accetta, and Noonan (2018:26), allows the collection of data through the investigation process, which provides the opportunity for the development of various scientific process skills. An attempt at *explanation* follows that enables learners to suggest an explanation. The next phase is *elaboration or extension,* whereby the scientific concept that has been taught is extended beyond the classroom, into real-life situations. Finally, the *evaluation* phase assesses evidence of learning. It is vital to cite some research findings on how some science teachers perceived inquiry-based teaching.

1.5 TEACHER PERCEPTIONS OF INQUIRY-BASED TEACHING

Research that has been done on teacher perceptions indicates that some researchers within South Africa and abroad revealed that some teachers had different perceptions about inquiry-based science teaching, particularly the belief that it is not as effective as behaviourist-oriented approaches (Ramnarain & Hlatshwayo 2018:2**).** They also perceived inquiry-based teaching as challenging (Silm, Tiitsaar, Pedaste, Zacharia & Papaevripidou 2017:375), due to limited availability of resources such as laboratories and relevant teaching apparatus.

1.6 AN INDICATION OF LIMITED SCIENCE LEARNER DEMOTIVATION

The limited learner enrolment in sciences was revealed in the *Business Tech* newspaper report (2018), which indicated that a total of 217 300 high school learners wrote the Physical Sciences in 2008. This dropped to 184 056 in 2011 and 171 549 in 2014. In terms of percentage, 37.8% enrolled for the subject in 2008, 35.3% in 2011 and 32.7**%** in 2014. According to the *Business Tech* report, the 2017 matric results indicate that there were close to 75 000 fewer matriculants who wrote the Physical Sciences examination in 2017, compared with those in 2016. This suggests that many learners opted not to take Physical Sciences at FET level. This necessitates an investigation into teachers' perceptions about inquiry-based teaching to solve the problem of limited learner interest in science.

1.7 THE PROBLEM STATEMENT

The inquiry-based Natural Sciences curriculum for the senior phase level (Grades 7 to 9) serves as a foundation for further studies in pure sciences (DBE 2011:11), but most learners prefer not to specialise in science beyond compulsory schooling level, despite the introduction of inquiry-based teaching. Teachers are at the core of curriculum implementation (Shalem & Peddlebury 2010:27); their perceptions about inquiry-based teaching can provide pedagogical insights that can enhance learner motivation in science. Teacher perceptions about inquiry are a problem that relates to curriculum delivery, and its investigation can improve the quality of learning and hopefully stimulate learner interest in science.

1.8 RESEARCH QUESTION AND SUB QUESTIONS

Based on the preceding discussion of the problem statement, the research questions for this study are:

- What are Natural Sciences teachers' perceptions on the use of inquiry-based teaching to stimulate learner interest in science?
- To what extent is the Natural Sciences teachers' classroom practice aligned to the principles of inquiry-based teaching?

The following sub-questions apply:

- What are the epistemological orientations of Natural Sciences teachers at a particular high school in Pretoria?
- What are Natural Sciences teachers' understanding of the inquiry-based approach as a way to stimulate learner interest in science subjects?
- To what extent is the Natural' Sciences teachers' classroom practice aligned with principles of inquiry-based learning and teaching?
- What problems do teachers face in their attempt to implement inquiry-based teaching?

1.8.1 Aim and objectives

The aim of this research is two-pronged:

- To explore Natural Science teachers' perceptions on the effectiveness of using an inquiry-based teaching to develop learners' interest in science subjects in a high school in Pretoria.
- To determine the extent to which the Natural Sciences teachers' classroom practice is aligned with principles of inquiry-based teaching.

This study will:

- Discuss Natural Sciences teachers' perceptions of inquiry-based teaching.
- Determine the epistemological orientation of Natural Sciences teachers in a specific high school in Pretoria.
- Determine the extent to which teachers' practice reflects principles of inquiry-based learning and teaching.

1.8.2 Research site issues and concerns

At this specific school, teachers seemed eager to teach content so that they could cover the Annual Teaching Plan within stipulated time frames. Emphasis was placed on providing evidence of learning in the learners' workbooks in the form of regular informal and formal tests and homework activities. However, teachers were concerned that learners were not keen to complete homework assigned to them. This revealed that there was limited learner enthusiasm to learn science. Teachers did not seem keen to use the investigative approaches, and this made the researcher keen to investigate what their perceptions were with regard to inquiry-based teaching.

1.9 ORIGIN OF RESEARCH IDEA/RATIONALE

The researcher's desire to obtain science teacher perceptions about the use of inquiry-based teaching at the GET phase sired this investigation. After an in-depth study of various epistemological theories, this researcher observed that the inquiry-oriented approach was the prescribed pedagogy of the CAPS document. The researcher also wanted to pursue research that would also reveal the motivational effects of inquiry-based teaching.

1.9.1 Research design

A research design is a framework or structure that makes it possible to collect credible data in a cost-saving and time-saving manner (Kumar 2002:37). According to Maree (2013:70), a research design is a plan or strategy which begins from the founding philosophical assumptions to stipulating the selection of participants, data collection and analysis techniques.

This study used a qualitative research approach. Qualitative research is a type of research that is not driven by predictions or expected results (McMillan & Schumacher 2010:23) and obtains data by using fewer specific questions. It probes for a deeper understanding of a certain phenomenon using participants who rich data sources. Qualitative designs include ethnography, phenomenology, case studies and grounded theory. A case-study research design was in this instance preferred to other designs because it provided the researcher with an in-depth analysis of a specific high school where learners did not seem enthusiastic to learn science, despite the inquiry-oriented, constructivist CAPS policy and seemingly adequate infrastructure and other educational resources in the school.

1.9.2 Case study

Bromley (1990:302) defines a case study as ‘a systematic inquiry into an event or a set of related events which aim to describe and explain the phenomenon of interest’. The case in this study was a specific former model C, multi-racial, mainstream school in Pretoria, with well-qualified subject specialist teachers and fully equipped laboratories. The school enrolled learners residing mainly in the Pretoria Central Business District, suburban areas of Thaba Tshwane, Valhalla, Centurion and the high-density locations of Soshanguve, Mamelodi and Atteridgeville. As the school was equipped with laboratory equipment, qualified teachers and internet facilities, it was surprising that few learners selected science subjects when they reached Grade 10 but preferred to take other subjects as indicated in the following table that was obtained from the School Management Team (SMT)

Table 1: The number of Grade 9 learners who opted for science subjects in the high school in Pretoria.

Year	Total Grade 9 in Natural Sciences	Total enrolment in Physical Sciences	% Enrolment Physical Sciences	Total enrolment in Technical Sciences	% Enrolment Technical Sciences	Total enrolment in Life Sciences	% Enrolment Life Sciences
2015	259	35	14%	N/A		106	41%
2016	198	42	21%	N/A		102	52%
2017	220	36	16%	21	10%	98	45%
2018	262	40	15%	20	7%	113	43%
2019	213	45	21%	13	6%	115	54%
2 020	236	40	15%	15	6%	120	51%

Obtained from the SMT

Enrolment in Physical Sciences hardly reached 20% and Technical Sciences enrolment was largely below 10%. There was, however, an average enrolment in Life Sciences. There was a clear five-year trend revealing a decline in enrolment for Physical and Technical Sciences. This indicates learner demotivation. An investigation of Natural Sciences GET teachers' perceptions about the inquiry-based approach could possibly provide insights about issues that impacted on learners' motivation and enthusiasm to continue with science subjects beyond the compulsory learning stage.

1.9.3 Sampling

This study required qualified and experienced science teachers, particularly those who taught the GET phase to provide their perceptions about inquiry-based science teaching. The teachers were conveniently sampled so that it would be easy to contact them for interviews and arrange for lesson observations. Maree (2013:79) defines sampling as the selection of a research site and choosing a portion from a population for a study of people or events in research field. The selected research site, as mentioned earlier, was a well-resourced, former model C school. Eight science teachers were selected from a population of ten science teachers in the school. Although the sample appeared small, qualitative case studies can obtain rich data from small samples (Dawson 2002:46), unlike quantitative studies that tend to use larger, generalisable samples. Data obtained from qualitative samples is not generalisable but can be validated using data rich sources over a period.

Although many sampling methods exist, this researcher preferred purposeful and convenient sampling that resulted in the selection of well-qualified and experienced participants. It was easy to locate the sampled teachers as they were the researcher's colleagues in the Science Department. The advantage of purposeful sampling was that participants who were relevant to the study were selected, therefore reducing costs and saving time (McMillan & Schumacher 2010:326). Flick (2018: 3) states that purposive sampling enables the researcher to select participants who have some special quality. The researcher believed that valuable information could be obtained about teachers' perceptions and implementation of inquiry-based teaching.

1.9.4 Data collection techniques

1.9.4.1 Lesson observations

The researcher observed classes to answer the research question: *To what extent is the science teachers' classroom practice aligned with the principles of inquiry-based teaching?* The data collected was then corroborated with interview data. McMillan and Schumacher (2010:347) define observation as the researcher's method of directly observing and recording without communication. Observation enabled the researcher to gain an in-depth insight into the phenomena being investigated. Maree (2013:83) warns that researchers should guard against bias during observation. This researcher designed an observation checklist that clearly specified what was being observed, particularly the level of inquiry used during each lesson.

1.9.4.2 Interviews

Interviews were conducted to answer the following research question: *What are Natural Sciences teachers' perceptions on the use of inquiry-based teaching to stimulate learner interest in science*? An interview is an interaction between two or more people for the purposes of exchanging information through a series of questions and answers (Kumar 2002:72). This researcher preferred the qualitative research interview to a quantitative research questionnaire because rich and credible data could be obtained from a face-to-face interaction. The feedback from the interview was immediate and the researcher kept probing to obtain further details or clarifications from the participant, unlike the questionnaire that would have been impersonal and limited the scope of the responses.

Interviews can be structured, semi-structured or unstructured and require the participant to answer predetermined questions that permit the interviewer to probe and seek clarifications (Dawson, 2002:26; Maree 2013:8). This researcher used semi-structured interviews to control and direct the responses to the research question.

1.9.4.3 Document analysis

To determine the extent to which science teachers' classroom practice aligned with the principles of inquiry-based teaching, lesson plans as well as the annual teaching plans were analysed.

1.9.5 Trustworthiness and credibility of the research

1.9.5.1 Triangulation

McMillan and Schumacher (2010:491) define triangulation as 'qualitative cross-validation among multiple data sources, data collection strategies, time periods, and theoretical schemes'. Creswell (2009:191) also states that triangulation occurs when the researcher examines details from the data and uses them to make valid interpretations about emerging themes. In other terms, triangulation is the use of several perspectives to study a single research question so that a researcher can get a clearer picture of the situation being studied. In this study, the researcher conducted lesson observations and document analysis and triangulated the findings with interviews. Triangulation reduces subjectivity on the part of the researcher and the participants. Setati (2011:120) states that the greatest value of triangulation is its ability to confirm the validity of findings obtained from various approaches and theoretical lenses. This ensured that this researcher's subjectivity was eliminated through several cross-validation methods.

1.9.5.2 Member checking

McMillan and Schumacher (2010:330) define member checking as a validation process that allows participants to check the accuracy during data collection. Member checking increased the validity of the study because the participants verified that the researcher's interpretation of their data represented their views. In this study, the researcher provided transcriptions of interview data to the participants so that they could verify the accuracy of data interpretation.

1.9.5.3 Prolonged and persistent fieldwork

McMillan and Schumacher (2010:331) state that a lengthy data-collection period provides the researcher with enough time to analyse data and make comparisons that allow refinement of ideas obtained from the participants. In this study, the researcher spent six months analysing data that had been collected and constantly verified it with the participants immediately after the procurement of ethical clearance.

1.9.5.4 Verbatim accounts

The researcher used verbatim accounts to ensure the reliability of the findings. The participants' experiences about inquiry-based teaching were recorded as direct quotes to express the participants' understanding of the studied phenomena. McMillan and Schumacher (2010:360) believe that audio-recording of interviews guarantees that the verbal interaction between the interviewee and the participant is complete and provides the researcher with substantial material for reliability checks. All interviews were audio-recorded and transcribed verbatim to ensure accuracy.

1.10 THEORETICAL FRAMEWORKS: ONTOLOGICAL AND EPISTEMOLOGICAL PERSPECTIVES

Knowledge is a product of meaning-making between and among participants. Based on their mental frame of reference, people interpret events differently and assign meaning to them. In this regard, knowledge generation becomes a social construction which is context-bound as opposed to it being a separate entity that exists out there waiting to be discovered. Therefore, from an ontological point of view, reality is relative and there are no absolutes because context plays a major role in how events are perceived. Ideas are therefore fluid and subject to continuous revisions as reflective of changing situations. This stance is particularly relevant in the context of this study because the eight teachers, though teaching at the same school, are different in background, and each one has to negotiate change in the form of the newly introduced inquiry-based teaching approach.

Each teacher constructs his/her reality based on the prevailing circumstances. That is why this researcher conducted the study to obtain data to answer the research questions.

From an epistemological point of view, this researcher acknowledges that just as contexts differ, so do the realities. In this respect, there is a need to accept the value-laden nature of the data that was gathered, particularly on perceptions, because the same phenomenon can be viewed from different perspectives that mirror teacher diversity in terms of pedagogy. In the context of this study, the teachers' epistemological orientation has a bearing on not only the teachers' classroom practice but also their understanding and attitudes towards the inquiry-based approach. These factors determine the extent of their willingness to accept and implement the GET CAPS inquiry-based curriculum. In this regard, the nature of data would remain open because the focus is on the participants' multiple realities. Consequently, the findings cannot be generalised.

1.11 ETHICAL CONSIDERATIONS

Firstly, ethical clearance was obtained from the Research Ethics Committee of the College of Education at the University of South Africa. A letter requesting permission to conduct the study was then forwarded to the school principal and the Gauteng Department of Education (GDE) in the Pretoria South District. After obtaining permission from the school and the district, another letter was provided to the participating teachers. This letter informed teachers about their right to privacy (McMillan & Schumacher 2010:48), anonymity and access to the findings of the research. Participants were also assured that no recording gadgets would be used without their knowledge. Bertram and Christianse (2014:66) recommend that subjects who are recorded should give their consent, and their confidentiality be ensured. The participants were guaranteed access to their recorded interviews. The participants were also informed about the value of the research. Data was analysed in a way that did not tarnish the school's image. The name of the school was therefore kept anonymous.

1.12 CHAPTER OUTLINE

Chapter One provides an orientation to the study which includes the introduction, background to the problem, problem statement, research question, aim, objectives, a brief overview of the research design, data collection methods and ethical issues.

Chapter Two provides a literature review of the key concepts of the study, namely teacher perceptions, inquiry-based teaching, and learner motivation. Challenges that impede the implementation of an inquiry-based curriculum are also discussed.

Chapter Three describes the case study research design and methodology, along with specific measures to meet ethical requirements and trustworthiness of the results.

Chapter Four presents and discusses the findings from lesson observations, interviews and document analysis.

Chapter Five presents the conclusions and limitations of the study. Recommendations are also made for future research.

1.1.3 CONCLUSION

Teachers are at the forefront of curriculum delivery. It was therefore important to obtain their perceptions and practice on inquiry-based teaching to determine its effectiveness as a curriculum innovation that can stimulate science learner interest. This chapter provided the background to the research by discussing major epistemological orientations, the research problem, rationale for the study and aims. In addition, it briefly outlined research procedures that included the research design, sampling, data collection methods and ethical procedures followed to conduct this study. The next chapter presents related literature on teacher perceptions, inquiry-based teaching and learner motivation to learn science.

CHAPTER 2

REVIEW OF RELATED LITERATURE ON TEACHER PERCEPTIONS, INQUIRY-BASED TEACHING AND LEARNER MOTIVATION

2.1 INTRODUCTION

The previous chapter of this mini dissertation gave the background to the study. It provided the problem statement, research questions, research design, data collection methods and ethical procedures followed to conduct this study. A brief analysis of teacher perceptions of inquiry-based teaching and their epistemological orientations is provided. The inquiry-oriented approach was identified as a paradigm shift from the traditional teacher-dominated approach to a learner-centred one that motivated learners to learn science. The two major dichotomies that influence educational practice, namely the behaviourist, logical positivist approach that represents teacher-centred teaching and the inquiry-based approach representing learner-centred teaching were briefly discussed in Chapter 1. This chapter provides a literature review of three strands of this study which are inquiry-based teaching, teacher perceptions and learner motivation.

2.2 WHAT INQUIRY BASED TEACHING INVOLVES

It is important to define inquiry-based teaching and its theoretical orientations that create a basis for learner motivation. The National Research Council (NRC) (2000:23) defines inquiry as a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in the light of experimental evidence; using tools to gather, analyse, and interpret data; proposing answers, explanations; and communicating the results. There is research evidence proving that inquiry-based teaching enhances learner motivation because it connects school science to real life (Cetin-Dindar 2015:233; Campbell, Abd-Hamid & Chapman 2010:14).

2.3 INQUIRY BASED TEACHING AS OFFICIAL CAPS POLICY IN SOUTH AFRICA

The Department of Basic Education (DBE) curriculum and assessment policy statement (CAPS 2011) disseminates a learner-centred, inquiry-based Natural Sciences curriculum that is expected to transform classroom practices of teachers. Such a curriculum advocates learner autonomy as it stipulates that through investigations, teachers should provide opportunities for learners to demonstrate that they are able to work independently in their exploration of scientific phenomena (DoE, 2003, p.34). According to the Norms and Standards for educators document (2000), the teacher should know different approaches to teaching and learning and apply them in appropriate contexts. This implies that science teachers must be conversant with the curriculum approach.

There are various indicators that the GET CAPS curriculum is an inquiry-based curriculum that places scientific argumentation at the centre of the Natural Sciences subject. The CAPS (2012:15) document's three major aims are: knowing science, doing science and applying science knowledge in real life situations. So, the curriculum not only provides learners with theoretical, scientific knowledge but also provides the opportunity to conduct various investigations, making hypotheses about the variables and finally applying findings to real life situations.

2.4 INQUIRY-BASED EPISTEMOLOGICAL ORIENTATION

Dzerviniks (2009:49), Mugaloglu (2014:833) and Llewellyn (2013:65) state that learners tend to be naturally investigative and curious. It is therefore important to teach science through an authentic, stimulating, investigative and collaborative approach. It is also important, therefore, to provide a definition of learning that indicates a shift from the behaviourist to the inquiry approach. The behaviourist approach was discussed in detail in Chapter 1. This chapter provides a detailed discussion of the inquiry-based approach, which is the focus of this study. To illustrate a shift from behaviourist-based teaching, Bruner (1983:183), defines learning as the learners' ability to remember not only what had been taught but also as their ability to figure out how to use what they already know, to go beyond what they already think. This implies learning is not primarily concerned with regurgitation of scientific facts and formulas but goes beyond that to include 'figuring' out how knowledge that is practically obtained could be related to what learners already know and where possible, extended to real-life situations. The inquiry approach therefore provides a basis for a motivating, dialectic approach to teaching and learning, rather than a didactic, demotivating approach (Steenkamp's 2018:3). Bosch and Bifano (2017:1) state that inquiry- based science teaching stimulates learning by allowing learners to:

- Make a conjecture
- Devise their own questions

- Obtain evidence to be able to answer their questions
- Explain the evidence gathered
- Link this explanation to the knowledge obtained during the research
- Create an argument and a justification for the explanation, or else make a new conjecture and begin the cycle again

Although there are various scientific inquiry models, one major feature that defines all of them is the use of science process skills. Learners can use the basic process skill of observation to make a conjecture. Where possible, learners may also use integrated science process skills to record and interpret data that is used to answer the questions they generate. So, the whole process of making observations, posing questions, planning, conducting investigations, collecting, analysing, and interpreting data promotes science learning that develops science process skills (Mugabo 2015:88).

When teaching through the inquiry-based approach, the teaching process shifts from the mere presentation of scientific facts to an imitation of how scientists in the real world get knowledge. Although this approach may appear too complicated for novice teachers without experience in inquiry-based teaching, it is necessary to implement it because it has been proven to be effective in motivating learners to appreciate science (Silm et al 2017: 322). It is in this regard that Campbell et al (2010:14) state that inquiry-based laboratory investigations (IBLI) should be the core of every science lesson and concept strand to motivate learners.

2.5 DIFFERENT TYPES OF INQUIRY

The inquiry process has different levels that suit different contexts. Gudyanga and Jita (2019:717) present the following categories of inquiry-based teaching. They can be sequentially arranged, according to the degree of complexity, as confirmation inquiry, structured inquiry, guided inquiry and open inquiry. Each will be briefly discussed.

2.5.1 Confirmation inquiry

This is the most basic level of inquiry, whereby teachers demonstrate and instruct learners on what to do in every part of the investigation (Banchi & Bell 2008). Teachers may, for instance, provide learners with the hypothesis, set the apparatus of the investigation, and provide learners with conclusions. Other researchers believe that confirmation inquiry is logical positivist because it merely conveys information through a demonstration. It is important, however, to mention that confirmation inquiry is better than the lecture method that relies on 'chalk-and-talk' without any practical illustration.

2.5.2 Structured inquiry

In this type of inquiry, learners are provided with the question and procedure, but from the collected evidence they must generate an explanation. The teacher creates parameters and procedures for inquiry. Learners are provided with a hands-on problem to investigate as well as the procedures and materials necessary to complete the investigation, and questions are presented by the teacher, who makes sure that learners realise relationships between variables or generalise from data collected. The value in using structured inquiry is that it allows the teacher to teach learners the basics of investigating as well as techniques of using various equipment and procedures that can be later used in more complicated investigations. In other words, structured inquiries provide learners with common learning experiences that can be used in guided or open inquiry (NRC, 2005; Zion & Mendelovici, 2012).

2.5.3 Guided inquiry

Teachers may also choose guided inquiry, where learners are provided with the research question, and they design the procedure to test their question and generate explanations. The teacher may give a prompt or question as a starting point, and learners find their own way to answer the question (Murphy et al 2010). The teacher delivers the problem for investigation as well as the necessary materials. Learners are expected to plan their own procedure to solve the problem. In this approach, questions are usually presented by the teacher, but procedures should be planned or selected by learners. The procedures for data analysis, interpretation, and drawing conclusions are usually teacher-guided, but learner-interpreted (NRC, 1996; NRC, 2005; Zion, Cohen, & Amir, 2007).

2.5.4. Open inquiry

Investigative questions, procedures, data interpretation and conclusion are designed by learners (Alabdukareem 2017:68). An open inquiry provides learners with the opportunity to formulate questions, design and conduct investigations and communicate their findings. An open inquiry is defined by the absence of a predetermined result, where learners initiate their own questions and formulate their own processes to answer their questions. This is the highest level of inquiry. The CAPS curriculum does not specify the level of science inquiry suitable for the learners in the GET phase; the choice of the inquiry level was left to the teacher's discretion.

Science teachers should assess their contexts to determine the suitable level of inquiry. Given the option to raise an opinion, this researcher believes that science teachers should, where there are challenges to using full inquiry, use confirmation inquiry rather than the verbal, lecture method. It is also important not to leave learners solely on their own in the name of open inquiry because this may be too difficult for them. There is research that proves that inquiry-based teaching is an effective teaching approach.

2.6 RESEARCH ON THE EFFECTIVENESS OF INQUIRY-BASED LEARNING

Keller, Neumann, and Fischer's (2016:586) investigated teachers' epistemological orientations and found that teachers who had inquiry-oriented science teaching approaches increased their learners 'motivation to learn. Muntasheri, Gillies, and Wright (2016:16) compared the motivational levels of one class of learners who were taught 'density' through the teacher-directed lesson and another class that was taught through guided inquiry. The learners in the guided inquiry demonstrated significant improvement in conceptual understanding and motivation to learn. Awan (2013:41) also conducted an experimental study that compared the traditional textbook method and the inquiry-based approach in the teaching of the concept 'solution' to Grade 9 learners. The findings indicated that the inquiry approach was significantly better than the traditional textbook method in facilitating the development of correct scientific conceptions. Other studies, which also proved that learners who were exposed to inquiry-based learning displayed greater motivation to engage in science learning activities than those who were taught through teacher-oriented approaches, were conducted by Osborne (2010); Ramnarain (2015) and Veloo and Viknesawry (2013).

In South Africa, Mupira and Ramnarian (2017) used a quasi-experimental design to investigate the effect of an inquiry pedagogy (5E-inquiry-based learning) on the achievement goals orientation of science learners at historically disadvantaged township schools. The findings proved that the experimental group of learners who were exposed to inquiry-based learning demonstrated better motivation to engage in science learning activities than the control group, which was taught through teacher-centred methods. It can therefore be concluded that the adoption of inquiry-based teaching creates optimism for improved learner motivation in science (Ornstein & Hunkins 2018:165; Ramnarain & Hlatshwayo 2018:2).

In summary, inquiry-based teaching is an investigative approach to science learning that focuses on posing questions, formulating hypotheses, designing experiments, collecting data, and drawing conclusions (Campbell et al 2010; Mupira & Ramnarain 2017:81; Ramnarain 2014;65; Rundgren 2018:610). It is important to mention that inquiry-based teaching is not only based on experimental models. There are other non-experimental models where learners can use the interactive approach to investigate phenomena.

2.7 RESEARCH FINDINGS ON TEACHER PERCEPTIONS ABOUT INQUIRY-BASED TEACHING IN TURKEY, AUSTRALIA, SAUDI ARABIA, RWANDA AND THE UNITED KINGDOM

The following section presents research findings about teachers beyond the borders of South Africa.

Taskin-Can (2011:219) investigated how science teachers in Turkey perceived inquiry-based teaching; it found that pre-service science teachers held teacher-centred beliefs. McDonald and Hecks (2012:22) found that Australian teachers perceived the use of inquiry-based teaching as a challenge because they had not been trained to use it. After seven years, Fitzgerald, Danaia and McKinnon (2019:562) also investigated Australian teachers' perceptions of inquiry-based teaching approaches in secondary school science classes and found that there were teachers who were not sure about what inquiry-based teaching involved. Gillies and Nichols' (2015:175) study also showed that teachers struggled to teach through inquiry because they believed that they did not have the content knowledge or pedagogical skills to do so. Savasci and Berlin's (2012:80) research findings also indicated that public high schools with a large teacher-learner ratio found it impossible to allow learners to actively construct knowledge using inquiry-based teaching and this resulted in the use of behaviourist-based approaches. (Fazio & Volante 2011:128).

In Rwanda, Mugabo (2015:77) found that science teachers did not understand what inquiry-based science teaching meant and tended to associate inquiry-based teaching with teacher-dominated demonstration, even though inquiry-based teaching was the official curriculum policy in that country. There were however some studies that found that science teachers were familiar with and very confident about inquiry-based teaching. Alabdukareem's (2017:68) study established that science teachers in Saudi Arabia were very confident and enthusiastic about all models of inquiry-based teaching. Those teachers could teach full inquiry lessons. The study by Mumba, Banda, Chabalengula and Dolenc (2015:192) also revealed that science teachers acknowledged the benefits associated with inquiry-based teaching in inclusive chemistry classes. In the United Kingdom, Shirazi's (2017) proved that there was very low enrolment in science subjects in a particular secondary school as illustrated in the following table:

Table 2: Science learner enrolment percentages in a high school in the United Kingdom. Shirazi (2017)

Year	Biology/ Life sciences	Chemistry	Physics
2009–2010	18.9	14.5	10.1
2010–2011	19.6	15.4	10.6
2011–2012	19.9	15.8	11.1
2012–2013	20.3	16.8	11.5
2013–2014	20.3	17.1	11.9
2014–2015	19.4	16.4	11.4

This table indicates extremely low enrolment in Biology, Physical Sciences and Chemistry. If a developed country such as the United Kingdom recorded very low learner enthusiasm in science subjects, it can therefore be surmised that this downward trend is similar to the current situation in South Africa as displayed in Table 1 (Chapter 1).

2.8 RESEARCH FINDINGS ON TEACHER PERCEPTIONS OF INQUIRY IN SOUTH AFRICA

Among relatively few studies that conducted research on teacher perceptions on inquiry-based teaching, Ramnarain (2014: 67) and Mtsi, Maphosa and Moyo (2016) also found that some teachers perceived inquiry-based science teaching as too complicated. Ramnarain's (2015) study in South Africa found that teachers' lack of pedagogical content knowledge, and general pedagogical knowledge greatly contributed toward their inability to teach through inquiry. This implies that some teachers had difficulties in teaching science subjects in a practical way and in so doing, demotivated learners. The problem of the lack of resources such as well-equipped laboratories (Ramnarain & Hlatshwayo 2018) was perceived as a challenge that discouraged teachers from using inquiry-based teaching. Teachers in Ramatlapane and Makonye's (2013:22) study found that the CAPS curriculum document was heavily loaded with content that was impossible to teach through inquiry.

2.9 IMPLICATIONS OF NEGLECTING INQUIRY-BASED TEACHING

It can therefore be surmised that learners can become demotivated when teachers 'hog the limelight' (Dudu 2014:549) with excessive use of behaviourist-oriented teaching approaches. Shirazi (2017) also maintains that the neglect of inquiry-based teaching causes learner demotivation. Mudau and Nkopodi's (2015:128) study found that some Grade 9 NS teachers demotivated learners by not using the inquiry-based approach., Despite the challenges that restrict the implementation of inquiry-based teaching, Ramnarain and Hlatshwayo (2018:7) suggest that science teachers should not reject inquiry-based learning but need to consider other inquiry-oriented approaches that suit their contexts so that learners are kept motivated to learn science.

2.10 SCIENCE LEARNER MOTIVATION

Motivation can be defined as a theoretical construct that accounts for the impetus, initiation, intensity, and persistence of goal-directed behaviour and can only be inferred from actions such as effort, persistence, and achievement (Schunk et al 2014:4). This implies that learners have a goal that they wish to achieve and work towards. Motivation within the behaviourist tradition or logical positivism is extrinsic. On the other hand, motivation within the inquiry-based approach tends to be intrinsic. This refers to an engagement in science activity for innate interest and pleasure rather than for some separable consequence (Ryan & Deci 2000: 56; Mustafa 2018:152). Learners' enthusiasm in science is heightened when they are internally motivated (Du Plessis 2020:7; Shah 2019:4). Motivated learners are therefore likely to undertake challenging activities, be actively engaged, enjoy, and adopt a deep approach to learning that results in improved performance, persistence, and creativity within the auspices of the inquiry-based teaching. Although inquiry-based teaching promotes learner motivation, teachers may have different perceptions about its practical implementation. The next session provides research findings about teacher perceptions on inquiry-based teaching.

Ramnarain and Hlatshwayo, (2018) proved that lack of specific models for science teachers on what inquiry-based practical classes should be like, coupled with limited professional development on the inquiry approach, stifled teachers' abilities to teach through inquiry in South Africa. The same challenge was found in the Australian context, where teachers also indicated that they had limited time to implement an inquiry-based, investigative approach, considering the breadth of the curriculum that had to be covered (Fitzgerald et al 2019).

2.11 SOME PRACTICES THAT DEMOTIVATE SCIENCE LEARNERS

Learners tend to be demotivated when science, which they already consider to be a difficult subject, is taught through teacher-centred approaches (Lin-Siegler, Ahn, Chen, Fang & Luna-Lucero, 2016 2016:2). The overuse of the lecture method tends to demotivate learners, as stated by Shirazi (2017:1903) in the study whose participants stated the following about the use of the lecture method:

- 'Too much notetaking; dislike the dreary way it is taught, hate PowerPoints.'
- 'My teacher was dull to listen to and I forgot how interesting science was because she made it seem so boring'.
- 'She (the teacher) never made anything fun or interesting, she would make you sit there and make you listen when she was writing on the board.'
- 'Just the way they [teachers] go about it really, just flipping through PowerPoint presentations and talking at you, I think you won't enjoy that as much as someone who gets you involved'.

The negative remarks provided by the participants in Shirazi's study proved that lengthy, teacher-centred science lessons failed to motivate them. Draghicescu, Petrescu, Cristea and Gorghiu (2014) propose that there is a relationship between learner interest in science and the use of inquiry-based teaching. There are indications that limited learner specialisation in science is related to the continued use of behaviourism because teachers perceive inquiry as a challenge. The following table indicates very limited learner interest that could be connected to the continued use of teacher focused learning.

Table 3: Number of South African learners who enrolled sciences subjects from 2013 to 2019 (Obtained from the National Senior Certificate examination reports 2019:7; 50; 2016;5-6).

Subject	Physical Sciences	Technical Sciences	Life Sciences	Total number of Grade 12 candidates
Year	Enrolment	Enrolment	Enrolment	
2013	184,383	Subject not yet introduced in South Africa	301,718	Not supplied
2014	103,348		209,783	Not supplied
2015	193,189		348,076	Not supplied
2016	192,618		347,662	Not supplied
2017	179,561		318,474	Not supplied
2018	172,319	10,503	310,041	512,735
2019	164,478	10,862	301,037	504,303

From the evidence given in Table 1, there is clear trend of an annual decline in the number of learners that enrolled for Grade 12 Physical Sciences examinations which can possibly be linked to teaching approaches that have very limited motivational value.

2.12 CONCLUSION

This chapter presented a review of literature on three concepts that gird this study, namely inquiry-based approach, teacher's perceptions and learner motivation. It discussed the major tenets of inquiry-based teaching, teacher perceptions and the learner motivation that tends to be decreased by excessive use of behaviourist-oriented approaches. The next chapter focuses on qualitative research methodology used in this study of limited scope.

CHAPTER 3
METHODOLOGY

3.1 INTRODUCTION

The previous chapter discussed theoretical orientations and different types of inquiry, together with research evidence supporting the motivational effect of inquiry-based teaching. Science teacher perceptions on inquiry-based teaching were also discussed. This chapter discusses a qualitative case-study research design as the methodological framework that was used in this study. Hammarberg, Kirkman and De Lacy (2016:499) propose that qualitative designs are more appropriate when researching participants' experiences and perceptions – as was done in this study. After identifying the design, this chapter specifies the population, discusses the method of sampling participants, data collection and analysis methods. The chapter ends with measures that were implemented to ensure that the study was credible and ethically sound.

3.2 RESEARCH APPROACH, DESIGN AND PARADIGM

A research design can be viewed as the theoretical framework that shapes the entire research orientation right from the formulation of the problem statement and methodology to data analysis. Punch (2011:112) states that a research design is the basic plan that encapsulates the conceptual framework and relevant data collection and analysis procedures. This implies that the researcher should plan the selection of participants, data-collection techniques, ethical matters, trustworthiness, and analysis. In other words, a design can be viewed as a paradigm or theoretical framework that guides the entire research process. A qualitative research design aims to explore, understand, and describe the phenomenon from the perspective of the participants (DuPlooy-Cilliers, Davis & Bezuidenhout 2014:174). Qualitative designs can also be classified as ethnographic, grounded theory, phenomenological, narrative and case studies (McMillan & Schumacher 2010:344-346). This researcher sought to collect legitimate teacher perceptions about learner motivation through the qualitative approach, which holistically describes events in authentic teaching environments (Kilicoglu 2018:949).

3.3 QUALITATIVE RESEARCH DESIGN: THE CASE STUDY

Simons (2009:21) defines a case study as a multipronged, in-depth exploration of the complexity and distinctiveness of a specific project, policy, institution, or programme. In this study, the case was an educational institution (single high school). A qualitative case-study design was used in this research because it allowed the researcher to be immersed in the phenomenon being studied (Merriam 1998:7) to obtain genuine, primary research evidence about perceptions about inquiry-based teaching. The case study also provided in-depth understanding of research phenomena that occurred in natural, authentic situations (Korstjens & Moser 2017:275; Leedy & Omrod 2015:269). Since this study sought to understand the participants' perceptions and interpretations of inquiry-based science teaching, it was therefore located within the interpretive paradigm (Creswell & Poth 2018:24).

The qualitative case study design has some disadvantages which the researcher should know to enhance the validity of the study. McMillan and Schumacher (2010:205) acknowledge the high probability of bias and subjectivity in qualitative research. To reduce subjectivity, qualitative researchers eliminate bias in all the phases of the investigation by not allowing their perspectives, assumptions, or preconceptions to dominate any part of the research. Bogdan and Biklen (2012:54) state that qualitative researchers should reduce bias by maintaining neutrality as they inductively conduct their research. They should conduct research as if they do not know much about research phenomena and possible research findings. This researcher therefore attempted to conduct this investigation without any preconceptions about teachers' perceptions about inquiry-based teaching.

Three instruments, namely observations, document analysis and semi-structured interviews were used to elicit data to answer the following research questions:

What are Natural Sciences teachers' perceptions on the use of inquiry-based teaching to stimulate learner interest in science?

To what extent are the Natural Sciences teachers' classroom practice aligned to the principles of inquiry-based teaching?

The case-study design effectively combined various data-collection methods and allowed the researcher to use different perspectives or what Foucault (cited in Thomas

2020:2) described as a 'polyhedron of intelligibility' that resulted in a balanced, unbiased interpretation of the research theme'. The qualitative case study allowed the researcher to be flexible during the research process. In other words, this qualitative research was not a linear, rigid process (Carl 2012:68). It was the flexibility of the qualitative case study design that provided the researcher with rich data that illuminated insights into teachers' perceptions about inquiry-based science teaching.

3.4 PURPOSIVE SAMPLING

Guest, Namey and Mitchel (2013: 41) define sampling as a process of choosing a subset of items from a defined population for inclusion in the study to draw conclusions about them. A qualitative researcher's discretion to select participants is based on three principles, identified by Creswell and Poth (2018:157). The first is the choice of information-rich participants who, in this study were knowledgeable and experienced science teachers. The second is the method of sampling, which in this case was convenient, purposive sampling, whereby participants were selected based on their proximity to the researcher. The third principle is the size of the sample. A sample of eight information-rich science teachers, although smaller than larger samples obtained from quantitative studies, can provide in-depth data. Bertram and Christianse (2014:83) also state that a smaller sample size is preferable in qualitative research designs, unlike quantitative designs that use large sample sizes. A qualitative case study can, therefore, use a small sample, provided that the few, sampled participants possess in-depth knowledge about the research phenomena (Hammarberg et al 2016:500). Considering that there was a total of ten science teachers in that school from which eight were selected, one can trust that the sample was almost a full representation of all the science teachers that taught at the time in that school.

Purposive sampling includes the deliberate selection of the setting and participants who can provide the information that is required. Drew, Hardman and Hosp (2008:82) state that participants selected in a qualitative case study should be appropriate to the research question by being knowledgeable about the situation, willing to talk and have a wide range of perspectives. The participants selected in this study were keen to participate and through their diverse educational qualifications and experience in science teaching, provided great insight into the research question. Eight science teachers were sampled and named using codes to provide confidentiality as tabulated.

Table 4: Teachers selected for the study

Teacher	**Post level**	**Gender**	**Subject**	**Experience in years**	**Qualification**
M05FU	2	M	Natural Sciences Physical Sciences	25 years.	B.Sc.Hons. P.G.D.E.
M04SE	1	M	Natural Sciences Life Sciences	10 years.	B.Sc. M.Sc.
F01ES	1	F	Natural Sciences	25 years.	H.Ed.D.
F02NE	1	F	Natural Sciences Technical Sciences	28 years.	B.Sc.Ed.
F03OY	1	F	Natural Sciences Life Sciences	20 years.	M.Sc. P.G.C.E
M07DO	1	M	Natural Science Physical Science	5 years.	B.Ed.Hons B.Ed.(NS)
F06EL	1	F	Natural Sciences	10 years.	B.Ed. (Maths)
M07DA	1	M	Natural Sciences Technical Sciences	25 years.	B.Sc.Ed.

The sampled teachers represented diversity in terms of qualifications and teaching experience. They provided a variety of perceptions on the inquiry-based approach. All the sampled teachers taught Natural Sciences and either Physical Sciences, Technical Sciences or Life Sciences at FET level. Consequently, they were able to provide data required to respond to the research question and sub-questions The researcher approached the teachers individually and requested them to participate in a research study that could potentially find ways to motivate learners to specialise in science.

3.5 DATA COLLECTION METHODS

3.5.1 Lesson observations

An observer can unobtrusively collect live and authentic data *in situ* instead of relying on second-hand accounts (Cohen, Manion & Morrison 2007:396). There are various methods of observation that have been identified by Maree (2013:85), which are: complete observer, observer as participant, participant as observer and complete participant.

a. *Complete observer*: In this type of observation, the researcher does not participate and is least obtrusive. Its limitation is that the researcher is not immersed and has limited understanding of observed phenomena.

b. *Observer as participant*: In this type of observation, the researcher is immersed in the situation but only focuses on the role of observer. The researcher may investigate the patterns in the research phenomena but does not intervene and influence the setting dynamics.

c. *Participant as observer*: The researcher is immersed to get an insider perspective by working with the participants and intervening in the dynamics.

d. *Complete participant observer*: In this type of observation, the researcher is covertly immersed in the setting and participates in such a manner that participants are not aware of the fact that they are being observed. This type of observation poses ethical challenges because it violates the participants' right of consent.

In the light of the preceding observation methods, this researcher preferred the 'observer as participant' option because, unlike the 'complete observer', which is extremely distanced from the phenomenon, the 'participant as observer' that manipulates the dynamics or the 'complete participant observer' who is hidden from the participant, the 'observer as participant' allowed the researcher to unobtrusively collect data, making the data collected authentic, credible and reliable.

Data was collected through lesson observation to answer the following sub-research question: To what extent is the science teachers' classroom practice aligned with the principles of inquiry-based teaching? This researcher observed science lessons as part of the integrated quality management system (IQMS) requirements, whereby teachers should observe their peers' teaching so that they can share teaching skills. The researcher's presence initially created anxiety in some classes because there was a camera that was recording the lessons. This researcher minimised learners' anxiety by participating in some activities such as handing out learning material and minimally contributing to the class discussion to build rapport. When there was some interaction between the researcher and the learners, they became less anxious and continued learning as usual. As a practising teacher who is registered with the South African Council of Educators (SACE), and to comply with the Research Ethics Committee at Unisa, the researcher was ethically bound to keep the recorded class videos only for research purposes and not show them to other people who could possibly use them for unethical purposes.

This researcher prepared an observation checklist with specific constructs to be observed. The checklist sought to answer the research question: 'To what extent does the science classroom practice reflect principles of inquiry-based learning and teaching?' It was pilot tested during informal class visits for IQMS and was found to be valid because it mapped out various constructs of inquiry based and behaviourist teaching (which were obtained from the literature review (McMillan & Schumacher 2010:347) and determined whether lessons observed were either behaviourist or inquiry oriented. The researcher was a passive observer in the beginning and then later became a participant observer, as suggested by Creswell and Poth (2018:157). The observation checklist is attached as Appendix F.

3.5.2 Analysis of documents

To corroborate data obtained from observation and interviews and to improve the trustworthiness of the data collected, this researcher got more insight into the research question by analysing both published and unpublished documents used by teachers in the school (Mbanjwa 2014:40; Maree 2013:90). The researcher analysed the Annual Teaching plan (ATP) (Appendix C) and the lesson plan (Appendix D) to determine teachers' epistemological orientations. Creswell (2014:190) and Maree (2013:88) state that document analysis in qualitative research, among other documents includes minutes of meetings. One advantage of data collection through document analysis is that the process can provide insightful data in an unobtrusive manner (Pamela et al 2016:6).

3.5.3 The interview

There are a variety of styles of interview that include phenomenological, hermeneutic, ethnographic, and epistemic interviews (Flick 2018). The phenomenological interview tends to rely on open-ended questions to explore participants' perceptions and adopts a non-didactic stance. The ethnographic interview explores meanings that participants attach to actions and events within their cultural worlds. Ethnographic researchers tend to conduct on-going analysis of data recorded in field notes and multiple interviews over an extended period. This study used the epistemic interview because its focus was on the epistemological choices of science teachers. The epistemic interview allowed the researcher to ask questions related to specific epistemological concepts which were related to learner motivation.

Creswell and Poth (2018:43) state that interviews are qualitative data-collection methods. One of the advantages of face-to-face, live interview sessions is the presence of the interviewer, who can obtain rich data by probing and observing participants' non-verbal communication cues that include the tone of voice, body language and facial expressions (McMillan & Schumacher 2013:355). This study therefore used the interview method to obtain rich data about the perceptions of science teachers on the effectiveness of inquiry-based science teaching as a motivation strategy to increase learner enrolment in science when they completed compulsory schooling. Interviews, therefore, provided this researcher with an opportunity to ask as many questions as possible about research phenomena. Frey (2018:3) suggests that a research question can be investigated through several sub-questions, and it was in this regard that the interview questions for this research were developed (see Appendix B). The answers from participants obtained through probing developed new lines of inquiry that provided more insights into the teacher perceptions on inquiry-based teaching. Qualitative research interviews are therefore ideal for investigating participants' beliefs and perceptions and are also preferred for their flexibility and adaptability because they allow the researcher to probe so that complex matters can be clarified.

3.5.4 Different types of interview

Interviews can be broadly categorised as open ended (unstructured), semi-structured and structured (Dawson, 2002:26). A brief analysis of the interview types follows:

a) Open-ended interview

During this interview, the participants' view of phenomena is obtained through a spontaneous, conversational interview. The open-ended, exploratory nature of the interview allows participants to express their perceptions (Turner 2010:756).

b) Structured interview

Detailed questions are formulated prior to the interview and do not encourage probing. Cormac, Per and Matilda (2018) state that a structured interview has predetermined questions asked in the same way to all the interviewees to elicit responses using the same phrasing.

c) Semi-structured interview

Unlike the open-ended interview, the semi-structured interview corroborates data emerging from other sources. Participants are required to respond to a set of predetermined, open-ended, nonlinear questions that allow the interviewer to probe for clarification (Maree 2013:87).

3.6 THE SEMI STRUCTURED, EPISTEMIC INTERVIEW IN THIS STUDY

This study therefore used a semi-structured, epistemic interview that permitted the interviewer to probe and seek clarification from the participants (Cohen et al 2007:396). When the researcher had selected the type of interview, the next step was to prepare an interview guide. Kvale (2007:6) defines an interview guide as the script that structures the interview by formulating interview question. In this study, the questions in the interview guide (See Appendix B) were designed to elicit data in response to the following research question: *What are Natural Sciences teachers' perceptions on the use of inquiry-based teaching to stimulate learner interest in science?* The data enabled the researcher to validate the observations about the teachers' epistemological orientations. It also provided clarity on issues that were obtained from the analysis of documents.

Kvale (2007:8) states that good interview questions should contribute thematically to knowledge production and dynamically promote a spontaneous interview interaction. The interview questions were therefore free from highly specialised jargon. Technical terminology could create communication barriers and stifle spontaneous expression of the participants.

To avoid inconveniencing the participants, the interviews were scheduled during the June to July 2019 examination period when teachers had no classes to teach, since about ninety percent of the learners were preparing for examinations while at home. Follow-up interviews were done in June to July 2020 when teachers were at school but did not have classes due to the COVID 19 pandemic. As part of the ethical procedures, the interviews did not prejudice learning and teaching activities at school. The observation of classes was done in August 2019. The following section provides a detailed analysis of the data-collection strategies and procedures that were followed**.**

3.6.1 Pilot study/Pre-test

As part of ensuring that the semi-structured interview schedule was valid and reliable, a pilot study had to be conducted. A pilot study is a pre-test of the data collection tool, which is tested on participants like those in the main study (Dikko 2016:521). The pre-test on the interview protocol is conducted to identify potential challenges that may require adjustments (Bricki & Green 2007:13). In this study, the researcher conducted a pre-test interview with four science teachers from neighbouring schools within the same district. The piloting of the interview guide assisted this researcher to identify ambiguous questions, which were re-phrased and edited for conciseness and relevance to the research questions. Baffour-Awuah (2011:71) states that the piloting of the interview guide promotes accuracy, quality and relevance of the questions being asked. The pilot study improved the accuracy and relevance of questions in this study.

3.6.2 The interview stages

Flick (2018) recommends that the interview should begin with a briefing. This includes informing the participants about the theme of the study and assuring them of their right to voluntary participation and anonymity, and obtaining their consent to be recorded. The briefing process was also an ice breaker to relax the participant for the interview.

The interviews were thirty to forty minutes long and were conducted in each participant's classroom. Questions were asked and the researcher probed for clarity. Kvale (2007:6) says that probing for clarity and disambiguation can assist in data analysis and proves that the interviewer listens to the participant, thereby strengthening the discourse between the interviewer and participant. It was vital for the interviewer to listen more and talk less to allow participants to openly express their views. McMillan and Schumacher (2010:346) maintain that interviewers should not jeopardise the scientific process by inhibiting participants' views or openly disagreeing with them. This researcher did not interrupt the participant's trend of thought by talking more than the participants. This researcher therefore listened intensively, spoke less, and probed only when it was necessary.

The interviews ended when the researcher was satisfied that all the information needed to answer the research questions had been obtained. The participants were asked to suggest how learners could be motivated to study science. The recording instrument was then switched off. A debriefing process then followed, whereby the main points raised during the interview were summarised and participants were thanked for their invaluable insight into the research question. They were also given guarantees that the data they shared would be kept confidential. The next phase was the analysis of data.

3.7 DATA ANALYSIS

Creswell and Poth (2018:183) define qualitative data analysis as the reduction of data into themes that are obtained from codes. Coding breaks down the data into segments and assigns a name to each code. Saldana (2016:3) and Simons (2009:120) define a code as usually a word or short phrase that enables more insights into the data. In this study, qualitative data analysis was an iterative, rigorous, and systematic process of selecting, categorising, comparing, synthesising, and interpreting data (McMillan & Schumacher, 2010). In other words, it was a process of abstracting broader and more specific themes from transcribed, voluminous interviews, and observation data. This researcher got more insight from the data by reading it several times (*memoing)* to identify more codes. The codes that were created resulted in the development of themes that were linked to the research questions. The data analysis followed Saldana's (2016:12) data analysis method as illustrated below:

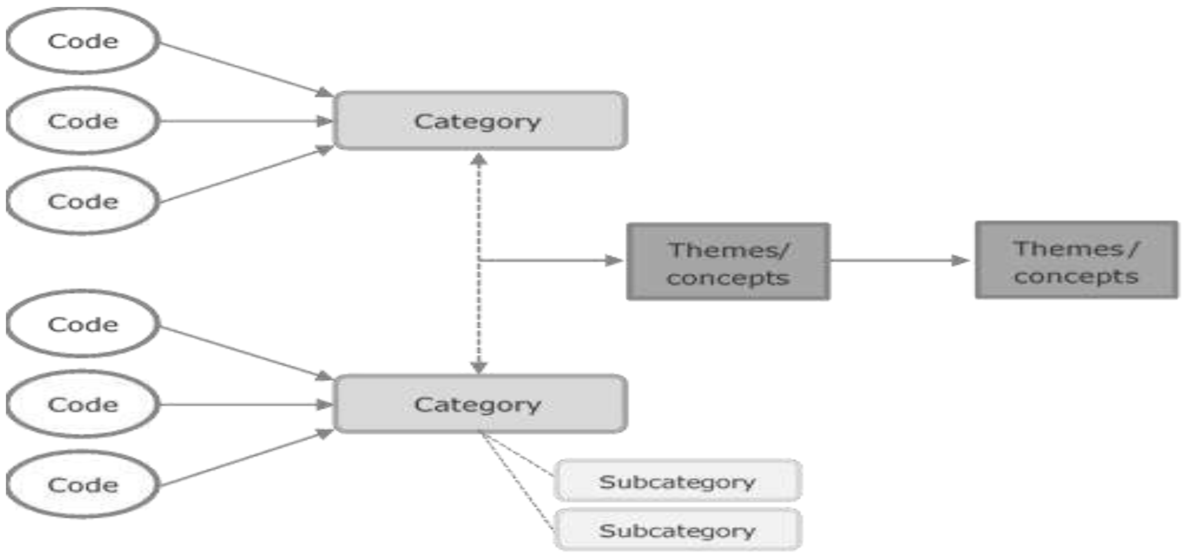

Figure 1: Saldana's (2016:12) method of qualitative data analysis

According to Saldana (2016:12; Maree 2013:107), data obtained from observation and interview can be coded so that patterns are created. In this research, the researcher intensively listened to the recorded interview data, transcribed it and coded it. A cluster of similar codes was organised to create categories and subcategories that later indicated a pattern. Those patterns were put into categories and subcategories that resulted in themes which provided answers to the research questions.

3.8 TRUSTWORTHINESS

Trustworthiness refers to the level of confidence one places in one's research findings and the confidence in the findings of the study that can be promoted through the elimination of bias that results from interpretive designs. Trustworthiness in this study was enhanced by ensuring credibility and confirmability (Yilmaz 2013:319).

3.8.1 Credibility

A qualitative study is credible when multiple triangulation methods have been used. Silverman (2011:45) defines triangulation as the mapping of one set of data over another, meaning that multiple perspectives were used to promote a comprehensive understanding of the research question and phenomena being investigated (Flick 2018:3). It is therefore important to use more than one data collection method to avoid misrepresentation of research results. Triangulation can be categorised as 'researcher, theory, and methodological' (Flick 2018:3).

This researcher used methodological and researcher triangulation. Flick (2018:3) states that methodological triangulation refers to the use of various sources of data or numerous approaches to data analysis to enhance the study's credibility, while investigator triangulation refers to the use of another researcher to verify findings. In this study, methodological triangulation was used when data obtained from observation and document analysis was corroborated through the interviews. This provided a balanced and holistic understanding of teachers' epistemological orientations. Another triangulation strategy that was used in this study was investigator or researcher triangulation: this researcher allowed another researcher (a qualitative data analyst) to identify major themes that were associated with the research questions of this study and the findings of that qualitative data analyst were synonymous with the findings of this researcher.

3.8.2 Confirmability

Qualitative research participants should confirm the researcher's interpretations of their own data if the study is to be trustworthy. Turner (2010) states that participants should be given the opportunity to review interview transcripts to verify if the researcher's interpretation of their statements is correct. In this study, the researcher engaged the participants in the research process by asking them to read the transcripts and confirm whether their perceptions had been correctly interpreted. McMillan and Schumacher (2010) describe the process of asking the participants to verify the researcher's interpretation of their data as 'member checking'. All the participants accepted the researcher's transcriptions as a correct interpretation of their views and this enhanced the trustworthiness of this study. The researcher also spent a long time in the field obtaining data from the participants.

3.9 ETHICAL CONSIDERATIONS

According to DuPlooy-Cilliers et al (2014:263), ethics refers to a professional code of conduct that standardises the researcher's moral conduct and also determines the credibility of the research findings. Therefore, any violation of ethical standards could have caused harm to participants, and it was important to make sure that the study did not cause physical, emotional, or social harm to the participants and the institution from which data was collected (Creswell & Poth 2018:54). This researcher followed all ethical procedures by applying for ethical clearance before collecting data from the participants. Prior to data collection, the researcher applied for ethical clearance from the University of South Africa's College of Education Research Ethics Committee (REC), which was granted. The ethical clearance certificate has been included in this mini dissertation as Appendix A. After obtaining ethical clearance from the University of South Africa (UNISA), this researcher applied for another ethical clearance from the Gauteng Department of Education (GDE) to conduct the study in a single school in Tshwane South District in Pretoria and clearance was granted (Appendix E). This researcher had to seek permission from the school principal, as recommended by Creswell and Poth (2018:5). The principal permitted the researcher to conduct the study.

McMillan and Schumacher (2010:397) state that qualitative researchers should be sensitised to the ethical issues surrounding qualitative research, particularly the need for informed consent and protection of confidential information. This researcher approached the participants and verbally requested them to participate in the study after showing them a letter confirming that the researcher was a registered Unisa student who was investigating teachers' perceptions about the effectiveness of inquiry-based, constructivist science teaching to motivate learners to specialise in science subjects. The participants' information sheet that provided a detailed description of the focus of the study has been included in this mini dissertation as Appendix H. The selected participants signed a form confirming their voluntary participation in the study (Bertram & Christianse 2014:66). This researcher protected the participants by using codes instead of their real names, as recommended by Korstjens and Moser (2017:279). The participants were also informed that they could withdraw from the study if they preferred to do so.

3.10 CONCLUSION

As was stated in the introduction, this chapter discussed the qualitative case study design and gave a rationale for the qualitative approach as well as the purposeful sampling of eight well-qualified and experienced science teachers. The semi-structured interviews were used to triangulate data collected through lesson observations and document analysis. The data obtained from observation, documents and interviews was coded for themes that were related to the research question. The audio recordings obtained from the interviews were transcribed and coded for themes and sub-themes and combined with findings obtained from lesson observations. Ethical standards that protected participants and trustworthiness issues were also discussed. The following chapter focuses on the presentation and discussion of research findings.

CHAPTER 4
PRESENTATION AND DISCUSSION OF FINDINGS

4.1 INTRODUCTION

The previous chapter described the methodology used to collect data, with key focus on the research design, selection of participants, data collection strategies and ethical considerations. This chapter presents data that was gathered through observations, interviews and documents. It also discusses the findings pertaining to teacher perceptions, implementation of inquiry-based teaching and the extent to which inquiry-based teaching motivated learners during observed lessons.

4.2 DATA PRESENTATION AND DISCUSSION

The following section presents data obtained through lesson observation, document analysis and interviews.

4.2.1 Presentation of findings from lesson observation that indicate the extent to which inquiry is used by participants

4.2.1.1 Participant coded as F01ES

The first participant, coded as F01ES, was a pacesetter for the Grade 8 teachers. A pacesetter monitors the coverage of the curriculum as prescribed in the ATP. The lesson observed was conducted in a laboratory to a Grade 8 class and the topic was 'electrolysis of water'. The participant began the lesson by defining key vocabulary that was associated with electrolysis. This researcher initially sat at the back and passively observed as the lesson unfolded. The desks were arranged in a linear formation and each learner had a textbook and a workbook in which notes were written. Each learner sat quietly and only raised a hand to respond to the participant's questions about the process of electrolysis. There was a diagram illustrating the 'cathode', 'anode', 'electrolyte', 'hydrogen', and 'oxygen bubbles' on the electrodes. Learners were instructed to draw and label the diagram after the participant had explained and responded to low- and middle-order questions. The participant provided interesting real-life examples to make the learners remember the cathode and the anode. The learners were well behaved and followed the participant's instructions. Only two learners asked questions and the participant answered the questions. One of the learners asked whether questions on electrolysis of water would be included in the next test and the participant mentioned that there was a strong possibility that the test would contain electrolysis. This researcher assisted in the handing out of worksheets. There was a lesson plan which followed the inquiry-based model of the Gauteng Department of education which is attached as Appendix D. This researcher rated this lesson as a non-inquiry teacher-centred lesson, despite the lesson template that was based on the inquiry model. It was a knowledge-focused lesson that allowed very limited scientific process skills such as drawing, labelling, and questioning. There was no group work or collaborative learning.

4.2.1.2 Participant coded as F02NE

The second participant, who presented a Grade 9 lesson on 'acid and base reactions', was the pacesetter for Grade 9 Natural Sciences. The participant began by asking learners what they already knew about the chemical properties of acids and bases and went on to explain the meaning of the terms 'universal indicator' 'acid' 'base' and 'pH', while learners sat in a linear formation, copying notes from the board as the participant spoke. The participant went on to explain a neutralisation reaction between sodium hydroxide and hydrochloric acid. Some learners kept on talking in the background as the participant explained how the reactants combined to form salt and water. She presented the chemical equation for the reaction and explained how it was balanced. The participant also explained the chemical formula and how it was written. There were instances when she diverted from the topic and chastised learners for inappropriate conduct. As an observer, the researcher sat quietly and observed. The participant explained chemical formulae until the period ended. There were some learners who asked questions and she gave clarity. There was a large periodic table chart which she occasionally referred to when explaining chemical symbols. The participant used the overhead projector to explain concepts. She did not provide a lesson plan but had the ATP (Appendix C) indicating that the topic on acids and bases had to be taught to Grade 9s. This researcher rated this lesson as a non-inquiry, expository, teacher-centred lesson. Just as in the case of the participant coded F01ES lesson, there were few scientific process skills such as defining and balancing, which were largely done by the teacher. There was limited use of inquiry- based teaching.

4.2.1.3 Participant coded as M04SE

The third participant taught ‘decomposition of compounds’ in the laboratory to a Grade 9 class. He used the chalkboard to explain processes involved in practical investigations by writing notes on the board before the class began and referred to the notes as he explained the process of decomposition. The class was a bit disruptive, and the participant kept on reprimanding noisy learners. Learners sat in a linear formation and had a workbook in which they wrote the notes about the investigative processes that included ‘background’ ‘hypothesis’ ‘apparatus’ ‘procedure’ ‘results’ and ‘conclusion’. The notes on the board illustrated the decomposition of calcium carbonate into calcium oxide and carbon dioxide. The participant demonstrated the reaction, provided a chemical equation and asked learners to balance it. He also gave analogies to assist learners to understand the concept of dependent and independent variables. The participant assigned learners some activities to complete as homework on decomposition of water, sodium chloride and other compounds. There was a lesson plan on a template prescribed by the Department of Basic Education (Appendix D) and this plan provided the topic, objectives, teacher-learner activity, resources used and the scientific process skills that learners had to learn. The process skills highlighted for that lesson were observing, hypothesising and investigating. The learners were curious as the participant demonstrated, and they asked questions. This researcher rated this lesson as confirmatory inquiry. It was not a full inquiry lesson, but the basic tenets of the inquiry-based approach were apparent.

The fourth participant taught a Grade 9 class ‘acid-base reactions’. He had his apparatus set up before the lesson and asked learners what they already knew about the qualities of acids and bases. He corrected some learners’ misconceptions about acids and bases. He then demonstrated a chemical reaction between hydrochloric acid and magnesium oxide. Learners observed the reactions and noted the products and then wrote these as a chemical formula which was balanced on the chalkboard by the participant. Learners were asked to work in pairs to balance other chemical equations. The participant went on to provide real-life examples about how acids were neutralised by bases. An example given was how an acidic bee sting could be neutralised by Bicarbonate of Soda and how vinegar could be used to neutralise the basic sting of a wasp. Learners were given a task to investigate more instances of acid-base reactions in real life and present these in the next class. As participant M04SE had done, this participant also relied on the demonstration to develop some science process skills such as observing, recording, and calculating. This researcher rated this lesson as confirmatory inquiry because the participant personally made the demonstration.

4.2.1.5 Participant coded as F06EL

The fifth participant taught the 'elements in the periodic table' in a classroom to a Grade 8 class. The participant began by explaining what the periodic table was. She mentioned that the first 20 elements are arranged in an ascending order, with the lighter elements at the top and the heavier elements at the bottom. She asked the learners to refer to the periodic table in their textbook as she explained. Learners were asked to copy and complete the table with the first 20 elements. They filled in the chemical symbol, and the number of protons, neutrons, and electrons, after the participant demonstrated how these were calculated. The researcher initially sat at the back and had the opportunity to walk around as the learners completed the worksheet and occasionally assisted learners to complete the table. The participant then provided the correct answers on the board and the learners ticked their books in pencil. A lesson plan based on the inquiry model template prescribed by the Gauteng Department of education was available, but the lesson was logical positivist. The learners were well behaved, sat in a linear formation and spoke only when they were asked to or responded to the question. This researcher rated this lesson as a teacher-centred, expository, non-inquiry lesson that focused on a few process skills such tabulating and listing.

4.2.1.6 Participant coded as F03OY

The sixth participant presented a Grade 9 lesson on 'the temperature gradient and the atmosphere'. She began by identifying different layers of the atmosphere and related current knowledge to previous knowledge by reminding learners of what they had learnt about the characteristics of each layer. Learners briefly discussed the characteristics of atmospheric layers in pairs. The participant explained what the temperature gradient was, and learners were given graph paper to draw the temperature gradient, given data about altitude in kilometres and the temperature range for each atmospheric layer.

Learners plotted the graph in groups of five members each as the participant observed. She gave feedback to the class on how they were supposed to draw the graph and the lesson was concluded by a summary stating that the temperature drops with an increase in altitude in the troposphere and slightly increases in the stratosphere, and drastically drops in the mesosphere before sharply increasing in the thermosphere. The meaning of the new words was explained. There was no lesson plan provided, but a copy of the ATP was provided. This researcher rated this lesson as a non-inquiry, expository teacher-centred lesson that focused on some process skills such as drawing, plotting, and comparing.

4.2.1.7 Participant coded as M08DA

The seventh participant presented a Grade 8 lesson on 'series and parallel circuits'. The learners sat in a linear formation and observed the participant demonstrating how to connect bulbs in series and parallel. He explained the path taken by current in series and parallel circuits and made analogies of traffic in a single lane to illustrate the current pathway in a series connection, while traffic in multiple lanes was used to explain the path taken by current in a parallel connection. The participant also explained that the removal of a bridge in a single traffic lane stops the traffic flow, just as the removal of a single bulb in a series circuit cuts the circuit. He further explained that traffic in lanes that fork could use an alternative route when one bridge was broken, to illustrate that current in a parallel circuit could not stop flowing when one bulb was broken. The learners were all quiet and watched with curiosity as the bulb lit. The participant asked the learners to get into groups of six and handed out circuit boards with a worksheet that instructed them to connect an ammeter to measure current in amperes. Learners made connections in series and parallel and then measured and recorded current. This researcher walked around observing and occasionally assisted some learners to connect the ammeter. They concluded that current strength increases when more bulbs are connected in parallel and decreases when more bulbs are connected in series. The participant also gave real-life examples of series and parallel connection. The participant also explained that the next lesson would be on voltage in series and parallel circuits. Learners were asked to research the definition of voltage in preparation for the next lesson. There was a lesson plan that was based on the inquiry model prescribed by the Gauteng Department of education (Appendix D). Process skills that included observing, recording, connecting, and reading. This researcher rated this lesson as a confirmatory inquiry that focused on several process skills such as observing, measuring, recording, connecting, and comparing.

4.2.1.8 Participant coded as M05FU

The eighth participant presented a Grade 9 lesson on ‘Forces’. The learners sat apart from each other and listened to the teacher throughout the period. The participant began by explaining vocabulary that was related to the topic. Learners wrote the new terms in their workbook. The participant explained contact and non-contact forces and gave real-life examples for gravitational, magnetic, electrostatic, friction and compression force. Learners listened curiously. The participant also explained the unit of measuring force. The relationship between mass and weight was explained using the formula: ‘$\boldsymbol{F_g = mg}$’. The participant explained gravitational acceleration on earth and the moon, and the learners calculated weight of objects on earth in Newtons, given their mass in grams and kilograms. The learners were given a written exercise with five questions on calculation of weight and the learners exchanged their books and marked each other’s work in pencil. The participant also ticked a few books. The participant predominantly used the chalkboard to explain. There were charts showing different types of forces. The lesson plan indicated the topic, content, and activities to be done. This researcher rated this lesson as a non-inquiry, teacher-centred lesson that focused on few process skills such as calculating and writing.

Table 5: Summary of lesson observations

Teacher code	Topic taught	Introduction	Main part of the lesson 5 E & learner interest	Process skills	Lesson orientation
F01ES	Grade 8 Electrolysis of water	No curiosity nor link with previous knowledge.	Engaged learners, explained, elaborated but did not explore and expand. Very limited learner interest.	drawing labelling	Behaviorist
F02NE	Grade 9 Acids and Bases	Linked current to previous knowledge but not stimulating.	There was a good engagement and explanation, but no elaboration and expansion. Very limited learner interest.	defining balancing	Behaviorist
M04SE	Grade 9 Decomposition of compounds	No link with previous knowledge but stimulating	Explored, explained, elaborated. Needed to engage and expand but there was no group work. Average learner interest.	Observation recording, hypothesizing, and predicting	Confirmatory inquiry
M07DO	Grade 9 Acids and Bases	Stimulating	All 5Es evident but no group work. Learners were curious.	observing, recording calculating	Confirmatory inquiry
F06EL	Grade 8 The periodic table	No curiosity nor link with previous knowledge.	Teacher-led explanation only. Limited learner interest.	tabulating listing	Behaviorist
F030Y	Grade 9 Temperature gradient	Linked current to previous knowledge but not stimulating.	There was a limited engagement, exploration and explanation. Limited learner interest.	drawing plotting comparing	Behaviorist
M08DA	Grade 8 Series and parallel circuits	No link with previous knowledge but stimulating	Explored, Explained, elaborated...Needed to engage and expand but there was group work. Sustained learner interest.	Observing demonstrating, recording, hypothesizing.	Confirmatory inquiry
M05FU	Grade 9 Forces:	No curiosity nor link with previous knowledge.	Explain only. Very limited learner interest.	calculating	Behaviorist

4.3 FINDINGS FROM LESSON OBSERVATIONS ABOUT PARTICIPANTS' EPISTEMOLOGICAL ORIENTATION.

As presented in the preceding section, the lessons observed were rich in content but tended to be oriented towards behaviourism and were thus not aligned to the CAPS' inquiry-based curriculum policy, as was also stated by Botha and Reddy (2011:260). The individualised, linear arrangement of desks also revealed an emphasis of individualised teaching as opposed to collaborative teaching. To fully understand the participants' epistemological orientation, this researcher observed specific lesson procedures. In most lessons observed, participants spent the entire lesson presenting factual scientific content, typically through the explanation of terminology and teacher-based demonstrations, proving that teachers preferred transmissive teaching approaches that were perceived as effective strategies for enhancing learner performance in tests. Ramnarain (2014: 66) states that despite the existence of an inquiry-oriented curriculum reform in South Africa, there is a strong focus on teaching for tests and examinations, which tend to promote rote learning and reduce learner motivation.

Table 6: Participants' epistemological orientations

Behaviourist oriented	Eclectically oriented	Inquiry oriented
F01ES	M05FU	M04SE
F02NE	M07DO	M08DA
F06EL		
F030Y		

The classification of participants was done after obtaining epistemological views from the interviews. There was slight variance between how participants coded as M05FU and M07DO taught during observation and what they stated about their epistemological orientation during the interview. Although M05FU presented a behaviorist-oriented lesson, the participant had a positive perception about inquiry and stated that it was difficult to teach through inquiry due to extremely limited time constraints. Participant M07DO's lesson was rated as inquiry oriented but stated that the inquiry-based approach could not be exclusively used without behaviorist approaches but needed to be blended with logical positivism. There were two participants (M04SE and M08DA) whose teaching and epistemological orientations were consistent. The two participants perceived inquiry-based teaching as an appropriate approach for motivating learners in science.

4.4 PRESENTATION OF FINDINGS FROM DOCUMENT ANALYSIS THAT INDICATE TEACHERS' EPISTEMOLOGICAL ORIENTATIONS: Lesson plans and annual teaching plans

Most participants kept educator files which had lesson templates suggested by the Department of Education. An inquiry-oriented sample lesson template that guided lesson planning is attached as Appendix D. The lesson plan had to state the process skills the teacher was focusing on, as required in inquiry-based teaching. Natural Sciences lessons had to be extracted from the ATP (Appendix C) and taught through an investigative approach in a stimulating and engaging learning environment. This implied a clear shift from teacher-centred pedagogy. Data obtained from the ATP revealed a list of topics to be covered within each knowledge strand that had to be completed within a term. Emphasis was on main topics and the duration of coverage.

4.5 PRESENTATION OF FINDINGS FROM INTERVIEW QUESTIONS

All the participants were interviewed with the intention of obtaining their perceptions about inquiry- based teaching, the extent to which their classroom practice reflected inquiry-based teaching and identifying challenges they experienced as they attempted to teach through the inquiry approach. The following section presents interview questions asked and what the participants stated in verbatim.

4.5.1 Question 1: What is the CAPS policy on how GET Natural Sciences should be taught?

This question was asked in order to determine teachers' pedagogical awareness about CAPS. Basing on the inquiry-based lesson template (Appendix D), all the participants stated that CAPS science teaching should not only be about knowing subject content, but should also be about doing science (making investigations). Participants were, however, ambivalent about the nature and pedagogical depth of scientific investigations prescribed by CAPS. There were only two participants who stated that CAPS required teachers to design their teaching activities in such a way that learners can collaboratively do investigations. Participant M07DO said: the CAPS policy requires teachers who can teach through the inquiry approach, although there are practical limitations to this type of teaching. Some participants were not sufficiently conversant with terms like 'inquiry-based science teaching' – as stated by participant F06EL, who said, 'I am not familiar with inquiry-based teaching'. This implied that there were some participants who could not confidently use the inquiry approach because they were not familiar with it. Anderson (2002) asserts that although a lot has been written about the inquiry approach, some teachers still need training on the use of inquiry-based teaching. Teachers shun the inquiry-based approach because they have very limited competence in using it.

4.5.2 Question 2: How do you align your teaching to the principles of inquiry-based teaching?

This question was asked to determine the extent to which teachers aligned their practice towards inquiry-based teaching. This question led to the classification of the participants into three categories. Firstly, there were four participants whose behaviourist orientation made them state that they were not aligning their teaching to inquiry-based teaching, secondly there were two participants who stated that they preferred an eclectic blend of behaviourism and inquiry-based teaching. Participant M07DO stated that there was a need to blend the inquiry approach with other approaches, saying: 'I change pedagogical techniques, use multiple modes of learning such as visual, auditory…I use more practical investigations, more demonstrations, use online simulations'. Participant M05FU also said, 'an eclectic blend was better than allegiance to a single approach'. This finding revealed that these participants did not believe that inquiry-based teaching was effective when used without combining it with other approaches (Campbell et al 2010:6). There were only two participants who embraced inquiry-based teaching but found it extremely difficult to implement due to a variety of challenges that included time, resources, and curriculum-related challenges.

4.5.3 Question 3: Do you approach your science lessons from a teacher-centred or inquiry-based approach?

This question sought to determine the epistemological orientation of teachers. There was a clear trend revealing that four behaviourist-oriented participants such as F06EL, F030Y, F02NE and F01ES approached their lessons from teacher-centred approaches.

Participant F06EL, in agreement with F02NE, stated that inquiry-based teaching promoted disruptive behaviour as cited: 'I use the teacher-centred approach because kids do not always have the best behaviour when you allow them to be active, they will be disruptive '(*sic*). Participant F01ES also stated that a full inquiry approach was not possible at the school because of disruptive learner behaviour. So, from the verbatim statements given above, it was clear that inquiry-based teaching was not the dominant teaching approach in that school. Teachers were reluctant to implement it. Participant M04SE, together with M08DA, stated that they approached science teaching from an inquiry-based perspective because inquiry-based learning enhanced learner motivation, as Participant M04SE was cited, 'To me, science is an experimental subject, it's fun, learners should be allowed to interact with various kinds of science equipment'. The participant alluded to the need to teach through inquiry, as opposed to the behaviourist-oriented approach. Participant M08DA said, 'inquiry-based teaching in one of the best approaches of making science real and stimulating to learners, unlike the lecture-based approaches that promote learning'

4.5.4 Question 4: How can the method of investigation be improved to enhance learner interest in science?

This question sought to determine whether teachers appreciated the motivational value of inquiry-based teaching. Six participants did not relate learner motivation to inquiry-based teaching. They tended to mention methods that were not linked to the inquiry-based teaching approach. They believed that field trips could enhance learner interest, as cited by participant F01ES, who said 'Take them out to the field and show them some of the ecology, make it really interesting for them, not just sitting in class. Make them also become inquisitive'. M08DA said, 'Learners should visit technically developed places where they see engineering complexes that manufacture goods so that that they can be motivated.' Participant M05FU, in agreement with F01ES, also stated that teachers should motivate learners by providing 'trips to different laboratories so that learners can see that any human being can do science'. Participant F01ES said, 'Tell them about very interesting careers in science, like microbiology today with the coronavirus, not only book science'. Participant M05FU attributed low learner interest in science to lack of science-related career awareness. Participant M08DA also accentuated the need for experiments in science lessons when he said, 'experimentation motivates science learners; I as a teacher motivate my learners by focusing on experimental methods of teaching because if a learner uses his vision, sense of touch, observes the results practically, that learner is bound to develop a lot of interest. So, when I carry out experiments, I make sure they are visible enough, they are motivating and raise their curiosity.'

4.5.5 Question 5: What are your perceptions about inquiry-based teaching in this school?

Four behaviourist-oriented participants; F06EL, F01ES, F030Y and F02NE perceived inquiry-based teaching as a possible cause of learner disruptive behaviour. Participant F02NE stated that she did not believe that inquiry-based science teaching was possible for learners in the GET phase. She said, 'To let loose the Grade 8 and 9 on inquiry-based teaching is very dangerous. You are wasting their time and you are frustrating yourself. I am of the old school, and I would like to be in control.' Participant F06EL also justified the behaviourist stance by stating that it was much easier to summarise the main ideas of the lesson and get the learners to write notes and do some revision exercises than to engage in activities that take more time. Participant F06EL further stated: 'Unfortunately in our school we cannot do investigation, I would rather do the experiment of the investigation myself and show them the results, doing it step by step and showing them the results, make everybody see, take the sample around.' The two eclectically oriented participants perceived the exclusive use of inquiry as a challenge. Participant M05FU said, if we are to use inquiry regularly, we may not cover the content knowledge in the ATP in an effective way. We also need teacher-centred methods to explain concepts effectively.' The two inquiry-oriented teachers were confident that the effective use of inquiry, given the elimination of challenges that affect its implantation, can promote quality science teaching.

4.5.6 Question 6: What are the challenges that impede the use of the investigative approach in this school?

This question was asked to elicit challenges related to inquiry-based teaching in that school. In addition to the lack of time to teach through inquiry, Participant M05FU said, 'The use of inquiry implies that I have to set up the apparatus before class and clean the apparatus after class and that is impossible because seven different classes use the laboratory per day. There is no time to keep on re-assembling and cleaning the apparatus'. Participant F01ES stated that there was no clear support from the

Department of Education to assist the teachers to teach through inquiry when she said, ‘No matter how well the teachers are trained, if the system does not make it easy for them to perform, they may not teach properly.’ This participant was alluding to the fact the Department of Basic Education had not provided support for teachers to teach through the investigative approach. When participant F030Y was asked about her perception on inquiry-based teaching, she emphatically stated that inquiry-based teaching could result in chaos and was therefore not suitable for the junior classes: ‘I think it can work at some schools, but because of our disruptive learners, we can’t do a lot of group work. It will have an impact on the classroom next to you. It might end up in chaos. I don’t do group work.’ It was, therefore, generally a challenge for most participants to teach through inquiry.

4.5.7 Question 7: What suggestions do you have for improving learner interest in science?

This question sought to give participants the chance to provide more relevant measures to motivate learners which had not been captured from the discussion. Most participants suggested that learners needed career training and excursions. Participant M05FU believed that learners’ enrolment in science could also be improved by ‘dispelling the myth that science subjects were difficult’. Participant M04SE also said, ‘Remove the mentality that science is difficult.’ Participant M04SE said, ‘To see the need to learn science, learners need to be enlightened on scarce skills which are basically science related; 80% of these scarce skills are science-related courses. Most participants from the behaviourist orientation suggested that parents should be involved to assist learners with homework so that they may not experience science as difficult and feel discouraged. The behaviourist-oriented participants suggested more extra classes for learners that experienced challenges.

4.6 DISCUSSION OF FINDINGS

Table 7: Summary of themes and subthemes obtained from data analysis

Data collection method	Major themes	Subtheme
Observation	Varied participants' epistemological orientations	Logical positivist approach Limited inquiry approach
Document analysis	Epistemological orientation of the curriculum	Inquiry oriented Behaviourist oriented.
Interview	Varied participants' epistemological orientations	Logical positivist, eclectic and Inquiry oriented.
	Participants' perceived barriers to inquiry	Learner indiscipline
		Limited training
		Overloaded CAPS
		Time related constraints
	Participants' suggestions to improve learner interest	Career guidance
		Use of field trips
		Use of experimentation
	Participants' reasons for limited science learner interest.	Fear of science
		Logical positivism Limited Mathematical background.
	Teacher perceptions about inquiry.	Cynical Motivating.

Although participants knew that the CAPS curriculum was based on inquiry-based teaching, data from observation and interviews revealed that most participants were cynical about the use of inquiry as an approach that could motivate learners. The behaviourist-oriented participants dismissed the motivational effect of inquiry-based teaching, proving that there was a significant number of teachers whose classroom practice was not aligned to the principles of inquiry. Five out of eight participants presented teacher-fronted lessons and when interviewed, four of them rejected the use of inquiry-based teaching because they did not perceive it as an effective way to enhance learner motivation and preferred to teach science the way their mentors taught. Mulhall and Gunstone (2012: 430) state that many science teachers are products of logical positivist teaching approaches and would like to teach science the same way in which they were taught. The overuse of behaviourist-based strategies poses a threat to the prospects of enhanced science learner motivation.

The participants had different epistemological orientations. Participants oriented toward logical positivism rejected inquiry-based teaching and preferred teacher-centred lessons. Eclectic teachers, on the other hand, preferred to combine inquiry-based teaching with logical positivism. These varying epistemological orientations indicated that teachers did not follow a single approach in their teaching. It is indeed appropriate to use various pedagogical techniques; however, inquiry-based teaching should be a prominent feature of Natural Sciences teaching. There were a few participants who were oriented toward inquiry-based teaching who mentioned that time-related and work-overload constraints could not allow them to teach full inquiry lessons. Gudyanga & Jita (2019: 715) state that there are many administrative duties that severely limit teachers' ability to implement inquiry-based teaching.

All the participants mentioned that inquiry-based teaching was too demanding in terms of resources and preparation time needed and therefore had an effect of increasing their teaching load, considering that the curriculum was already overloaded with the subject content knowledge that had to be taught within limited time frames. This finding confirms Ramatlapa and Makonye's (2013) study, which found that teachers could not teach through the inquiry approach because of time-related constraints. The EU report (2007:51) also found that teachers found it more suitable to teach through a teacher-centred approach to deliver a curriculum that was heavily loaded with content. This was an indication that behaviourist teaching was the dominant one in the school, even though inquiry-based teaching had become a global norm. If research findings about the pitfalls of the logical positivists are to be believed, this researcher can give an opinion that the origin of science learner apathy in this case study possibly emanated from conservative behaviourist teachers who were not willing to shift from logical positivism to either eclectic or inquiry-based teaching. In most lessons observed from participants oriented toward logical positivism, learners lost concentration and began fidgeting and chatting with classmates, which frustrated the participants, who had to admonish them to be silent.

The teaching approach was generally teacher-centred, except for three participants who presented basic inquiry-based lessons and could not afford to teach through structured, guided or open inquiry because of limited time. Most participants controlled the teaching process and did not afford learners the autonomy to engage in scientific inquiry, thus confirming Ramnarain's (2014:67) findings. As a teacher in that school, the researcher also observed that the textbook was the central teaching tool used by teachers. Teachers had a tendency of copying texts from textbooks and instructing learners to paste these in their workbooks as proof that topics had been taught. When asked why learners pasted hand-outs on a regular basis, most of the teachers said that they were 'covering their backs' to avoid possible victimisation by educational authorities if learners failed prescribed tests. The researcher therefore sought to undertake a scientific investigation into the reasons why some teachers possibly avoided the inquiry-based teaching and simply bombarded learners with worksheets that enriched learners' knowledge. Williams (2018:5) states that the focus on churning knowledge and facts may make learners obtain knowledge that they do not understand and get demotivated.

One major reason why participants avoided inquiry-based teaching was poor learner discipline. Learners in that school were perceived as disruptive and because of that, collaborative learning was 'not possible' because teachers wanted to avoid excessive noise levels. This finding therefore provided proof that learner discipline was an important factor that determined teaching strategies. Learner indiscipline could be a direct result of ineffective teaching approaches. It is therefore important to train participants on the use of more effective teaching approaches that engage learners and reduce indiscipline.

Most participants in this study had limited understanding of inquiry-based teaching because they did not demonstrate in-depth and critical awareness of inquiry-based teaching. They seemed to think that any demonstration or practical activity constituted inquiry-based teaching. In other words, they did not differentiate between a practical activity and inquiry-based teaching. Inquiry-based teaching occurs when there is an investigative question, hypothesis and variables are identified. So, there were participants who believed that they were teaching through the inquiry approach, yet they were only conducting practical activities which were not investigative in nature. Since the inquiry approach is the official policy of the CAPS science curriculum, there is need for in-service teacher development. These misconceptions presented a threat to inquiry based teaching and thwarted hopes for increased learner interest in science.

There was evidence that most participants presented expository, content- based lessons that were not oriented towards scientific inquiry. Data obtained from lessons observed from behaviourist-oriented teachers revealed that learners were not keen to participate in the learning process. This possibly explains why learners opted not to specialise in Science after GET. On the contrary, participants, particularly of behaviourist orientation, did not associate science learner demotivation with epistemological choices and this should be a topic for further research. Most participants did not acknowledge epistemological barriers as the reasons for learner demotivation but tended to identify learners' poor mathematical and language backgrounds as the reason why they found science a difficult and discouraging subject. Although this was correct to some extent, it was necessary to use the inquiry-based approach because the approach could assist learners who experience linguistic and mathematical barriers. It is of great importance for participants to understand the impact their epistemological choices have on learners' motivation if effective learning and teaching that enhances motivation is targeted.

4.7 CONCLUSION

This chapter presented and discussed the findings from observations, document analysis and interviews. The data was linked to each research question and sub-questions. The focus of the chapter was on how participants perceived inquiry-based teaching, their epistemological orientation, the extent to which inquiry-based teaching was implemented and the level of learner motivation observed. Other strategies for enhancing learner motivation in science have been discussed. From the findings, it is evident that most of the participants held a cynical and cautious perception about the instructional value of inquiry-based teaching. This implies that the envisaged pedagogical shift from didactic to inquiry- based teaching has yet to be fully realised. The hope for increased intrinsic learner motivation therefore remains elusive. The next chapter summarises, concludes and provides recommendations for this study.

CHAPTER 5
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The previous chapter presented findings of this study and discussed them. This chapter provides a summary of participants' perceptions about the motivational value of inquiry-based teaching at the GET level in a specific school. It was the focus of this study to determine the level to which inquiry-based teaching was perceived and implemented by science teachers in a specific school in Pretoria. This chapter also provides conclusions and outlines recommendations for this study.

In the global arena and South Africa as well, there have already been epistemic shifts from logical positivism to inquiry-based teaching. It was important to obtain science teachers' perceptions about inquiry-based teaching as an approach that was intended to motivate learners to learn science, considering the low enrolment in science-related subjects at a specific high school in Pretoria.

5.2 SUMMARY OF THE STUDY

To begin this investigation, this researcher obtained ethical clearance from the Research Ethical Clearance Committee of the College of Education at the University of South Africa and from the Department of Basic Education's ethical committee before obtaining permission from the school principal to conduct the research. It was therefore necessary to purposefully and conveniently sample eight teachers who taught Natural Sciences at the GET phase because they were considered the ones that had the ability to stimulate learner interest in science. The sampled participants were informed about voluntary participation and consent. Three instruments, namely observation, document analysis and semi-structured interviews were used to collect data. This researcher then arranged to observe lessons during school hours so that authentic teaching situations were observed. There was no inconvenience done to the school because this researcher had been allocated observation time by the School Management Team (SMT) as part of peer development required for IQMS. This study focused on the following research questions:

- What are Natural Sciences teachers' perceptions on the use of inquiry-based teaching to stimulate learner interest in science?
- To what extent is the science teachers' classroom practice aligned with the principles of inquiry-based teaching?

5.3 SUMMARY OF RESEARCH FINDINGS

There were varied perceptions about inquiry-based teaching. Teachers' perceptions seemed to be influenced by their epistemological orientations. The study also revealed that inquiry-based science teaching was implemented by few participants who were classified as inquiry oriented. The participants' epistemological preferences determined their teaching approach.

5.3.1 The epistemological orientations of participants

Although there have been epistemic shifts in curriculum theory in South Africa, there is a clear indication that teachers' perceptions and beliefs do not necessarily change. Chisholm (2000) states that behaviourist-oriented teaching continues to dominate the teaching and learning space, even though Curriculum 2005 presented a shift from a performance-based to a competence-based curriculum. Lesson observations in this study revealed that five out of eight participants did not teach through the inquiry-based approach. Similar trends were recorded in the Cook-Sather, Demetriou et al. (2015:4) study that was done in the USA. The prevalence of behaviourist-oriented teaching therefore remains a global challenge.

In this study, there were participants who embraced both behaviourist and inquiry-based teaching because they wanted to benefit from the advantages associated with each epistemological orientation. One of the reasons why teachers adopt behaviourist-based teaching approaches is to save time that could be spent on using inquiry-based teaching (EU 2007:51). The findings therefore revealed that there are many teachers who have not adjusted their teaching approach to meet the demands of contemporary, learner-centred teaching approaches that are dialectic rather than didactic and this certainly presents a challenge of perpetuating learner demotivation. There is, however, some ray of hope emanating from the fact that eclectically oriented and inquiry-oriented participants attempt to teach science through the inquiry-based approach. If more pedagogical training is provided for science teachers, there could be a steady increase of teachers adapting to the requirements of inquiry-based teaching.

5.3.2 Participants' perceptions about inquiry-based teaching.

There were mixed perceptions about the use of the inquiry-based approach, despite the fact that it was already a dominant philosophy of the CAPS document. Participants who were classified as behaviourists were cynical about the instructional worth of the inquiry-based approach in a school they considered as having a lot of disruptive learners. The interview data revealed that there were four advocates of behaviourist-based teaching who rejected inquiry-based teaching and described it as a potential source of anarchy and ineffective science teaching, particularly in the GET phase. This cast little hope for the implementation of inquiry-based teaching. The eclectic participants were cautious about adopting a single instructional approach, maintain that inquiry-based teaching should be interchangeably used with logical positivism in order to take advantage of the strengths of the two approaches. Participants who tended to teach through the inquiry approach acknowledged that limited learner interest in sciences was a direct result of the overuse of behaviourist-based teaching approaches. Time-related constraints and the overloaded CAPS were identified as other challenges that were perceived to be impediments on the use of the inquiry-based approach.

5.3.3 The level of learner motivation during lesson observations.

All the five participants who were initially observed as presenting behaviourists-oriented lessons had passive learners who did not take any initiative in their learning but exclusively relied on the teacher in every aspect of the lesson. Learners learnt primarily through the oral mode and their concentration spans could not last for the entire duration of the lesson; as a result they began losing focus. One of the pitfalls of the transmissive teaching approach is that it tends to present too much content which learners may not be able to understand within a single session. There is, therefore, need to incorporate inquiry-based approaches to stimulate learning. On the contrary, there was heightened enthusiasm form the three participants who presented inquiry-based lessons. The data from lesson observation therefore provided evidence that inquiry-based teaching had the potential to keep learners stimulated during the learning process, compared to the behaviourist approach that kept learners passive and distanced from the teaching and learning process.

5.3.4 The extent to which inquiry-based teaching is being implemented

From the small number of teachers that demonstrated a rare ability to teach through inquiry-based teaching, there is an indication that the inquiry-based approach has not gained much traction in the school in which this case study was done. Part of the challenge that compounded the non-implementation of the inquiry approach was participants' lack of understanding about what inquiry-based teaching involved and as a result, most participants did not implement it.

5.3.6 Barriers impeding the implementation of inquiry-based teaching

All the participants were concerned that poor learner discipline would make it impossible to teaching grades eight and nine learners through the inquiry-based approach. They stated that junior secondary school learners tended to be naughty and disruptive and did not take responsibility for their learning and an attempt to teach them through the investigative approach would result in chaos and limited learning. These were perceived challenges because most participants had not attempted using the inquiry approach.

Some participants attributed their non-inquiry-based teaching to lack of adequate time because the NS CAPS was heavily loaded with factual content. They also stated that inquiry-based teaching needed more preparation time, which they did not have because they had to cover the heavily loaded ATP. This was indeed a genuine concern because the teachers were allowed only a week to teach numerous concepts and there were prescribed tests that followed at regular intervals to monitor teaching. Teachers were indeed left with no option but to drill learners so that they could pass the tests. It was therefore evident that the NS curriculum, although theoretically founded on inquiry-based teaching, practically did not allow teachers the autonomy to teach through inquiry.

In this study, most participants did not identify the problem of resources because the school had laboratories and all the apparatus required for the inquiry-based approach. So, the presence of resources implied that there were other challenges that impeded the use of inquiry. Teachers did not have time and willpower to use inquiry-based teaching in the junior phases because they believed that it was suitable for more senior learners in the FET phases who were more responsible. Some participants stated that there was limited parent support if learners were to carry out investigations beyond the classroom. It was reported that some parents were not involved in the education of their children, particularly with science that was considered difficult, so teachers were reluctant to share teaching responsibilities with parents.

5.3.6 Measures to encourage learners to specialise in science subjects

Most participants did not provide any pedagogical solutions to this problem, particularly those who were classified as logical positivists who believed that science was not meant for all learners. There is need to dispel the myth that science, particularly Physical Sciences, is for gifted learners. This type of thinking is so deeply rooted that learners developed a phobia for Physical Sciences because they have been conditioned to believe that is a very difficult subject; teachers should not spread that perception to learners. A great science teacher’s passion should be the desire to teach Physical

Sciences to all learners, without assigning any ability-related labels. It is indeed worth noting that Physical Sciences does not begin in the FET phase but in the GET phase ,and therefore if learners are motivated to learn it in the GET phase, they are likely to elect it in the FET phase. One cannot underestimate the power of inquiry-based teaching when teaching science subjects, compared with the logical positivist approach

The issue of limited learner enrolment in science was a critical issue in this study and participants' responses to this question varied. Participants who were categorised as logical positivists and eclectic believed that learners did not enrol for Grade Ten sciences because they had limited mathematical abilities and deprived linguistic background that made them fail to excel in science as well. Although the challenge with Mathematics was real, learners' performance in GET Natural Sciences, where there was very limited mathematical background needed, was below average. This implies that Natural Sciences teachers had to improve learners' confidence in sciences as a motivation to excel in Mathematics so that it complements their achievement in science.

The findings of this study proved that there was very limited use of the inquiry-based approach in that school because teachers had varying convictions about its effectiveness. The following recommendations aim to promote the use of inquiry-based teaching in that school.

5.4 RECOMMENDATIONS

At policy level, there has been a paradigm shift from transmissive, didactic teaching to inquiry based, dialogical science teaching. In this study, there were a significant number of teachers who perceived inquiry-based teaching as rather too idealised and impractical in their school. A permanent threat to learner motivation to enrol in sciences looms and it is therefore important to find means of empowering science teachers to teach through inquiry-based teaching and stimulate learner interest in science. The following measures are recommended to motivate learners to appreciate science subjects and pursue them at higher levels of education so that they can actively contribute to the scientific and economic development of the country.

Recommendation 1: **In-service training of teachers on inquiry-based teaching**

There are some participants who demonstrated very limited understanding of inquiry-based teaching. The Department of Basic Education should therefore provide empowerment training and workshops on the use of the inquiry-based approach. Each teacher must score certain points for science-related professional development so that they maintain their professional accreditation with the SACE.

Recommendation 2: Hiring of laboratory assistants

The implementation of inquiry-based teaching needs a lot of preparation time on the part of the teachers. Teachers could not teach through inquiry because they were not able to re-assemble apparatus after every class each day, considering teaching and other administrative duties they had perform. The Department of Basic Education could assist teachers to implement the inquiry-based science teaching approach by employing laboratory assistants whose main responsibility would be to set up the apparatus for the investigation, clean it and keep it safe.

Recommendation 3: Trimming some content to accommodate inquiry-based teaching

Most participants indicated that they did not have time to teach all the topics in the overloaded ATP. Curriculum policy planners need to evaluate the curriculum and integrate certain topics so that adequate time is given to teaching through inquiry. It does not really help to have a list of topics that are superficially taught through logical positivist teaching. The trimming of the curriculum may also provide opportunities for field trips that can enhance learner motivation.

5.5 SIGNIFICANCE OF THE STUDY

This study has identified a gap between the envisaged and the enacted curriculum. It has established that teacher perceptions about a pedagogical innovation vary. In this study, there were very few participants who complied with the requirements of inquiry-based teaching because most participants had negative perception about inquiry-based teaching. It is therefore important for science teachers to express their epistemological orientations so that appropriate intervention is provided to those with limited understanding of inquiry-based teaching. The data obtained from this research can be used for evaluating the implementation of the Natural Sciences curriculum and the extent to which learners are stimulated to learn through effective and motivating strategies used by teachers.

5.6 RECOMMENDATIONS FOR FUTURE RESEARCH

This study focused on teacher perceptions about inquiry in a single school. It did not focus on the learners' perceptions about inquiry-based teaching. There is still fertile ground for research about learners' perception about their teachers' epistemological choices.

5.7 LIMITATIONS OF THE STUDY

The major limitation of this study is that data was obtained from a single high school in an urban area. The perceptions and experiences of the sampled participants may not be generalised to other contexts. In addition, science learners' perceptions about inquiry-based teaching in that school were not included in this study; future research could therefore concentrate on learner perceptions as well. This study may be criticised for bias because this researcher was part of the teaching staff at the school and his familiarity and prior knowledge about the participants, who were his colleagues, could have affected the neutrality of this researcher's interpretation of data obtained from the participants. Methodological triangulation, however, limited the researcher's possible bias.

5.6 CONCLUSION

Although inquiry-based teaching is gaining traction in South Africa and globally, this qualitative research has proven that this approach of teaching has not been fully implemented in a single school in South Africa. This is because most participants in that school who were oriented towards behaviourism perceived inquiry-based teaching as challenging and ineffective in promoting quality teaching and learning to learners in the GET phase. There were a few eclectic teachers who perceived inquiry-based teaching as inadequate without the use of behaviourists-based approaches. Only a few inquiry-oriented teachers perceived inquiry as an effective pedagogy that can result in increased learner motivation. To promote the use of inquiry-based teaching and ultimately improve learner interest in science, this researcher recommends in-service teacher training on inquiry-based teaching, the inclusion of more specific models of inquiry in the CAPS document to guide the teachers, the trimming of factual content in the ATP to accommodate the use of inquiry-based teaching approach and the employment of laboratory assistants to assist teachers to prepare for inquiry-based science teaching.

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Appendix A: Ethical clearance certificate

UNISA university of south africa

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2019/04/17

Ref: **2019/04/17/40760359/18/MC**
Name: Mr J Mkandla
Student no: 40760359

Dear Mr Mkandla

Decision: Ethics Approval from 2019/04/17 to 2022/04/17

Researcher(s): Name: Mr J Mkandla
E-mail address: 40760359@mylife.unisa.ac.za
Telephone: +27 78 151 3521

Supervisor(s): Name: Prof JG Ferreira
E-mail address: ferrejg@unisa.ac.za
Telephone: +27 12 429 4540

Title of research:

Natural Sciences teachers' perspectives on constructivist-based teaching to improve learner academic performance.

Qualification: M. Ed in Curriculum studies

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 2019/04/14 to 2022/04/17.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2019/04/14 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
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Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
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2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the UNISA College of Education Ethics Review Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No field work activities may continue after the expiry date **2022/04/17**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2019/04/17/40760359/18/MC** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Kind regards,

Prof AT Motlhabane
CHAIRPERSON: CEDU RERC
motlhat@unisa.ac.za

Prof PM Sebate
ACTING EXECUTIVE DEAN
Sebatpm@unisa.ac.za

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Appendix B: Interview guide

Biographical details

Date:		Gender	
Participant code		Age range	
Teacher Qualification		PL	
Teaching experience		Interview duration	

What are the epistemological orientations of Natural Sciences teachers at a high school in Pretoria?

1. What is the CAPS policy on how GET Natural Sciences should be taught?

2 ((a) How do you align your teaching to the principles of inquiry- based teaching.

(b) Could you provide more detail for your stance in question 2?

To what extent is the science teachers' classroom practice aligned with principles of inquiry-based learning and teaching?

3 Do you approach your science lessons from a teacher centred or inquiry-based approach?

What are the teachers' understanding of the inquiry-based approach as a way to stimulate learner interest in science subjects?

4 How can the method of investigation be improved to enhance learner interest in science?

5 What are your perceptions about inquiry-based teaching?

What problems do teachers face in their attempt to implement inquiry-based teaching?

6 What are the challenges that impede the use of the investigative approach in this school?

Appendix C: Sample of Annual Teaching Plan (ATP)

education
Department: Education
GAUTENG PROVINCE

Natural Sciences ATP **Grade 9: 2020**

(Calculated time needed for each context)

Dates	Contexts according to Strands	Formal Assessment	Completed	Curriculum Coverage %
15Jan – 17 Jan	Cell structure, difference between plant and animal cells	√		2.7%
20 Jan – 24 Jan	Cells in tissues, organs and systems			5.4%
27Jan – 31 Jan	Body systems: Digestive, circulatory, respiratory and musculoskeletal	√		8.1%
03 Feb – 07 Fb	Body systems: Excretory, nervous			10.8%
10 Feb – 14 Feb	Body systems: Reproductive			13.5%
17 Feb – 21 Feb	Purpose of reproduction and puberty / ***PRACTICAL TASK***			16.2%
24 Feb – 28 Feb	Reproductive organs, stages of reproduction	√		18.9%
02 Mar – 06 Mar	Breathing, gaseous exchange, circulation and respiration			21.6%
09 Mar – 13 Mar	Healthy diet / Alimentary canal and digestion	√		25.00%
16 Mar – 20 Mar	***Revision and Test*** ***(Minimum 40 Marks)***			
21 Mar – 30 Mar	**School Holidays**			
31 Mar – 03 Apr	Periodic Table, Names of compounds			27.27%
06 Apr – 09 Apr	Chemical equations: representing and balancing	√		29.54%
14 Apr – 17 Apr	Chemical equations: representing and balancing			31.81%
20 Apr – 24 Apr	General reaction of metals with oxygen: Iron and magnesium			34.08%
28 Apr – 01 May	Formation of rust, prevention of rust			36.35%
04 May –08 May	General reaction of non-metals with oxygen: Carbon and sulphur/ / ***PRACTICAL TASK***	√		38.62%
11 May –15 May	Concept of pH value Neutralisation and pH			40.89%
18 May –22 May	General reaction of an acid with a metal oxide (base), applications			43.16%
25 May –29 May	***General reaction of an acid with a metal hydroxide (base)***			45.43%
01 Jun – 05 Jun	***General reaction of an acid with a metal carbonate (base)*** General reaction of and acid with a metal	√		50.00%
08 Jun – 12 Jun	Revision and **June Examination** ***(Minimum 80 Marks)***			
13 Jun – 06 Jul	**School Holidays**			
07 Jul – 10 Jul	Types of forces, Contact forces – Friction, tension and compression			52.27%
13 Jul – 17 Jul	Field forces – Gravitation, magnetic and electrostatic	√		54.54%
20 Jul - 24 Jul	Electric cells as energy systems			56.71%
27 Jul – 31 Jul	Uses of resistors			59.08%
03 Aug – 07 Aug	Series circuits			61.35%
11 Aug – 14 Aug	Parallel circuits ***/ PRACTICAL TASK***	√		63.62%
17 Aug – 21 Aug	Safety practices: Electricity			65.89%
24 Aug – 28 Aug	Electricity generation and Nuclear power in RSA			68.16%
31 Aug – 04 Sep	National electricity grid	√		70.43%
07 Sep – 11 Sep	Energy consumption of different electrical appliances & Cost of Electricity			75.00%
14 Sep – 18 Sep	**Revision and Test** ***(Minimum 40 Marks)***	√		
19 Sep –28 Sep	**School Holidays**			
29 Sep – 02 Oct	Spheres of the Earth			78.57%
05 Oct – 09 Oct	Lithosphere, rock cycle	√		82.14%
12 Oct – 16 Oct	Extracting ores, refining minerals			85.71%
19 Oct – 23 Oct	Mining in RSA ***/ PRACTICAL TASK***			89.28%
26 Oct – 30 Oct	Atmosphere, Troposphere and Stratosphere			92.85%
02 Nov – 06 Nov	Mesosphere and Thermosphere. Greenhouse effect	√		96.42%
09 Nov – 13 Nov	Life cycle of a star			100.00%
16 Nov – 20 Nov	**Revision and Final Examination** ***(Minimum 80 Marks)***			
23 Nov-27 Nov	**Consolidation and Analysis**	√		
30Nov – 02 Dec	**Planning**			
03 Dec	**School Holidays**			

******* INDICATE DATE COMPLETED ON THE 4TH COLUMN***

Appendix D: Sample of lesson plan from Gauteng Department of Education

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NATURAL SCIENCES: LESSON PLAN 9
DURATION: 30 Minutes
CAPS SENIOR PHASE

GRADE: 9
STRAND: MATTER AND MATERIALS
TERM : TWO

DAURATION: Week Three Lesson One and Two	**OBJECTIVES: LEARNERS MUST BE ABLE TO:** Write out word equations for chemical reactions.	
TOPIC: CHEMICAL REACTIONS		
SUB TOPIC: Balanced Equations		
REFERENCES	**Sasol Inzalo workbooks- Natural Sciences Grade 9A**	
TERMINOLOGY:	Chemical equations must be written as balanced chemical equations. The total number and type of atoms of the reactants is the same as in the products.(In words)	
SPECIFIC AIMS	1. DOING SCIENCE	
	2. KNOWING THE SUBJECT CONTENT & MAKING CONNECTIONS	x
	3. UNDERSTANDING THE USES OF SCIENCES & INDIGENOUS KNOWLEDGE	

- 202 -

SCIENCE PROCESS SKILLS					
Accessing & recalling Information	x	Identifying problems & issues		Doing Investigations	
Observing		Raising Questions		Recording Information	
Comparing		Predicting		Interpreting Information	
Measuring		Hypothesizing		Communicating	
Sorting & Classifying		Planning Investigations			

CONTENT AND CONCEPTS	ACTIVITIES	RESOURCES
Chemical equations to represent reactions • chemical reactions can be represented with models • chemical reactions are usually represented with symbols such as in chemical equations: For example: -- $C+O_2 \rightarrow CO_2$	To introduce the lesson the teacher will show learners how to write equations in word form, for example: Hydrogen + Oxygen →Water.	• Textbooks: eg. Sasol Inzalo Explore Gr. 9A Projector, laptop and white board/screen.

Appendix E: Approval letter from Gauteng Department of Education.

GAUTENG PROVINCE

Department: Education
REPUBLIC OF SOUTH AFRICA

814141112

GDE RESEARCH APPROVAL LETTER

Date:	27 August 2019
Validity of Research Approval:	04 February 2019 — 30 September 2019 2019/252
Name of Researcher:	Mkandla J
Address of Researcher:	462 De Kock Street
	Pretoria, 0002
	South Africa
Telephone Number:	078 151 3521
Email address:	jmkandla@yahoo.co.uk
Research Topic:	Teachers' perceptions on using inquiry-based teaching to enhance learner interest in science.
Type of qualification	Master of Education
Number and type of schools:	One Secondary School
District/s/HO	Tshwane South

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the school (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

27/08/2019

1

[redacted]

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (01 1) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

1. Letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.
2. The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.
3. A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.
4. A letter/ document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.
5. The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.
6. Research may only be conducted after school hours so that the normal school programme is not interrupted. The principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.
7. Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.
8. Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.
9. It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.
10. The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.
11. The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.
12. On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.
13. The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.
14. Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings, and recommendations of the research study.

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

Mr Gumani Mukatuni
Acting CES: Education Research and Knowledge Management

Appendix F: Observation checklist

Date:		Teacher Qualification	
Subject observed		Teaching experience	
Topic:		Age range	
Lesson duration:		Participant code	

Introduction

The introduction linked current information to previous knowledge.

Yes		No	

Learners were engaged through stimulating activity that made them inquisitive.

Yes		No	

The learners were made curious to discover or experience scientific phenomena.

Yes		No	

Main lesson

There was evidence of the 5 E instructional model.

Yes		No	

If yes indicate in the table, the instructions used.

	Evidence
Engage	
Explore	
Explain	
Elaborate	
Expand	

Scientific processes observed.

Process	**Activity**
Observing	
Recording	
Comparing	
Hypothesis	
Communicating	
Predicting	

Working was done.

individually		Groups	

Overall level of scientific inquiry

Level	**Reason**
Confirmation inquiry	
Structured inquiry	
Guided inquiry	
Open inquiry	

Appendix G: Consent to participate in the study.

CONSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, __________________ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the interview.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (please print) ____________________________________

____________________________ ___________________________________

Participant Signature Date

Researcher's Name & Surname (please print) ____________________________________

_____________________________ __________________________________

Researcher's signature Date

Appendix H: Participant's information sheet

PARTICIPANT INFORMATION SHEET

Date: 20/10/2019

Title: Teachers' perceptions on using inquiry-based teaching to enhance learner interest in science.

DEAR PROSPECTIVE PARTICIPANT

My name is Mkandla Justice. I am doing research under the supervision of Ferreira G, a professor in the Department of Education (Curriculum studies) towards an M. Ed at the University of South Africa. I am inviting you to participate in a study entitled: Teachers' perceptions on using inquiry-based teaching to enhance learner interest in science.

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could help teachers to use appropriate teaching approaches for Natural Sciences. When appropriate approaches are selected, teachers can therefore use appropriate teaching methodology that can lead to improved teaching and learning environment. This will ultimately improve learners' motivation to specialize in science and perhaps perform better in science as well.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited because you are an experienced and qualified educator whose input on teaching approaches is of great importance. I obtained your contact details from the teacher contact list after getting permission from the school principal and I assure you that your personal contact details will not be disclosed to anyone else. I have sampled eight teachers from the Sciences Department in the school and there are no external participants.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves a lesson observation, document analysis and an interview. I will request to record the interview so that I can transcribe and analyse the data. The interview will be semi structured and questions about your teaching approaches will be asked, particularly how you perceive the effectiveness of learner centred approaches such as constructivism in your teaching practice. I will observe at least three forty-minute lessons. The interview will be about 30 minutes long and there will be one follow up interview where I will be verifying your responses with you.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

This study will assist in the selection of appropriate teaching approaches so that there is improvement in the teaching and learning atmosphere, thereby improving learners' learners' motivation to learn science subjects.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There is no potential risk to this study because I will visit you during your scheduled classes as part of my IQMS visit. I will then use the observation class visit to collect data about how you teach. I will make a follow-up on your teaching and discuss your insights on effective strategies, particularly within CAPS. I am aware my visit to your class may create a bit of discomfort to learners who may not understand my presence, I will not in any way attempt to interfere with your teaching process and I will where possible move around the classroom to observe how the learners interact with each other. The data obtained will be kept confidential.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research **OR** Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be given a code, or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. will however, provide your responses to data transcribers who will assist me with data analysis. These transcribers have also signed an oath of secrecy. The University of South Africa Ethics Review Committee will also have access to the data in order to make sure that the data was correctly collected and analysed. You are guaranteed that your participation in this research will be anonymous.

HOW WILL THE RESEARCHER PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet in the school library for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. The audio tapes will be deleted from the devices uses when data analysis is completed.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

There are no monetary rewards for this study, but refreshments will be provided to those that will be interviewed soon after school.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee*,* Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

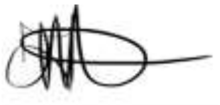
If you would like to be informed of the final research findings, please contact Pro. Ferreira on or email Ferrejg@unisa.ac.za. The findings are accessible for five years.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact Mkandla Justice on 0781513521 or email jmkandla@yahoo.co.uk

Should you have concerns about the way in which the research has been conducted, you may contact Pro. Ferreira on or email Ferrejg@unisa.ac.za

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.



Mkandla Justice

APPENDIX I: Language editing certificate

CERTIFICATE OF EDITING – MJ MARCHAND

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Protea
THE WILLOWS
Pretoria
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15 February 2021

To whom it may concern:

I certify that I am a professional, very experienced editor, accredited with Unisa, and that I edited the dissertation for a Master of Education in Curriculum Studies by Justice Mkandla, entitled '**Teachers' perceptions and enactment of inquiry- based teaching to stimulate learner interest in science'**, supervisor Prof. JG Ferreira.

I edited the dissertation for clarity, correctness and flow of language and expression. This included spelling, concord, **tense**, vocabulary, number, punctuation, pronoun and verb matches, word usage, correct acronyms, sentence structure and consistency. I also carefully checked the references with the text.

The dissertation left my hands on 28 January 2021. It was returned to me on 12th February with alterations which I edited. I am not responsible for any alterations made after the 15th of February. I reread the dissertation and reedited it on 18 and 19 June.

Marion J Marchand

BA, H Dipl Lib, HED,

Postgraduate Certificate in Editing UP; Accredited Translator (Afrikaans to English) and English Editor, South African Translators' Institute, Full Member of the Professional Editors' Guild; Member of the English Academy