DEVELOPING GRADE 9 TEACHERS' NATURAL SCIENCES SUBJECT CONTENT KNOWLEDGE THROUGH PROFESSIONAL COLLABORATION

by

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DECLARATION

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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.

_____ 28/12/2023

SIGNATURE DATE

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ABSTRACT

Continuous Professional Teacher Development (CPTD) is critical in deepening Natural Sciences (NS) teachers' content knowledge. The NS subject in the South African curriculum is a subject that lays a foundation for science knowledge and skills in the lower grades; that is, Grades 4 to 9. It comprises other subjects such as Life Sciences, Physical Sciences, Geography, Astronomy and Chemistry. Although the NS subject content is mainly located in Life Sciences and Physical Sciences, most teachers specialise either in Life Sciences or Physical Sciences; hence, there is a gap in the NS subject content. This often results in teachers either not treating the topics they did not specialise in well or not teaching them at all. This results in low learner performance and related problems, like a shortage of science skills that are so needed in the country. Thus, learners are lagging in terms of science skills compared to their international counterparts. The CPTD interventional programmes organised by the Department of Basic Education do not assist much in addressing the challenge of teachers' subject specialisation. The idea of NS teachers working in collaboration for mutual information sharing leaves room to be reconnoitred. It is on this basis that this study explored the usage of Teacher Professional Collaboration (TPC) in developing Grade 9 NS teachers' content knowledge. Ten Grade 9 NS teachers from five schools located in the Madibeng subdistrict of Northwest Province were conveniently sampled to participate in this study. Data was collected through semi-structured interviews and observations within Collaborative Action Research (CAR). The findings showed that teachers understood and taught the topics they did not specialise in better and they were motivated to do so. The study contributes knowledge on TPC and the broader dialogue on effective and sustainable CPTD programmes.

Keywords: Natural sciences, teacher professional collaboration, subject content knowledge

TSHOBOKANYO

Kgodiso e e Tswelelang ya Seporofešenale ya Barutabana (CPTD) e botlhokwa mo kgatelelong ya kitso ya diteng ya barutabana ba Disaense tsa Tlholego (NS). Serutwa sa NS mo kharikhulamong ya Aforika Borwa ke serutwa se se tlhomang motheo wa kitso le bokgoni jwa saense mo digerateng tse di kwa tlase, e leng Digerata 4 go ya go 9. Se akaretsa dirutwa dingwe jaaka Disaense tsa Botshelo, Disaense tsa Fisikisi, Thutalefatshe (Jiokerafe), Thutadinaledi (Aseteronomi) le Khemisiteri. Le fa diteng tsa serutwa sa NS di fitlhelega kwa Disaenseng tsa Botshelo le Fisikisi, bontsi jwa barutabana bo na le bokgoni jwa go ruta Disaense tsa Botshelo kgotsa Disaense tsa Fisikisi, mme ke ka moo go nang le phatlha magareng ga diteng tsa dirutwa tsa NS. Kwa bokhutlong, se se dira gore barutabana ba se ka ba ruta ditlhogo tseo ba se nang bokgoni jwa go ka di ruta sentle kgotsa ba se ka ba di ruta gotlhelele. Ka ntlha ya se, katlego ya baithuti mo dirutweng tse e ya kwa tlase mme se se tlhola tlhaelo ya bokgoni jwa disaense joo bo tlhokegang ka tshoganyetso mo nageng. Se, se kaya gore baithuti ba tlhaela bokgoni malebana le bokgoni jwa saense fa ba bapiswa le baithuti bangwe mo lefatsheng ka bophara. Mananeo a tsereganyo a CPTD ao a rulagantsweng ke Lefapha la Thuto ya Motheo ga a thuse mo go kgotsofatsang ka go sutisa dikgoreletsi tsa go nna le bokgoni jwa go ruta dirutwa dingwe tseo barutabana ba itemogelang tsone. Kakanyo ya gore tirisanommogo ya barutabana ya go ka arogelana ka tshedimosetso e tlhoka go ka sekasekwa ka tlhoafalo. Ke ka ntlha ya se moo patlisiso e e tlhatlhobileng tiriso ya Tirisanommogo ya Seporofešenale ya Barutabana (TPC) ka go bopa kitso ya diteng ya barutabana ba NS ba Gerata 9. Barutabana ba NS ba Gerata 9 ba le lesome ba ba tswang kwa dikolong di le tlhano tsa kwa kgaolong ya Madibeng kwa Porofenseng ya Bokone Bophirima ba ne ba tlhophiwa go ka tsaya karolo mo patlisisong e. Tshedimosetso e ne ya kokoanngwa ka tiriso ya ditherisano le ditemogo tse di rulagantsweng gosenene kwa Patlisisong ya Tiro ya Tirisanommogo (CAR). Diphitlhelelo di supile fa barutabana ba tlhaloganya ebile ba ruta ditlhogo tseo ba neng ba se na le bokgoni jwa go ka di ruta sentle ebile fa ba ne na rotloetsegile go ka tswelela go dira se. Patlisiso e e thusa ka kitso mo TPC mme gape le ka dipuisano ka ga mananeo a CPTD a a tswelelang ebile a le mosola.

Mafoko a a botlhokwa: Disaense tsa tlhago, tirisanommogo ya seporofešenale ya barutabana, kitso ya diteng tsa serutwa

OPSOMMING

Deurlopende Professionele Onderwyserontwikkeling (DPOO) is van kritieke belang om Natuurwetenskaponderwysers se inhoudskennis te verdiep. In die Suid-Afrikaanse kurrikulum is Natuurwetenskappe (NW) 'n vakgebied wat die grondslag lê vir wetenskaplike kennis en vaardighede in die laer grade, dit wil sê Graad 4 tot 9. Dit bestaan uit ander vakke soos Lewenswetenskappe, Fisiese Wetenskappe, Geografie, Sterrekunde en Chemie. Alhoewel die NW-vakinhoud hoofsaaklik in Lewenswetenskappe en Fisiese Wetenskappe geleë is, spesialiseer die meeste onderwysers in Lewenswetenskappe en Fisiese Wetenskappe – derhalwe is daar 'n leemte in die NW-vakinhoud. Dit beteken dikwels dat onderwysers die onderwerpe waarin hulle nie gespesialieer het nie óf nie goed dek nie óf glad nie onderrig nie. Dit lei tot lae prestasie onder leerders en verwante probleme, soos 'n tekort aan wetenskapvaardighede wat die land nodig het. Derhalwe het leerders 'n agterstand met wetenskapvaardighede in vergelyking met hulle internasionale eweknieë. Die DPOO-intervensieprogramme van die Departement van Basiese Onderwys help nie veel om die uitdaging van onderwysers se vakspesialisering aan te spreek nie. Die idee dat NW-onderwysers saamwerk om inligting te deel moet verder ondersoek word. Dit is om hierdie rede dat hierdie studie die gebruik van Professionele Samewerking vir Onderwysers (PSO) in die ontwikkeling van Graad-9 NW-onderwysers se inhoudskennis verken het. Tien Graad-9 NW-onderwysers van vyf skole in die Madibeng-subdistrik van die Noordwesprovinsie is met behulp van gerieflike steekproefneming gekies om deel te neem aan hierdie studie. Die data is deur middel van semigestruktureerde onderhoude en waarnemings binne Samewerkende Aksienavorsing ingesamel. Die bevindinge wys dat onderwysers die onderwerpe waarin hulle nie gespesialiseer het nie beter begryp en onderrig het, en hulle was gemotiveerd om dit te doen. Die studie dra by tot die kennis van PSO en die breër dialoog oor doeltreffende en volhoubare DPOO-programme.

Sleutelterme: Natuurwetenskappe, professionele samewerking vir onderwysers, vakinhoudskennis

DEDICATION

I dedicate this dissertation to God all mighty, who gave me the grace to complete it, and to my late father, Mr Lucas Tlotleng Molosiwa, for always being my greatest cheerleader in my education, I am forever grateful and may his soul continue to rest perfect in peace.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXURES

LIST OF ACRONYMS

4IR:	Fourth industrial revolution
CAPS:	Curriculum and Assessment Policy Statement
CAR:	Collaboration Action Research
CPTD:	Continuous Professional Teacher Development
DBE:	Department of Basic Education
FET:	Further Education Training
ICT:	Information Communication Technology
ISPFTED:	Integrated Strategic Planning Framework for Teacher Development
NS:	Natural Science
NSt:	Natural Science teacher
PLC:	Professional Learning Community
POPIA:	Protection of Personal Information Act
PSF:	Professional Support Forum
SABER:	System Approach for Better Education Report
SAASTE:	South Africa Association for Science and Technology Educators.
SACE:	South African Council for Educators
TIMMSS:	Trends in International Mathematics and Science Study
TPC:	Teacher Professional Collaboration
UNISA:	University of South Africa

CHAPTER ONE

ORIENTATION, PROBLEM FORMULATION AND AIMS OF THE STUDY

1.1 INTRODUCTION

The aim of this study is to explore the development of Grade 9 Natural Sciences (NS) teachers' subject content knowledge through professional collaboration. In this chapter, the background of the problem, the purpose and aim of the study, and research questions are introduced. The research methodology and data collection used are also briefly outlined.

The quality of education in every country is measured by the quality of professional development and training offered to its teachers (Davids, 2009). Teachers are vested with the responsibility of preparing learners to face the global demands of skills development, the world of work, and self-sustainability. This requires teachers to have the necessary expertise in both the subject content and pedagogical skills. It is, therefore, important for teacher development programmes to be structured such that they not only address the teachers' needs but have an element of sustainability in terms of professional support. Recent research studies indicate that teacher professional collaboration (TPC) is not only an effective tool to build quality curriculum delivery but is also considered one of the main pillars of teacher development in various countries such as America and Portugal (Kolleck, 2019). For example, in her case study research on professional learning and collaboration in American elementary schools, Greer (2012) indicates that America requires teacher collaboration as part of teachers' professional development. This led to TPC being introduced among the 12 standards for quality staff development in American schools (Kolleck, 2019).

Despite the consistency of research literature in stressing the advantages of TPC, there is not enough emphasis on the importance of teachers learning from each other during TPC programmes. Hence, this study investigated this phenomenon. In Portugal for

instance, teachers regard TPC as an integral part of their professional development but due to some limiting factors such as time constraints and workload, it may not be effective. According to Forte and Flores (2014), teachers in Northern Portugal identified a few constraints to effective TPC such as lack of training in collaboration, time, working conditions, as well as the different personalities of individual teachers. This recommends that more focus must be on allocating enough time to encouraging and training teachers not only on TPC, but collaboration based on their contextual factors for effectiveness. Countries with successful education systems, such as Ontario, Finland, Japan, South Korea, and Singapore, allocate more time for activities that are related to the pedagogical improvement of their teachers at the school level. These include collaboration among teachers on the analysis of instructional practice, mentoring, and professional development (Darling, Hammond & Rothman, 2011). The above-mentioned factors adduce that devoting more time to TPC programmes as part of teacher development is imperative for quality curriculum delivery.

Delivering a quality curriculum is a great concern in South Africa, particularly in science subjects. The quality of education in South Africa has been an issue of national debate. The Department of Basic Education (DBE) (2015) also affirms that education requires collaborative efforts from both the Government and all South African citizens at large. The national consensus in the media has been that South African education is not on par with international standards, even lacking behind some less developed African countries (Davis, 2009:1). The results of Trends in International Mathematics and Science Study (TIMSS) (2019) intensify this by revealing that science education in South Africa is ranked very low. TPC has the potential to contribute toward the better understanding of the NS subject; it is interactive in nature as knowledge and understanding are derived from discussion among teachers (Montiel-Overall, 2005).

The effective teaching of content knowledge of any subject requires teachers to have adequate expert content knowledge of that subject. NS content teaching may pose a challenge since there is more than one subject embedded in it, hence, NS teachers should have enough knowledge in all the subjects included in it. The research conducted

by Bantwini (2017) about the analysis of teaching and learning of NS and Technology in selected primary schools in South Africa elucidates that some teachers lack proper fundamental content knowledge and skills in the NS subject. He further expounds that science education does not receive adequate attention as compared to other countries, particularly in the lower grades. NS teachers struggle with subject content despite the teacher development programmes administered to them. Many teachers complain of lack of support, complex curriculum design, and teacher development programmes that lack follow-up support, making them less effective (Bantwini, 2010). Part of the cause for the problem is that the teacher development programmes are included in separate policies such as Minimum Requirements for Teacher Education Qualification but are not included in important policies such as Curriculum Assessment Policy Statement (CAPS) even though the science process skills and content topics that need to be taught for each grade are outlined.

In TPC, mutual intervention and progressive interaction with objects and discourse take place (Duffy, 2014). Darnell (2017) argues that teacher collaboration can assist teachers to achieve institutional and curriculum goals by enabling them to identify the best practices which are best suited for a particular context. Although there is a plethora of conceptions of collaboration (Bantwini, 2018) which includes shared activities such as joint lesson planning and common assessments, the most salient components are openness, trust, support, shared goals, and mutual beneficiation among collaborators. Through collaboration, teachers will be able to share ideas, teaching approaches, and techniques, resources, subject content knowledge, etc. Furthermore, collaborators share mutual benefits through offering and receiving assistance from each other and sharing mutual connection as characterised this implies the need to use *Ubuntu* in collaboration. *Ubuntu* is an indigenous African way of life that condones interdependence such that the society must be run for the sake of all, requiring co-operation and sharing (Gumbo, 2014).

Magano (2009) asserts that NS is an inquiry-based subject that also encompasses basic scientific investigative skills such as observation, experimentation, and hypothesising, recording, comparing, etc. These investigative skills require effective professional

collaboration and specialisation. This makes it imperative for NS teachers to continuously engage in research about the latest trends in the subject and to collaborate with colleagues to share different contexts and experiences.

1.2 BACKGROUND TO THE STUDY

The inequality in teacher development in South Africa fundamentally emanates from the Bantu education system which denied black South Africans access to quality education (Davids, 2009). South Africa has altered its curriculum a few times during the past 20 years. These changes produced the current CAPS. CAPS emphasises equipping learners with the ability to apply the knowledge and skills they acquired in the classroom in their everyday lives. It also requires NS teachers to teach science focusing on solving problems which fosters an understanding of the natural world, the ability to communicate and evaluate findings, and completing practical investigations (DBE, 2011).

Several research studies' findings suggest that most of the challenges experienced in the teaching and learning of science in the classroom mainly result from teachers' deficiencies in either content knowledge, methodology, or teaching strategies (Makhubele, 2016). The development and enhancement of the quality of the NS subject content knowledge in teachers, particularly in Grade 9 through TPC is the primary focus of this study. Collaboration and teamwork among colleagues in any profession including teaching is always recommended for best practice and performance. In the schooling environment, a platform that will allow positive collaboration among teachers must be created. It is, therefore, important that education systems should have explicit policies which foster TPC. For example, in her study conducted on professional learning and collaboration in Virginia, America, Greer (2012) emphasised the importance of the education system in using collaboration among teachers in order to meet the challenges and demands posed by various cultures in schools, she compounds the matter further by indicating that a shift to a more collaborative paradigm is deterred by the deeply rooted processes and structures which promote isolated learning. Apart from the subject knowledge, professional teachers are vested with a huge responsibility of preparing

children for a world of work beyond high school (Fan & Williams, 2010). This necessitates a succinct TPC.

In my opinion, learning implies the development of both the learners' knowledge of concepts and skills. This can be better facilitated through the interaction between the teacher, learner, context, and content. This then draws to attention the importance of teachers mastering the content matter of the subject they teach. However, in South Africa, there are no well-defined policies or teacher development programmes that foster collaboration among teachers, as such professional teacher development, programmes mainly depend on and are planned by the DBE in the form of in-service workshops. These workshops are episodic rather than continuous and often lack follow-up support. This sentiment is also shared by the DBE in Professional Learning Communities Guideline for Teacher Development (2015), where it stresses the importance of teachers working together as a cornerstone of effective professional development. This framework also emphasises the importance of professional learning communities (PLC). According to it, PLC provides the settings and necessary support for groups of classroom teachers, school principals, and subject advisors to participate collectively in determining their own development trajectories and to set up activities that will drive their development (DBE, 2015:14). TPC as a form of teacher development programme enables teachers to derive knowledge from mutual sharing and understanding through social interaction.

1.3 RATIONALE OF THE STUDY

As a senior education specialist who was supporting the NS teachers in various schools of Bojanala District in the Northwest Province, I realised that many teachers struggle not only with the subject content of NS but also with the science process skills embedded in the subject. This challenge makes it difficult for them to teach the learners to link the content of the subject with the related topics for better understanding. Buthelezi (2018) affirms this by asserting that content knowledge, teaching approaches, and professional attitudes are the three dimensions in which teachers need to develop. One other factor is the lack of specialisation. Some teachers are specialists in one or two subjects embedded in NS while others are not specialists at all. The latter group of teachers is

mainly found in the primary schools. My interest in NS subject and experience in the field inspired me to conduct this study. When I initiated the Professional Support Forums (PSF) wherein teachers from different schools planned lessons together and shared good practice, this led to improved confidence in teachers when teaching the subject and their zeal to be good teachers was stimulated. It is on these premises that I strongly believe that the implementation of TPC in the PSF forums curbs the challenge of content gaps in teachers. When collaborating, teachers learn from each other. TPC, as I understand it means the intentional building of useful interpersonal relationships wherein teachers meet each other to share information, resources, ideas, expertise and skills which can result in positive interdependence among them to better their classroom practices.

1.4 PROBLEM STATEMENT

The unpropitious latest results of the TIMSS suggest that South African learners lack science skills and competencies that match their international counterparts; this alludes that the fundamental challenge to advance science education lies in improving the quality of the science teachers (Villanueva, 2010). Bantwini (2017) asserts that when learners acquire adequate science learning in the early grades, they will develop curiosity, appreciation, and understanding of the natural world which are fundamental for learning progression in the NS subject. This calls for quality science teaching in the lower grades which can only be achieved if teachers in the lower grades have adequate science subject knowledge. I regard Grade 9 as a lower grade still, which lays the foundation for Further Education and Training (i.e., Grades 10–12). According to the National Research Council (2012) the high quality of science education teaching and learning in the lower grades is fundamental for learners' advancement in life. This clearly implies quality NS pedagogical practices.

NS as a subject located in the lower grades demands more competencies from teachers compared to other subjects due to its '*multi subject'* nature. There is more than one subject embedded in it, which includes Astronomy, Chemistry, Physical Sciences, and Life Sciences. One of the deficiencies prevalent in teachers when teaching NS subjects emanates from a lack of specialisation in one or two subjects embedded in it; this

deficiency impacts learners' performance in the subject. Magano (2009) compounds this by asserting that some teachers avoid teaching certain content areas of the NS subject due to their limited scientific skills and content knowledge in the subject. This deficiency results in a lack of basic scientific skills and knowledge in learners which ends up in them not pursuing the science stream in FET and beyond.

TPC provides a platform for common understanding, knowledge, experience, and common goals which have the potential to increase the quality of teaching. The question is why is TPC not included in the education policies such as CAPS, except in the frameworks such as Professional Learning Communities Guideline by DBE, which are just guidelines and are not monitored for implementation? Goodnough (2003) asserts that literature on the teacher learning community is also silent on the development of productive professional norms and practices. This study postulates that TPC must be consistent, continuous, and anchored on the *Ubuntu* principles.

1.4.1 Research questions

The main research question for this study, which follows from the above problem statement, is as follows: *How can Grade 9 Natural Sciences teachers' subject content knowledge be developed through teacher-professional collaboration?* This main research question leads to the following sub-questions:

- What is Grade 9 Natural Sciences teachers' understanding of professional collaboration?
- How can Grade 9 Natural Sciences teachers use professional collaboration for their effective understanding of the subject content knowledge?
- How can Grade 9 Natural Sciences teachers use professional collaboration for effective teaching of the subject?
- How can teacher professional collaboration be sustained amongst Grade 9 Natural Sciences teachers?

1.4.2 Research aim and objectives

The aim of this study was to explore the usage of the teacher professional collaboration approach in developing Grade 9 Natural Sciences teachers' content knowledge. This aim was achieved through the following objectives:

- To establish Grade 9 Natural Sciences teachers' understanding of collaborative professional development.
- To explore the usage of professional collaboration by Grade 9 Natural Sciences teachers to improve their subject content knowledge.
- To assess the Grade 9 Natural Science teachers' usage of professional collaboration for effective teaching of the subject.
- To suggest ways through which teacher professional collaboration can be sustained among Grade 9 Natural Sciences teachers.

1.5 THE SIGNIFICANCE OF THE STUDY

One of the things that I observed from the education and teaching fraternity is that there is a prevailing propensity of assuming that all teachers are subject content experts in the subjects they teach. To the contrary, content gaps, inadequate teaching techniques, methodology, and lack of professional support are the main challenges faced by NS teachers. More insight into teacher development through TPC is added by this study. In addition, this research draws into attention the importance of TPC as a form of the teacher development programme. It further seeks to contribute positively to the existing forms of science teacher development programmes formulation and implementation, particularly in the lower grades. Furthermore, it injects the role that TPC can play in deepening the subject content knowledge and pedagogy of NS teachers. Ultimately the analysis presented in this study will contribute valuable information for future research on TPC as a form of the teacher development programme.

1.6 OVERVIEW OF RESEARCH METHODOLOGY

This study followed a qualitative research approach. According to Aspers and Corte “qualitative research is about oscillation between theory and evidence, analysis and generating material, finding sources, becoming deeply familiar with a topic, and then distilling and communicating some of its essential features” (2019:145). Teherani, Martimianakis, Stenfors-Hayes, Wadhwa and Varpo (2015) describe qualitative research as a systematic inquiry that focuses on natural settings. This can include the life experiences of individuals or groups and how interactions build relationships. They further assert that the researcher is the main data collection instrument. TPC is characterised by positive relationships and interdependence among individuals. It is on this premise that qualitative research was used in this study. In the qualitative research study process, there are multiple stages of data collection, refinement, and interrelationship of categories of information (Buthelezi, 2018). In the light of this, this study was conducted in the lower grades of the secondary school environment which participants are familiar with.

Critical paradigm underpinned the study. Niehaves and Bernd (2006) opine that the main focus of critical research is to change the social reality and promote emancipation. These authors further assert that critical research is concerned with changing reality rather than describing it. Based on this, it is then safe to argue that the critical paradigm is more concerned about what is wrong rather than what is right and how to effect the changes that will make that wrong right. Since the critical paradigm is transformative and seeks to emancipate those involved, it is very important to overcome repressive ideological and social conditions that preclude humans to develop to their potential (Niehaves & Bernd, 2006). In this instance, it is important to break the non-interaction culture of teachers to benefit their curriculum-related activities.

Critical theory connects well with collaborative action research (CAR) because it can help teachers to eradicate cocooned professional practices wherein, they are not working together. Moreover, the adaptation to TPC will empower them in a transformative manner such that they defeat the tradition of working in silos.

According to Kivunja and Kuyini (2017), critical paradigm assumes a transactional epistemology wherein there is an interaction between the researcher and the participants. This design is widely used to determine the intervention for the identified problems in a particular profession. In this study, the identified problem is a subject content gap in NS teachers, which affect their classroom practices. CAR is used in this study. Action research is a spiral process that includes problem investigation, taking action, and fact-finding of the action (Lesha, 2014). More than one data collection method is used (detailed in Chapter 4). When teachers engage in CAR, they acquire the skills of assessing their area of need, documenting the steps of inquiry, and analysing the information gathered. This leads to collaborative decision-making that achieves the desired outcomes.

Through CAR, teachers can acquire fundamental skills. For instance, they can develop:

- improved communication skills and interaction with colleagues;
- reflection and evaluation of own work;
- adaptation to new and effective working routines;
- continuous professional development; and
- acquisition of data interpretation and analytical skills.

Ten Grade 9 NS teachers from five secondary schools in Madibeng Sub-district of Northwest Province were conveniently selected to participate in this study. Convenience sampling is a non-probability sampling method in which not every unit of the population has an equal chance of being selected. Rather, is a subjective method that is used to determine whether the elements are included in the sample. Etikan, Musa and Alkassim (2016) describe convenience sampling as a selection of members of a target population based on certain practical criteria such as geographical proximity, easy accessibility, and availability at a given time, or the willingness to participate for the purpose of the study.

In this study, elements such as geographical proximity between the sampled schools and accessibility were considered. This was done to reduce travel costs, maximise contact time, reduce interruptions on the participating teachers ‘normal daily routine’, and most

importantly, to create convenience for common CAR meetings convened for discussions, planning, and reflections.

Lesson observation and semi-structured interviews were used to collect data during the CAR activities. Observation enables the researcher to obtain information from the activities of the participants in their natural setting through observing or participating in those activities (Kawulich, 2005). These methods were augmented by checklists, reflective journals, and audiotapes.

1.7 DEFINITION OF KEY CONCEPTS

1.7.1 Teacher professional collaboration

TPC is when teachers engage in progressive interactions in which they share knowledge and skills relating to their teaching profession. It is a practice used to advance the purposes of schooling (Leonard & Leonard, 2001). This enables teachers to mutually share their perceptions, beliefs as well as their experiences from their diverse contexts. Through it, teachers can share and examine their values and beliefs to build strong relationships of trust and respect (Benade, 2017). In my view, TPC is the sharing of knowledge, skills, experience, and values by teachers which is characterised by interdependence and mutual respect.

1.7.2 Natural Sciences

Natural Sciences is described as a subject in the Senior Phase which lays the basis of further studies in more specific disciplines such as Life Sciences, Physical Sciences, Earth Sciences, and Agricultural Sciences (DBE, 2011b:9). It is a branch of science concerned with the description, understanding, and prediction of natural phenomena based on empirical evidence from observation and experimentation (Wikipedia, 2021). This study aligns with these definitions and will therefore refer to Natural Sciences as a science subject in the Senior Phase (Grades 7 to 9).

1.7.3 Subject content knowledge

Subject content knowledge is the actual concept that teachers are expected to teach (Bantwini, 2017). Furthermore, it is an understanding of a specified body of information contained in a subject. Myhill, Cremin and Olivier (2021) describe content knowledge as the knowledge, understanding, skills, and disposition that are to be learned in a particular subject.

1.7.4 Teacher development

Bertram (2011) defines teacher development as the progressive growth of teachers during their professional activities. Through teacher development, teachers gain instructional expertise which adds to their professional knowledge and growth (Williams, 2010). In the context of this study, teacher development is a process wherein teachers acquire skills, ideas, beliefs, attitudes knowledge, and experience that will add to both their personal and teaching profession.

1.8 CHAPTER OUTLINE

Chapter 1 orientates the reader to the study. The chapter covers the introduction, background, problem statement, and motivation among others.

Chapter 2 presents a review of the literature relevant to the study. The context, theoretical, and conceptual framework of the study are discussed and motivated as well.

Chapter 3 discusses details of the research methodology used in this study such as research paradigm, approach, and issues of trustworthiness, reliability, and ethical considerations.

Chapter 4 presents data analysis and interpretation of the findings.

Chapter 5 concludes the study by providing a summary of the findings and making conclusions, implications, and relevant recommendations.

CHAPTER TWO

REVIEW OF RELATED LITERATURE ON NATURAL SCIENCES TEACHER COLLABORATION

2.1 INTRODUCTION

In the first chapter, the concern over low-quality curriculum delivery, particularly on science subjects in South Africa was established. The content knowledge gap among the NS teachers, a lack of proper teaching methodologies or techniques in teachers, a lack of proper teacher support as well as the absence of TPC were identified as some of the contributing factors. This chapter, therefore, discusses the literature addressing the characteristics and importance of effective TPC, and how it is perceived and implemented by different countries relative to the South African situation. In this study, a relevant literature is reviewed covering the theories and research on collaboration, particularly in TPC programmes. The professional teachers' development programmes in South Africa and the NS content subject as prescribed by CAPS are discussed. The theoretical, contextual, and conceptual framework of the study are also discussed in this chapter.

2.2 COLLABORATIVE LEARNING THEORY

Collaboration can help improve teacher knowledge and performance in the subject. Collaboration is anchored on teamwork wherein all team members have equal opportunity to contribute for the benefit of all team members. Furthermore, collaboration has the potential to break vertical superiority by creating a platform for interaction among individuals or officials from different levels, for example, teachers, principals, district officials, provincial officials etc. can collaborate. This, however, is not always the case in many schools. According to Colbry, Hurwitz and Adair (2014), most often than not, theories of collaboration exist at the inter-firm and intergroup level, but not the intragroup or team level. Team interactions are often framed in terms of leadership and followership, a categorisation that may, or may not, accurately reflect the dynamics of intragroup interactions. The collaboration theory in its broader sense encompasses two categories

of collaborative behaviour which are "*individual first*", and "*team first*". The former is composed of three causal themes which are: *taking turn*, *observing or doing* and *status seeking,* while the latter is composed of *influencing others*, *organising work* and *building group cohesion* as its three causal themes (Colbry et.al, 2014).

Collaboration happens more when it involves groups without hierarchical authority structure. Based on that, and many other factors such as differences in intent, research methods and applicability, the collaboration theory should be considered separate from leadership, followership or team theories. Collaboration has been described as a ploy used to engender cooperation and commitment among individuals at an interpersonal level (Yukl, Chavez & Seifert, 2005). When there is cooperation and commitment among individuals, I strongly believe that there will be interaction and exchange of knowledge through meaningful learning.

One of the pillars of general African culture and practice is interdependence. This is encapsulated in the concept of *Ubuntu*. *Ubuntu* is a term which is derived from the Zulu language and speaks to the fact that we are only human through others; *Ubuntu* encourages compassion, humility and mutual caring among all, as well as interdependence as opposed to individualism, e.g., if one person accomplishes anything in this world, it will be measured and accredited to the work and achievement of others (Gumbo, 2014). I am of opinion that the collaboration assists schools in building a climate of trust by developing positive interdependence among teachers, and also enhances self-efficacy in their abilities to modify their classroom practices. Hence, teacher collaboration can be contextualised within *Ubuntu* so that it benefits from this principle and that teachers can show a commitment and care for one another.

Collaboration, therefore, resonates well with *Ubuntu* which emphasises working togetherness, mutual beneficiation and interdependence among the participants. *Ubuntu* discourages selfish competition among individuals, and it promotes collegial relationships in which there will be an exchange of benefits. This study, therefore, revolves around the collaborative learning theory. Roselli (2016) describes collaborative learning theory as a

concept that defines a theoretical and research area of great interest and strong identity in that it emphasises the importance of interactions, interdependence and intellectual cooperation. The issue of intellectual cooperation has a long tradition in the field of research for psychology and education. Roselli (2016) further asserts that collaborative learning encourages dialogue, listening to others and mutual assessment; collaboration for negotiation and consensus-building work; organisation of activities; conceptual elaboration; collective writing, etc. *Ubuntu* befits this notion of collaboration well as collaboration implicates mutual respect and accommodation of each other's ideas, thus treating each other truly collegially. Real collaborative learning involves an ideological and operational union; and in this sense, both objectives are convergent.

The collaborative learning theory is pivoted around different terms such as collegiality, congeniality, cooperation, consultation, and collaboration to describe a variety of different activities and interactions among individuals in the quest of acquiring knowledge. These tenets of collaboration are also enshrined in *Ubuntu*, which by implication presents *Ubuntu* as an augmentation of the collaborative learning theory. Butera, Batruch, Mugny, Quiamzade, Putfrey and Autin (2013) define knowledge as a process of negotiation or joint construction of meanings, and this applies to the whole process of teaching. Through my experience as a Natural Science teacher, I learned that the meaningful acquisition of knowledge is attained through collaborative learning; this applies to both teachers and learners. As a teacher, I was able to understand some of the subject content more and explore different teaching techniques through interactions with my colleagues. Learners, on the other hand, produced better results when they were involved in cooperative learning. Although the main idea of the concept is the recognition of the value of cognitive peer interaction, collaborative learning also involves teachers and, in general, the whole context of teaching. In this sense, it is not about circumstantial application of group techniques, but the promotion of exchange and participation of each member by building a shared cognition (Philander, 2018).

2.3 TEACHER PROFESSIONAL COLLABORATION

2.3.1 Perceptions of various countries on teacher professional collaboration

Research shows that many countries view teacher collaboration as one of the most effective types of professional development strategy (Philander & Botha, 2021). Some of these countries devote more time to TPC activities in their teachers' allocated working time. Japan, for example, devotes about 40 percent of its teachers' working time to teacher collaboration, on-site professional development, and research on the effectiveness of various teaching strategies as compared to actual contact time with the learners, while Ontario devotes 30 percent (Darling, Hammond & Rothman, 2011). In my view, teacher motivation and teacher collaboration are interdependent where teacher motivation is the driving force behind teacher collaboration. Benade (2017) corroborates this by asserting that teachers need to have personal commitment and motivation for true collaboration to take place, this will enable them to engage in robust debates and deep sharing. The relevance and mutual interdependency of teacher motivation and teacher collaboration have been demonstrated in different studies (Kollek, 2019; Slater, 2004; Clarke & Kinuthia, 2009). Teachers in a collaborative school culture seem to demonstrate increased motivation.

In Mozambique, the findings of the Systems Approach for Better Education (SABER) (2014) suggest that working conditions may play an important role in the decision to become a teacher. Talented candidates who have opportunities in other professions may be discouraged from becoming teachers if working conditions are too poor. This lack of motivation may hinder teachers' commitment, collaboration, and general performance. In Mozambique, even though there are existing standards that schools must meet regarding school construction, schools are not obliged to meet any national standards for infrastructure, hygiene, or sanitation. Student-teacher ratios, which are another indicator of teacher working conditions, are high relative to those in high-performing international education systems, where the maximum number of students per teacher is typically 30 for primary school and 20 for secondary school. The primary school learner-teacher ratio

for Mozambique is 74:1 at the lower primary level and 34:1 at the upper primary level. The secondary school learner-teacher ratio averages 51:1 at the lower-secondary level and 40:1 at the upper-secondary level. All the above-mentioned factors contribute to low or lack of motivation in teachers and lack of collaboration ultimately.

The findings of this report further indicate that effective teacher professional development is collaborative in nature and that it provides opportunities for the in-school analysis of instructional practice. This report also indicates that primary and secondary school teachers in Mozambique should participate in professional development activities each year. These activities should be collaborative in nature as they provide opportunities for the analysis of instructional practice contrary to one-time workshops or conferences. It further asserts that the more teachers can practice and share among each other their pedagogical theories, subject-matter knowledge, and classroom-management skills, the more they will be motivated to participate in TPC oriented programmes. Moreover, the quality of their curriculum delivery will improve.

In her primary school principal's sabbatical report, compiled in catholic primary schools situated in Auckland New Zealand, Benade (2017) outlines the following factors for effective collaboration: relational trust, collective responsibility, clear purpose, time allowance, effective communication, and collective inquiry. Kollek (2019) asserts that the motivation to collaborate is influenced by teachers' personal attributes such as age (i.e. older teachers are collaborate to a lesser degree than their younger colleagues), gender (i.e. female teachers are more likely to cooperate than male teachers), and experience (i.e. teacher collaboration is higher among novice teachers), furthermore, teachers with a strong sense of efficacy who believe in their capabilities to achieve goals are more likely to engage in structured collaboration and improvement strategies.

2.3.2 Teacher professional collaboration in South Africa

Throughout the past decade, DBE has formulated different policies as remedial action to improve teacher performance through CPTD. These include the Norms and Standards for Educators (DBE, 2000), National Policy Framework for Teacher Education and

Development (DBE, 2015) and a Guideline in Professional Learning Communities (DBE, 2015). The South African Council for Educators (SACE) is responsible for the implementation and regulation of CPTD programmes in all nine provinces of the country. Only SACE is authorised to endorse any CPTD programmes administered to the South African teaching community by any service provider. Service providers should be credible with the ability to offer quality service and they can include private organisations, teacher unions, higher education institutions, independent schools, non-governmental organisations or provincial education departments (SACE, 2011).

Among the seven teacher roles in South Africa as outlined in the Norms and Standards for Educators is that a teacher must be a scholar, researcher and a lifelong learner. Learning in teachers can occur in planned reflection meetings between teachers or from unplanned conversations with other colleagues before or after teaching. Postholm (2012) opines that a teacher can learn through observation and reflecting on others' teaching and co-operation with colleagues. Collaboration boosts confidence in teachers and fosters their professional growth (Bantwini, 2019).

Research on teacher development points to the importance of teacher professional learning communities in promoting teacher development (Slater, 2004). Due to the dire need to improve curriculum delivery, DBE developed a Guideline in Professional Learning Communities (PLCs) for South African schools as part of its role and responsibility to support the provincial education departments and other stakeholders to set up, maintain and ensure that PLCs work effectively (DBE, 2015). The PLCs are characterised by collaboration and teamwork. Even though the guideline outlines the strategic planning framework of PLCs, it is not mandatory, hence, cannot be enforced on schools. Moreover, many schools still struggle to understand the concept and implementation of PLCs. Although the practice of teachers working together is not new in the South African education system and despite some pockets of excellence, it is totally absent in many schools (Kolleck, 2019). In some schools, it exists but not in a form that supports teacher learning and development (Maistry, 2008).

Research snippets indicate that most studies on teacher learning did not put more attention on the interaction and collaboration of high performing schools which enable them to produce good results (Poulos, Culberstton, Piazza, & D'Entremont, 2014; DBE, 2015). Teachers can articulate their views and challenges or examine the views of others by being part of the learning community. Through this process, new and deeper meaning and understanding will be adapted (Steyn, 2017) which ultimately leads to better performance. According to Philander and Botha (2021), there is a lot of CPTD activities in South Africa which vary from workshops, conferences, short and long courses consultations and mentoring, demonstrations and observations, inductions for in-service and collaboration, but most of these activities are not well distributed throughout the country with the emphasis made in the urban rather than rural areas, with the latter areas not receiving adequate and sustainable CPTD activities (Bantwini, 2018).

Although there are separate guidelines on how collaboration can be implemented in schools, it is still a new concept which needs to be explored more (Jita & Mokhele, 2014). Since collaboration revolutionises the existing 'normal' teaching approaches of teachers, it is imperative that teachers are equipped with the necessary collaboration skills (David, 2009). Without collaboration, the teachers' professional growth is limited to experience and perception. For a sustainable and effective TPC to occur, the fundamental teaching factors such as teachers' subject content knowledge, teaching methodologies and strategies, attitudes towards teaching, motivation level or job satisfaction as well as their professional support system which includes mentoring need to be determined to resolve any gaps identified (Philander, 2018). Research shows that TPC can benefit teachers by contributing positively to their professional production. According to April, Darnell and Tesol (2017), teacher collaboration in teaching and learning:

- helps maintain student-centred classrooms;
- reinforces new styles of teaching and innovative approaches;
- fosters more effective classroom practices;
- enables teachers to share success stories, overcome a sense of isolation and facilitates mutual support and encouragement;

- contributes to the positive sense of collegiality and community; and is essential in meeting the needs of diverse or changing learner populations.

2.4 PROFESSIONAL COLLABORATION WITHIN NATURAL SCIENCES

The importance and need to improve science education in South Africa has been articulated in several research studies (Bantwini, 2010). There are several factors pointed out by researchers which contribute to the low rating of science in South Africa (Reddy, 2005). At this juncture, it is imperative to highlight the importance of good science performance in the lower grades of schooling, i.e., NS subject in both Intermediate and Senior Phases in the context of South Africa as a fundamental and transitional factor of attaining better science results in the higher grades of schooling, i.e., in the Further Education and Training Phase. NS as a multifaceted subject needs more skilled and specialised teachers in the subject content to ensure the desired learner attainment.

Although the DBE made a provision of professional support for NS teachers by conducting in-service workshops which are intended to enhance the pedagogical skills and content knowledge, it still has its shortcomings (Bantwini, 2010). Research has shown that most of these workshops are not achieving their goals based on the huge numbers or large areas that need to be covered. Bantwini and Diko (2011) asserts that some of the district science officials responsible for supporting NS teachers decried the lack of sufficient human resources, limited financial allocations and inadequate time as some of the factors that impede the provision of proper support to NS teachers. In their report on an Intervention into the Mathematics, Science and Technology Education in Mpumalanga Province, Gumbo and Team (2016) indicated that some of the factors contributing to the prevailing gaps in the teaching of NS and Technology subjects are teacher-learner ratio, lack of resources for practical tasks as well as short teacher development workshops. This clearly indicates the need for close collaboration between the NS teachers and the district officials. Furthermore, teachers need to engage in robust, meaningful, and sustainable collaboration to close this gap. The factors that contribute to effective TPC are depicted in Figure 2.1.

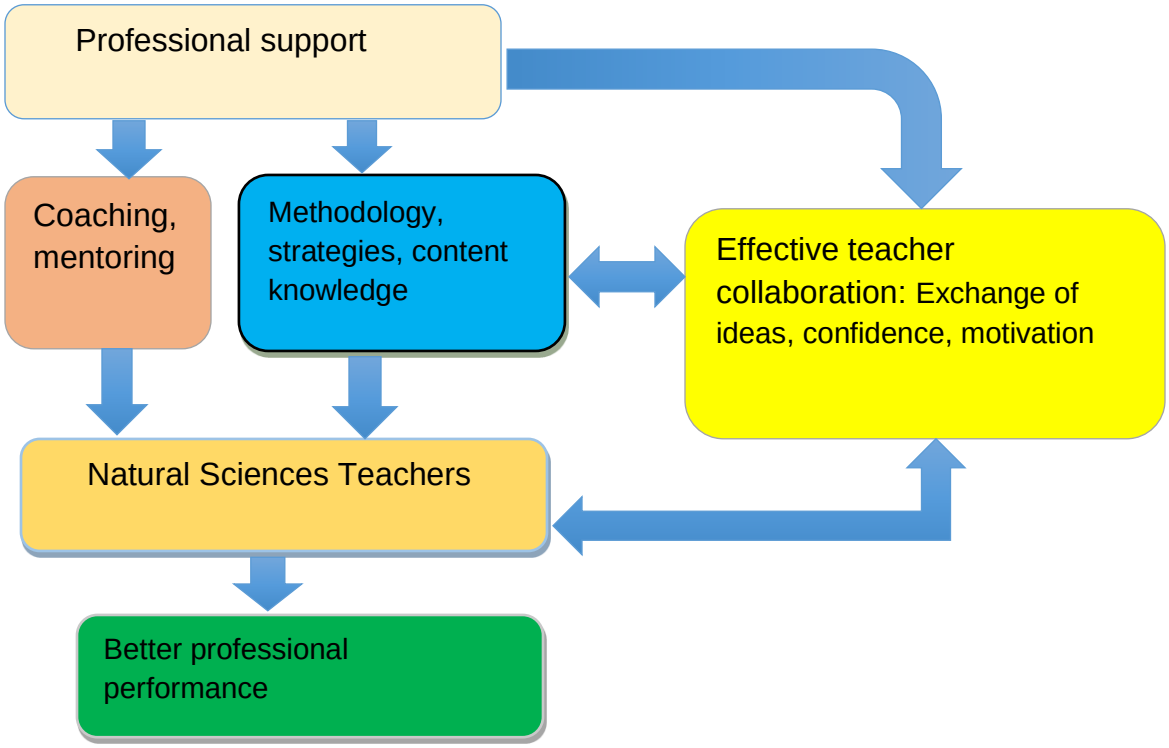

Figure 2.1: Factors contributing to effective teacher professional collaboration

In his research on the analysis of the state of collaboration between NS school district officials and primary school science teachers in Eastern Cape Province, Bantwini (2018) opined that the collaboration is implemented in the *'individual first'* theme wherein an individual influences other, organises work and builds group cohesion rather than in *'team first'* wherein team members take turns in observing or doing activities. Bantwini further asserts that the district officials are perceived as having to assume the leading role in this dual collaborative relationship which in most instances distorts the objective mentorship and professional support. In most instances, there is lack of follow-up classroom support from the district officials, this challenge is attributed to limited human resources and limited time since the NS teachers are in number as some officials are allocated both intermediate and senior phases (Buthelezi, 2018). However, it is important to indicate the necessity of collaboration among NS teachers themselves for sustainability.

2.5 SITUATING THE TEACHING OF NATURAL SCIENCES WITHIN PROFESSIONAL COLLABORATION

2.5.1 Continuous Professional Teachers Development programmes of Natural Sciences teachers in South Africa

"The NS subject in Senior Phase (i.e., Grades 7 to 9) lays the basis of further studies in more specific disciplines, such as Life Sciences, Physical Sciences, Earth Sciences or Agricultural Sciences. It prepares learners for active participation in a democratic society that values human rights and promotes responsibility towards the environment. NS can also prepare learners for economic activity and self-expression" (DBE, 2011a:9). The NS teachers are expected to construct lessons that will enable learners to acquire both scientific inquiry and investigative skills and subject content knowledge (Magano, 2009). The proliferation of research studies shows that many NS teachers in South Africa are not qualified to teach this subject either by subject content training or professional qualifications (Mji & Makgatho, 2006; Simon, Campbell, Johnson & Stylianidou, 2011; Lumpe, Czermiak, Haney & Beltyukova, 2012; Trygstad, Banilower & Smith, 2014; Geldenhys & Oosthuizen, 2015; Admiral, Kruitel, Lockhorst, Schenke, Sligte, Smit & Tigelaar, 2016). This lack of subject content knowledge adds to the plethora of challenges experienced by NS teachers. Magano (2009) adds that some NS teachers lack the zeal to teach some aspects of the subject matter due to lack of specialisation, which leads to poor teaching output.

DBE (2015) believes that there should be a collaboration between all the key stakeholders to curb the surfeits of challenges in South African science education. Although CAPS is more specific on which content to be taught at which grade as well as the assessments thereof, if the teachers are not well equipped with the necessary skills and content knowledge, the challenges will still persist. Science teachers should be able to instil interest in learners and be able to build on their innate curiosity, broadening their scientific

knowledge through investigations. Learners should be able to investigate, collect data and analyse scientific data as well as relate and defend their ideas (DBE, 2011).

It is, therefore, imperative for the NS teachers to know and understand the roles they are expected to play to identify their areas of need or improvement. Philander and Botha (2021) emphasise the importance of teacher confidence and motivation to participate in TPC activities. Regrettably, most of the science teachers in the lower grades claim that they have been neglected by the DBE officials including their school principals as compared to the higher-grade science teachers, particularly those in the exit grade (i.e., Grade 12) who receive more attention to improve learner pass rates (Bantwini & Diko, 2011).

There should be a conducive environment created for teachers to participate in TPC, particularly those teaching in the lower grades, i.e., Intermediate and Senior Phases. Tsotetsi and Mehlomaholo (2013) expatiate this by attributing some of the challenges to the absence of a conducive platform that enables teachers to share information and good practices, lack of proper mentoring of the novice teachers among others, not focusing on the pedagogical or subject content knowledge. Moreover, the exclusion of teachers in the planning of the interventional or in-service programmes demoralises them from actively participating in them. Teachers will have a sense of belonging and be more motivated if they are involved in the planning of the TPC activities since they are the ones who know the areas in which they need development. Feedback from teachers through collaboration and co-learning can be very critical for TPC effectiveness (Buthelezi, 2018).

2.5.2 The nature of Natural Sciences subject and role of teacher professional collaboration in its teaching

Collaborative teaching is any academic experience or activity in which two or more teachers design a lesson plan or a teaching and assessment strategy (April et al., 2017). In this instance collaborative planning takes place among the NS teachers for the whole Senior Phase, i.e., Grades 7, 8 and 9. The main objective of grouping this cohort of teachers for collaboration is that the content knowledge and scientific skills shows

progression from one grade to the other (DBE, 2015) and teachers need to have comprehensive competence in the content knowledge encompassed in each grade. Hagen and Nyen (2015) characterise a good teacher as having the ability to increase his/her competency by collaborating with other teachers while taking charge and striving to enhance his/her professional development. The sustainability and quality of these collaborations are important since they have the potential to address the challenge of lack of specialisation among NS teachers. This can create a conducive platform for teachers to exchange subject content knowledge.

NS subject is divided into four major themes or strands, namely Life and Living which has some basic concept knowledge of Life Sciences subject, Matter and materials which consists of basic concepts of chemistry subject, Energy and change which has Physical sciences basic concepts and Planet Earth and Beyond which is composed of Earth science concepts and a few astronomy concepts (DBE, 2011). This interdisciplinary nature of the NS subject is one of the major causes of what is termed as *'lack of specialisation'* in NS teachers. Until recently, there were no teaching courses with NS as a subject of specialisation offered by tertiary institutions (Clarke, 2009). Muwanga-Zake (2017) believes that the *'lack of specialisation'* in NS teachers should be partially ascribed to the nature of teacher training received by teachers during the apartheid era. Most of the teachers in the system either specialised in only one or two of the subjects encompassed in the four themes or strands.

Notwithstanding, NS teachers are expected to effectively teach all four themes of NS effectively despite the gaps created by their specialisation or lack thereof. For example, a teacher who specialised in Physical sciences and chemistry will have more subject knowledge on the Energy and Change and Matter and Materials strands than in Life and Living or Planet Earth and beyond strands. Although the Departmental districts conduct in-service training workshops for teachers as a form of CPTD, these workshops receive a lot of criticism from teachers (Bantwini, 2010; Luneta, 2012) for not meeting the teacher' needs, moreover, these workshops are periodic and more often lack the provision of follow-up and classroom support for continuity and sustainable support.

Furthermore, looking deeper into the structure of the NS subject, as out lined in the NS CAPS (DBE, 2011), there are three main specific aims which are indicated as follows:

i. Specific Aim 1: Doing Science. In this aim, learners should be able to complete investigations, analyse problems and use practical processes and skills in evaluating solutions. To achieve the objective of this specific aim, NS teachers need to be highly competent in the scientific inquiry processes and also be familiar with the setting up a practical task or experiment in order to effectively teach the learners.
ii. Specific Aim 2: Knowing the content subject and making connections. Here, the learners are expected to grasp scientific, technological and environmental knowledge and be able to apply it in new contexts.
iii. Specific Aim 3: Understanding the uses of science. This aim expects learners to understand the uses of NS and indigenous knowledge in society and the environment.

2.6 CONCLUSION

This chapter covered the collaborative learning theory and the review of literature. The collaborative learning theory was described and its choice for the study motivated. Findings of international studies on teacher collaboration were discussed. It is noticed, from such completed studies, that teacher collaboration is critical in teaching. The situation on teacher collaboration in South Africa was then assessed; there is evidence that this phenomenon is not yet receiving the attention that it deserves, thus emphasising the significance of this study. The important role that PLCs play in teacher collaboration was also expounded. The focus was also put on teacher collaboration within the NS subject. While unpacking the structure of NS as a subject, the relevance of teacher collaboration was also discussed.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The first chapter discussed the concern over the low quality of curriculum delivery in South Africa. Furthermore, it explored the factors this inferior quality curriculum delivery emanates from a lack of specialisation of teachers in the subjects they are teaching or expected to teach. In addition, this poor performance was also attributed to a lack of teamwork among teachers. These contentions mainly focused on the NS teachers. The second chapter presented a discussion on the theoretical framework and relevant literature. It also assessed research that elucidated teacher collaboration in other countries. In this chapter, the details of the research methodology used in this study, such as research paradigm, approach, sampling, and issues of trustworthiness, reliability, and ethical considerations are discussed. The way these concepts relate to each other is also explained. Moreover, the research methodology and paradigm adopted to achieve the aim and objectives stated in Chapter 1 Section 1.4.2 of this study are also expounded in this chapter. The research method must reverberate with and answer the research questions of a study (Creswell, 2003) since it is the strategy or plan of action that lies behind the choice and use of methods. This chapter also elaborates on the research design and methods used. This research study was undertaken following a qualitative approach using appropriate research instruments to collect in-depth data for analysis. Discussions in this chapter are outlined under headings and subheadings which ultimately provide a structure for the research methodology.

3.2 RESEARCH PARADIGM

The research paradigm of a study depicts the school of thought that a researcher belongs to and the researcher's perception of the world which informs the meaning and interpretation of data collected during the research process. Furthermore, it defines the researcher's philosophical orientation (Kivunja & Kuyini, 2017). In the same line of

thought, a paradigm is a rudimentary belief system and a theoretical framework with assumptions (Rehman & Alharti, 2016). However, there are different types of research paradigms that researchers can follow, and each type has its essential elements which extricate them from each other. According to Kivunji and Kuyini (2017), every research paradigm encompasses four components, namely epistemology, ontology, axiology, and methodology. These constituents influence the researchers' interpretation of data as well as the research process to be followed (Guba & Lincoln, 2005).

Researchers need to have an in-depth understanding and knowledge of how to express our beliefs about the type of reality and the methods we can use to acquire this knowledge. These skills and knowledge are embedded in the following elements of the research paradigm:

- Epistemology: It is used to describe how we acquire knowledge, how we know the truth, and what counts as knowledge in the world (Cooksey & McDonald, 2011). Not only the specialisation of NS teachers in the subject is important, but their consistent improvement in the content knowledge of the subject as well because they need to transfer the knowledge to the learners. In addition, the nature of the subject itself is not stagnant for it is affected by incessant scientific discoveries.
- Ontology: It is more concerned with the assumptions made to make something real, or as Rehman and Alharti (2016) argue, it examines the underlying beliefs of researchers about the nature of being and existence. This study advocates that TPC as opposed to the vertical and pre-determined teacher professional development approach used by the district officials often defeats its purpose because teachers are not consulted in the development of the developmental content meant for them (Bantwini, 2018).
- Axiology: It deals with the ethical considerations to be made when conducting research, such as privacy, accuracy, ownership of publications, accessibility, etc. (Scott & Usher, 2004). The axiology of this study pivoted around obtaining authentic information from the participants about the challenges they experienced when teaching NS due the subject content gap. I used semi-structured interviews

to allow the participants to express their views based on their subject specialisation. Furthermore, observations and lesson presentations on the non-specialised topics served as an indicator of that the establishment of the content knowledge in the participants.

- Methodology: It is the approaches, methods, procedures, and design used in a research study. This includes data gathering and analysis, instruments used, participants, etc. (Grix, 2004). CAR was used in this study and the data obtained through semi-structured interviews and lesson presentations were thematically analysed.

3.2.1 Critical Paradigm

Research paradigms can be summarised into four categories, namely: positivism, post-positivism, Interpretivist or critical realism (Kivunji & Kuyini, 2017; Scotland, 2012). At this juncture, it is important to note that every researcher must understand the different approaches and components used by other researchers to conduct educational research; this will widen and deepen their understanding of their field of research (Patton, 2002). This study is underpinned by the critical paradigm. Niehaves and Bernd (2006) opine that the focus of critical research is to change the social reality and promote emancipation. These authors further argue that the critical paradigm is epistemologically more concerned with changing reality rather than describing it. Based on this, it is then safe to argue that the ontological assumptions of critical research are more concerned about what is wrong rather than what is right and how to effect the changes that will make that wrong right.

This study, therefore, seeks to address the classroom challenges experienced by NS teachers in their classrooms, particularly those that emanate from inadequate subject content knowledge. It further wants to create an atmosphere wherein the NS teachers can explore solutions that are free from stringent policies prescribed to them and the content workshops which are developed from assumptions of the district officials and subject advisors. The suppositions of this study are that NS teachers should be able to identify their own curriculum implementation challenges that arise from their specific

contexts and personal experiences as well as to develop adapted solutions through collaboration and interaction. It is on this basis that I believe that the critical paradigm is more relevant to this study, more so that in critical research, the emancipatory function of knowledge is enfolded, and the real-world phenomena are linked with societal ideology (Rehman & Alharthik, 2016).

The critical paradigm is transformative and seeks to emancipate those involved, it also strives to overcome repressive ideological and social conditions that preclude humans from developing to their utmost potential (Niehaves & Bernd, 2006). In this instance, it is important to break the prevalent vertical intervention programmes conducted by the departmental officials which are more pre-emptive in nature and often lack the diagnostic element (Buthelezi, 2018). These interventions are often based on assumptions of what the NS teachers experience, therefore, they have a very limited result. I strongly believe that there should be a provision of activities through which the NS teachers can collaborate to encourage a culture of reciprocal interaction to yield maximum benefit from each other in their curriculum-related activities. According to Kivunja and Kuyini (2017), the critical paradigm assumes a transactional epistemology wherein there is an interaction between the researcher and the participants as well as an interaction between the participants themselves.

Critical research is widely used to determine sustainable interventions for the identified challenges experienced by teachers. This study focused on the subject content gap prevailing in NS teachers, which affects their classroom practices as an identified problem. As stated earlier in this study, critical theory congeals well with CAR because it can help teachers to rise above cocooned professional practices, wherein they are working in silos. Moreover, the adaptation to TPC will empower them in a transformative manner such that they defeat the tradition of working in isolation as they will now work together towards the benefit and improvement of their classroom practices.

3.2.2 Collaborative learning theory

Collaboration can help improve teacher knowledge and performance in the subject that they teach. It is anchored on teamwork wherein all team members have equal opportunity to contribute for the benefit of all team members. Furthermore, collaboration has the potential to create a platform for teachers to share information and thus reinforcing their interpersonal relationships. This, however, is not always the case in many schools.

Collaboration has been described as a ploy used to engender cooperation and commitment among individuals at an interpersonal level (Yukl et al., 2005). When there is cooperation, trust, and commitment among individuals, I believe that there will be interaction and exchange of knowledge through meaningful learning. This also resonates with the African concept of *Ubuntu* which emphasises mutual beneficiation and interdependence among the people. *Ubuntu* is a Zulu language term that means '*I am because we are'*, or humility towards others. *Ubuntu* discourages selfish competition among individuals and instead promotes collegial relationships in which there will be an exchange of benefits. Collaboration is characterised by an ongoing mutual relationship between individuals with the same goal or objectives (Colbry, Hurwitz, & Adair, 2014). This study, therefore, revolves around the collaborative learning theory. Roselli (2016) describes collaborative learning theory as a concept that defines a theoretical and research area of great interest and strong identity in that it emphasises the importance of interactions, interdependence, and intellectual cooperation. The issue of intellectual cooperation has a long tradition in the field of research for psychology and education. Roselli further asserts that collaborative learning encourages dialogue, listening to others and mutual assessment; collaboration for negotiation and consensus-building work; organisation of activities; conceptual elaboration; collective writing, etc. Real collaborative learning involves an ideological and operational union; and in this sense, both objectives are convergent (Roselli, 2016).

The collaborative learning theory pivots around different terms such as collegiality, congeniality, cooperation, consultation, and collaboration to describe a variety of different activities and interactions among individuals in the quest to acquire knowledge. Through

continuous collaboration, teachers are likely to improve their subject knowledge and explore new teaching strategies and ideas in their classrooms, compared to when they attend traditional classes and workshops. Butera *et.al* (2013) define knowledge as a process of negotiation or joint construction of meanings, and this applies to the whole process of teaching. As a former NS teacher, I learned through my experiences that the meaningful acquisition of knowledge is more attained through collaborative learning; this applies to both teachers and learners. As a teacher, I was able to understand some of the subject content more and explore new teaching techniques through interactions with my colleagues. Learners, on the other hand, produced better results when they were involved in cooperative learning. Although the main idea of the concept is the recognition of the value of cognitive peer interaction, collaborative learning also involves teachers, and, in general, the whole context of teaching. In this sense, it is not about the circumstantial application of group techniques, but the promotion of exchange and participation of each member to build a shared cognition (Philander, 2018).

3.2.3 Collaborative Action Research

CAR was used in this study. From my experience as a teacher and subject advisor, I gathered that in-service type of teacher training or workshops are given more consideration as the most if not the only answer for teacher professional development by both the teachers and the DBE officials, especially the subject advisors who are responsible for implementing professional teacher development programmes for teachers to enhance and improve their curriculum delivery. However, I align my views with Garces and Granada (2016), who advocate that CAR is a powerful resource that enables teachers to always keep abreast with the latest educational issues while they are actively involved in their own learning.

In the NS subject, there are ongoing discoveries, inventions, and conventions, which necessitate NS teachers to always be up to date with the current developments in the subject for them to improve their pedagogical practices. It is on these bases that I believe that through CAR, teachers can be able to assess their pedagogical practices and identify as well as incorporate any necessary changes that may emanate from the latest scientific

discoveries that may be connected to the NS subject. This is basically enshrined in TPC. Most importantly, it enables teachers to engage in collaborative inquiry to ascertain common goals, synthesise relevant data, and try different teaching approaches (David, 2009). This will benefit them as individuals and as a group. Moreover, they will be able to customize their teaching strategies and methodologies to suit their respective contexts.

Action research is defined as a spiral process that includes problem investigation, action, and fact-finding of the action (Lesha, 2014). In the same line of thought, Ferrance (2000:1) refers to action research as “a reflective process that allows for inquiry and discussion as components of the research”. Ferrance (2000:1) further states that “often action research is a collaborative activity among colleagues searching for solutions to everyday, real problems experienced at schools”. When teachers engage in CAR, they acquire the skills of assessing their areas of need, documenting the steps of inquiry, and analysing the information gathered. NS is a subject that comprises more than one subject, such as Life Sciences, Earth Sciences, Astronomy, and Physical Sciences. The skills that will be acquired by teachers through CAR will enable them to make constructive decisions that assist them in achieving the desired outcomes.

Through CAR, teachers can acquire fundamental skills. For instance, they can develop:

- improved communication skills and interaction with colleagues;
- reflection and evaluation of their own work;
- adaptation to new and effective working routines;
- continuous professional development; and
- acquisition of data interpretation and analytical skills.

3.3 RESEARCH APPROACH

There are three main types of research approaches, namely a quantitative approach, which encompasses positivism and post-positivism, qualitative approach which includes constructivism and transformative as well as a mixed method approach which relates to pragmatism (Grover, 2015). The qualitative research approach was used in this study. “Qualitative research is about oscillation between theory and evidence, analysis and

generating material, finding sources, becoming deeply familiar with a topic, and then distilling and communicating some of its essential features" (Aspers & Corte, 2019:145). Grad (2015) describes qualitative research as a systematic inquiry that focuses on natural settings. This can include the life experiences of individuals or groups and how interactions build relationships. He further asserts that the researcher is the main data collection instrument. Rallis and Rossman (2017) describes qualitative research as follows:

- It takes place in the natural world. In this study, the TPC activities for NS teachers, which are interactive in nature took place in the everyday classroom contexts of the respective teachers who participated in this study.
- It focuses on the context. The TPC interventional activities concentrated more on the challenges encountered by teachers during their curriculum implementations in their respective NS classrooms. These challenges were identified by the teachers themselves which exterminated the element of assumptions during the planning and design of these activities.
- It is emergent rather than tightly prefigured. The intervention activities or TPC activities conducted in this study, such as the collective lesson plans were designed based on the interaction and sharing of good practices among NS teachers. They were not pre-determined or pre-designed by myself based on my assumptions of what the challenges experienced by NS teachers are.
- It is fundamentally interpretive. For instance, all TPC activities in this study were dependent on what the NS teachers pointed out as problems that hamper their pedagogical practices. When teachers were observing each other's lesson presentations and were able to comment and ask questions, it allowed them to construe and suggest possible solutions. Moreover, when teachers did their own self-evaluations on how they presented the jointly developed lesson plan in their respective classrooms, they could interpret and analyse their own teaching practices.

In the qualitative research study process, there are multiple stages of data collection, refinement, and interrelationship of categories of information (Buthelezi, 2018). Considering this, the study was conducted in a secondary school environment which

participants are familiar with. More than one data collection method was used which will be explained in the method section later. Data was collected in multiple stages and phases of CAR. These phases included ten Grade 9 NS teachers who first identified the challenges in a particular topic impacting their teaching and learning negatively. Subsequently, teachers shared their identified challenges with each other collaboratively (Ferrance, 2000). This is done with the aim of addressing the identified challenges through the mutual sharing of information, skills, and knowledge. This may be done with assistance from the individual(s) outside the school setup, e.g., a higher learning institution, community partner, or an official from, which is me in this instance. The teachers then evaluate the suggested solutions to the identified challenges, implement them and thereafter reflect on them. Finally, the teachers will then apply these solutions in their respective classrooms. The process of CAR is summarised in Figure 3.1 below:

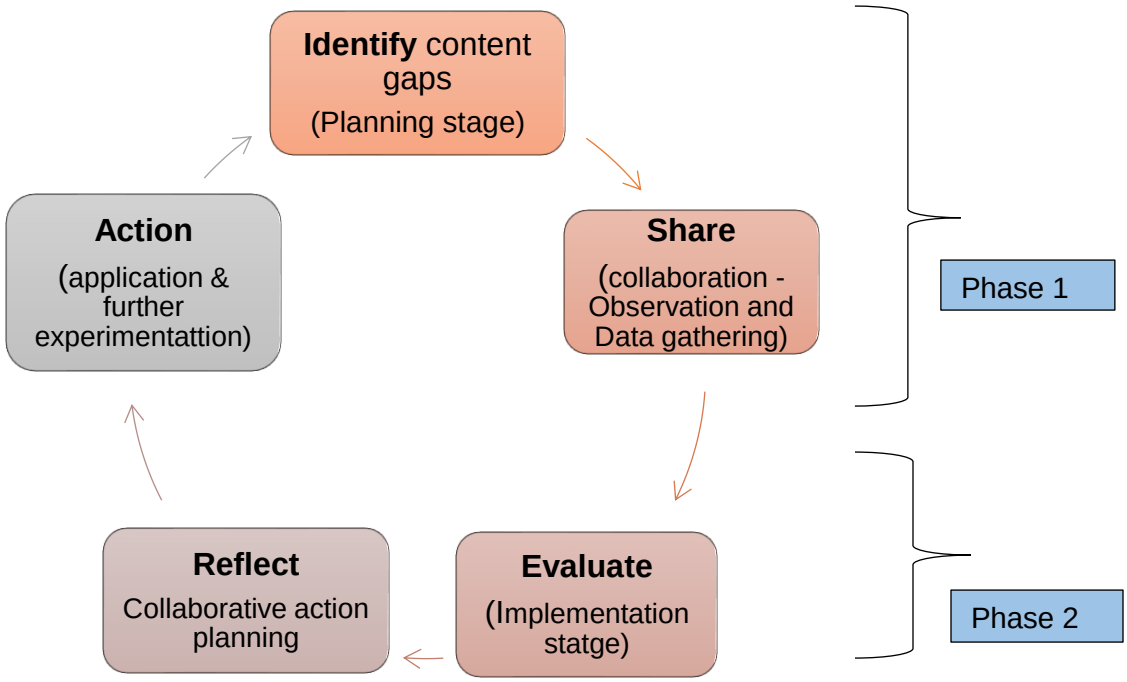

Figure 3.1: The process of CAR

3.3.1 The process of Collaborative Action Research

The process of CAR depicted in Figure 3.1 above, happened in a cycle. However, there were two phases within the cycle and each phase had different steps. Phase 1 had one

stage, wherein the participants identified the challenges that they experienced in their respective classrooms when teaching the NS subject topics given to them. Furthermore, the participants shared and discussed the challenges identified. The participants then collaboratively developed lesson plans that they would present per group. This was a collaborative session wherein they asked questions and learned from each other.

Phase 2 is implementation. This is a stage where the participants are assumed to establish a new understanding of the concepts under the topics identified in Phase 1. Moreover, during the second step of this phase, they are expected to reflect on the knowledge gathered in order to address the challenges identified in the topics and then determined on how they could use it to improve their classroom practices in their respective classrooms. In the third step, which is the last, where the participants will implement the knowledge acquired.

3.4 SAMPLING AND POPULATION

This research study was conducted in Madibeng Sub-district which falls under the Bojanala Education District in the Northwest province. This Sub-district consists of six circuits. The total number of secondary schools in Madibeng Sub-district is 82. Notwithstanding, ten Grade 9 NS teachers from five schools in Madibeng Sub-district were randomly selected to participate in this study which formed the population, i.e., two teachers from each school. The schools of these teachers were situated in three different geological locations within the Madibeng Sub-district. The selected schools which were conveniently sampled falls under the following geological categories, namely; rural settlement (these are the schools located in the rural areas), township or semi-urban (these are the schools located in the township and not necessarily rural areas), and urban settlement (these are the schools which are located in well-developed settlements better known as urban where they have access to social amenities). Therefore, the selected schools were sampled as follows;

a. Rural settlement: one school was selected from this category.

b. Township or semi-urban settlement: one school was also selected from this category.

c. Urban settlement: two schools were selected from this category.

d. one in a privately owned plot (semi-urban settlement).

Convenience sampling is a non-probability sampling method in which not every unit of the population has an equal chance of being selected. Rather, it is a subjective method that is used to determine which elements are included in the sample. Etican et al (2017) describe convenience sampling as a selection of members of a target population based on certain practical criteria such as geographical proximity, easy accessibility, and availability at a given time, or the willingness to participate for the purpose of the study. However, the selected schools for this study were sampled based on their proximity to each other. It should be noted that one of the selected schools was used as a meeting centre for the participants wherein they converged to participate in the TPC activities conducted in this study. The proximity of schools helped to reduce travel costs, maximise contact time, reduce inconveniences and interruptions on the participating teachers' normal daily routine, and most importantly, create a conducive environment for the common CAR meetings convened for discussions, planning, lesson presentations and reflections.

3.4.1 Biographical data of the participants

Table 3.1 shows the biographical information of the participants in the study. For ethical reasons, I allocated a code for each participant, i.e., Natural Science Teacher (NSt1, NSt2, and so on.).

Table 3.1: Biographical data of the participants

Participant	Specialisation	School location	Gender	No. of years teaching NS
NSt1	Life Sciences	Township	Female	4
NSt2	Life Sciences	Town	Female	1
NSt3	Life Sciences	Town	Male	5
NSt4	Life Sciences	Private Plot	Female	1
NSt5	Life Sciences	Township	Male	8 Months

Participant	Specialisation	School location	Gender	No. of years teaching NS
NSt6	Physical Sciences	Village	Male	3
NSt7	Physical Sciences	Township	Male	1
NSt8	Physical Sciences	Township	Female	3
NSt9	Agricultural Sciences	Village	Female	7
NSt10	Mathematics	Private Plot	Male	5

As shown in Table 3.1, five participants specialised in Life Sciences, three in Physical Sciences while two other participants (NSt9 and NSt10) neither specialised in Life Sciences nor Physical Sciences but in Agricultural Sciences and Mathematics respectively. Notwithstanding, I used their secondary school specialisations which included both Physical Sciences and Life Sciences. For instance, NSt9 specialised in Mathematics, Life Sciences, and Agricultural Sciences, therefore, I placed her in the Life Sciences Group. NSt10 specialised in Mathematics, Physical Sciences, and Geography. Based on that, he was placed in the Physical Sciences group.

In total, 10 Grade 9 NS teachers from five secondary schools participated in this study. Five of the participants were female and five were male. In addition, four worked in township schools, two in a town school, two in a village school, and two in a school that was in a private plot. The total teaching experience of the participants ranged from eight months to seven years in teaching the NS subject.

3.5 DATA COLLECTION METHODS

Qualitative data collection encompasses the collection, analysis and management of data. It also seeks to get the feelings, perceptions, and views of the research participants

(Buthelezi, 2018). However, different types of data collection methods can be used. The types of data collection methods used in this study are outlined below.

3.5.1 Semi-structured interviews

According to Ryan, Coughlan and Cronin (2009), there are three types of interviews, namely structured, semi-structured and unstructured interviews. Structured interviews are objective in nature, they contain overt questions and do not allow room for deviating from the subject being asked (Berg, 2009). Unstructured interviews on the other hand do not have any specific framework or sequenced questions, while semi-structured interviews have sequenced predetermined questions but have the flexibility of allowing unanticipated responses which emerge during the interview (Patton, 2002).

Semi-structured interviews were used in this study. This type of interview was chosen to guide the interviewee to a particular question or questions they should respond to. The semi-structured interviews were conducted with one participant at a time and they are often followed by why or how questions (Adams, 2015). These types of interviews also outline the main topics to be covered in an interview. That means the interviewer has more information about the topic, the subject to be discussed or data to be obtained from the interviewee.

3.5.2 Lesson observations

Observation enables the researcher to obtain information from the activities of the participants in their natural settings through observing or participating in those activities (Kawulich, 2005). Lesson observation assisted me to obtain first-hand diagnostic information obtained from the participating teachers during their lesson presentations. Through observation, data can be collected without asking questions though it will need the observer to add their understanding and judgment to the data obtained (Scott & Usher, 2004).

3.6 MANAGEMENT OF THE RESEARCH PROCESS

3.6.1. Phase 1: Planning stage

a) Day 1: Lesson planning activities by the two groups

All the participants converged in a central school which is referred to as a 'centre' for an interactive meeting organised by me. The reason for choosing this school as a centre was based on its distance relative to all other selected schools. It is important to note that none of the participants specialised in NS subject even though they were teaching it in Grade 9, because of the multifaceted nature of the subject. They either specialised in Physical Sciences or Life Sciences except two teachers who specialised in Agricultural Sciences and Mathematics as indicated in Table 3.1. During the meeting, I made a short orientation presentation to outline how the activities of that day would be carried out. The participants were also allowed to robustly discuss together the challenges they face in selected NS topics.

After the discussions that lasted for about 40 minutes, the participants were divided into two groups based on their specialisation by me. However, I used the matric result to place the two participants who neither specialise in Physical Sciences nor Life Sciences into the relevant groups. Matric results are obtained after the completion of Grade 12 examination. Hence, these participants were divided into Group A and Group B respectively according to their specialisation. After dividing them into groups, I assigned them topics derived from Grade 9 NS CAPS document on Physical Sciences topics and Life Sciences topics. The Physical Sciences topics fall under the '*Energy and Change* strand' while Life Sciences topics fall under the '*Life and Living* strand.'

The participants sat according to their groups, i.e., Group A and Group B. I then assigned each group a topic, based on their specialisation, i.e., Group A worked on a Physical Sciences topic titled *"Chemical equations to represent reactions,"* while Group B worked on a Life Sciences' topic titled "*Circulatory and Respiratory System"*. Based on my experience as a subject advisor, these topics often posed challenges to NS teachers, especially those that did not specialise in the subjects encompassing them. Each group was expected to develop a lesson plan collaboratively which would be presented by the groups' representatives. When a group presented the lesson, the other group listened

and asked questions where they needed more understanding. For example, when the representative of Group A presented the lesson, Group B listened and asked Group A questions for more clarity and understanding in a case where they did not understand, and this went vice versa.

i) Group A first lesson planning activity

The participants in this group based their discussions on how to structure and plan their lesson. During their deliberations, some of the group members suggested that they should start the lesson by asking the Group B members questions based on the periodic table and the chemical equations before going to the balancing of the chemical equations while others were insisting on starting the lesson activities with balancing of chemical equations. This was fascinating because most of the group members backed up their suggested approaches. Although, few members in the group still argued that the latter approach would be better because it would assist the Group B members who ought to be listening to their lesson presentation to ask questions and improve their understanding. The participants agreed on the former approach ultimately. The other thing the participants debated on was which teaching and learning materials to use, but what they debated on the most was the balancing method to use. Some participants suggested that balancing equations by inspection is the quickest and easiest method and is always used for simple equations at the entry level such as Grade 9, while others preferred the completing algebraic balance method. This was very interesting because the participants were now learning various methods of balancing the chemical equations.

ii) Group B first lesson planning activity

In this group, the participants' discussions were based on how the presenter should unpack the concepts in the topic, for example, which concept to start with between circulatory system and respiratory system. In the end, they agreed that these concepts must be introduced simultaneously as that would assist the observing participants to understand them better and clear the misconceptions around them. In other components of the lesson plan such as methodology to be used, there were no arguments, there were hence unanimous agreements among the participants.

b) Day 2: First lesson presentations by the two groups

i) Group A Lesson Presentation 1

During the lesson presentation, one group member from Group A presented the lesson on behalf of the whole group, while other members and the participants from Group B observed the lesson. Since group A specialised in Physical Sciences, their lesson presentation was on *"Chemical equations to represent reactions.*" The participants from Group B were given a chance to comment and ask questions directed to all the members of Group A. The lesson presentation by this group lasted for 30 minutes. I noted all my lesson observations on the observation sheet.

ii) Group B Lesson Presentation 1

The participants in Group B specialised in Life Science, hence they presented a lesson titled "*Circulatory and respiratory systems."* The group also chose a representative to present the lesson to all other participants including the participants from Group A. It should be noted that all the members of the presenting group (Group B) participated in the lesson presentation. The participants in Group A were granted an opportunity to comment and ask questions about the lesson presentation made. The lesson presentation by Group B also lasted for 30 minutes.

I observed the lesson presentations wherein I acted as a moderate participant observer. A moderate participant observation occurs when the researcher does not necessarily participate but only interacts occasionally as a facilitator (De Walt & De Walt, 2011). Furthermore, they claimed that one of the benefits of moderate participating observers is that their involvement with the participants leads to a good rapport, thereby encouraging participants to present and speak up freely. It is important to note that during these lesson presentations, the participants also used various relevant resources such as textbooks, Grade 9 Natural Sciences CAPS document, markers, board and charts.

3.6.2 Phase 2: Implementation stage

Note that immediately after the lesson presentations by the two groups based on their specialisation, I swapped the groups. Group A which specialised in Physical Sciences was to develop a lesson plan and present the topic which Group B earlier presented. Likewise, Group B that specialised in Life sciences was asked to develop a lesson plan and present the exact topic that Group A presented.

Day 3: Swapping of groups' topics and lesson planning activities

The participants came together again at the centre to plan their lessons extensively according to the swapped topics. Participants from each group, i.e., Group A and Group B respectively, engaged in collaborative lesson planning activities based on the topic assigned to them the previous day. Thereafter, the groups presented their lessons the following day. The reason for swapping the topics to be presented by each group who did not specialised in the topic but teaching NS was to enable me to understand whether or not the participants gained any insightful knowledge from one another during the lesson presentations by the specialists' groups.

Day 4: Second lesson presentations by the two groups

i) Group A Lesson Presentation 2

One group member from Group A presented the lesson on behalf of the whole group, while other members and the participants from Group B observed the lesson. Though Group A specialised in Physical Sciences, their lesson presentation was on "*Circulatory and respiratory systems."* The participants from Group B were given a chance to make comments and ask questions directed to all the members of Group A. This lesson presentation lasted for 30 minutes which I observed as it was presented.

ii) Group B Lesson Presentation 2

Group B members specialised in Life Sciences, but were tasked to present a lesson on the topic which Group A presented during phase one "*Chemical equations to represent reactions*". A member of the group presented the lesson on behalf of the whole group. While members of Group A listened, commented and asked questions at the end of the lesson presentation. This lesson presentation by Group B also lasted for 30 minutes, and I also observed the lesson presentation.

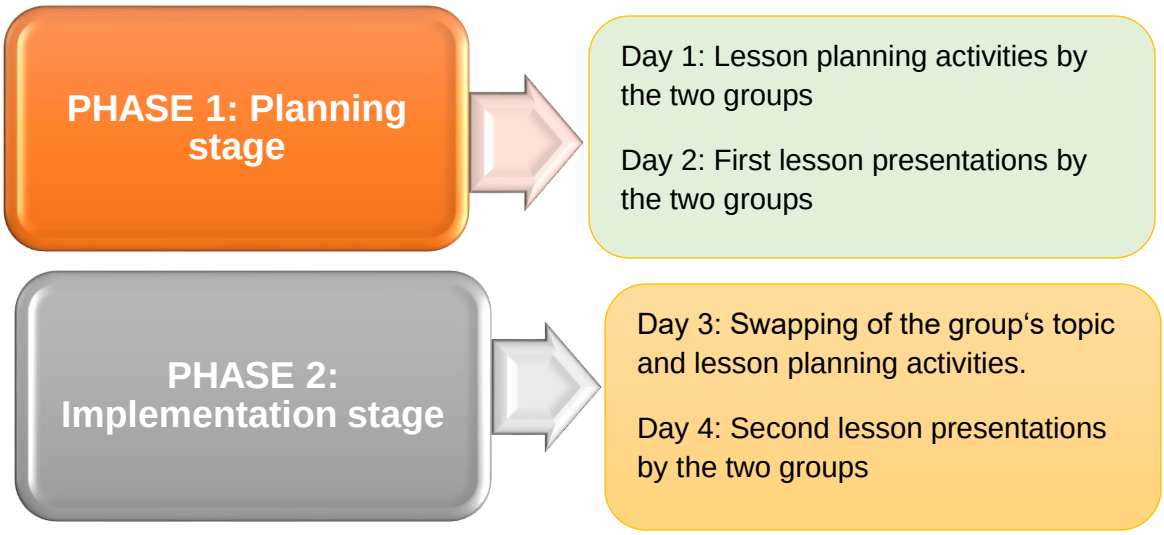

Figure 3.2: illustration of the research process

3.7 DATA COLLECTION INSTRUMENTS AND PROCEDURES

Data collection instruments refer to tools used to collect data such as interview schedule, lesson observation sheet, etc. In this research study lesson observation tools and semi-structured interview schedule were used as data collection instruments.

The participants reflected on the presentations of their lesson plans both before their interaction during the TPC activities and after they engaged in the TPC activities and discussed how to mitigate the challenges identified during the lesson presentations (Zultikar & Mujiburrahman, 2017).

a. Lesson observation sheet

The lesson observation sheets enable the researcher to obtain information from the activities of the participants in their natural settings by observing or participating in those activities (Kawulich, 2005). In this instance, the natural setting is the secondary school. The data gathered through the semi-structured interviews and lessen observation strived to answer the main research question of this study which is: "How can Grade 9 NS teachers use professional collaboration for their effective understanding of the subject content knowledge?" In addition, it intended to check whether the collaborative lesson planning activity assisted the participants to improve their subject content knowledge in

the topics that they did not specialise in. The lesson observation sheet used for this study contained list of criteria which assisted me to observe the participants. The lesson observation sheet is attached as Annexure D.

b. Semi-structured interview

The questions in the interview schedule were derived from the research questions of this study which inter alia strived to establish the understanding of professional collaboration by Grade 9 NS teachers. Most importantly, these semi-structured interviews envisioned to elucidate the views of participants on how the content gap in the NS subject can be exterminated among participants through TPC. The responses of each individual participant were noted on the research dairy. It is important to mention the significance of accuracy when capturing the responses of participants to eliminate the distortion of information. Therefore, an audio-recorder was used to capture the responses of the participants during the interviews in order to ensure precision. The semi-structured interview schedules were attached as *Appendix C* in the list of appendices.

After the second lesson presentations by Groups, the participants thus returned back to their respective schools. On the second day, I visited each of their schools to interview them based on their experiences of the activities. The participants were individually interviewed using the semi-structured interview and their responses were noted on the research dairy. Moreover, I audio-recorded all the interviews, this was done to avoid watering down the data obtained from the participants. It should be noted that the objective of these interviews was to get the participants' views on how the NS subject content gaps can be exterminated through TPC, as well as to establish the participants' understanding of TPC. The participants were free to express their views in a confidential space. This also saved a lot of time because each interview lasted for 20 minutes.

3.8 DATA ANALYSIS

The most important part of data analysis is that the researcher must have the ability to perceive the world through the eyes of the participants (Austin & Sutton, 2015) because it is their voices the researcher must be able to interpret and report for others to learn

from. According to Bowen (2009) refers to data analysis as a process of reviewing and evaluating data collected to elicit meaning, gain understanding, and communicate it effectively. There are different types of data analysis that can be used in qualitative research studies, however, for this study, I chose thematic analysis because it will give me an opportunity to analyse the semi-structured interviews and lesson presentation observations effectively.

3.8.1 Thematic data analysis

Generally, qualitative data analysis involves giving meaning to a set of data collected, whether is conversational data, lesson observations, semi-structured interviews, or unstructured interviews among others (Lester, Yonjoo & Lochmiller, 2020). It is customarily the initial stage in the data interpretation process. The objective of the data analysis in this study, which took a thematic approach was to present the findings as they were expressed by Grade 9 NS teachers as research participants during interviews and observations of their lessons. In accordance with Lester et al (2020), I went through the following phases of data analysis:

- Preparation and organisation: I put together all the data collected from the information noted down from the semi-structured interviews and lesson observations.
- Transcription: I transcribed the data I collated into a written document mode. To ensure precision, I used the information from the audio recordings to transliterate it.
- Familiar with data: I read the data several times to familiarise myself with it, and looked for basic observations or trends. This assisted to identify gaps or limitations in the data if any.
- Memoing: I developed memos from the data so that I could describe the initial reflections about the data and the emergent interpretations. Based on that, I revisited the objectives of this study to check whether the information gathered answered the research questions.

- Coding: I identified broad ideas, concepts, behaviours, or phrases and gave them codes. These are short descriptive words or phrases that assigned meaning to my analytic interests, for example, coding concepts such as the positive or negative reaction to a question. Coding aided me to organise and label the data, identifying patterns and connections.
- Codes to categories to themes: I developed themes from the codes formulated. I did this by formulating categories for the codes developed. For example, I searched for the most common responses to questions, discovered data or patterns that could answer the research questions.
- Transparent process: Since it is imperative that the data gathered is made as transparent as possible, I developed an audit trail that detailed the analytical process to delineate the link between data sources, codes, categories and themes (see Table 4.1).

In the light of these analysis phases, the information gathered from Group A and B presentations was collated, analysed, and evaluated with the aim of establishing whether collaborative lessons can improve classroom teaching. Most importantly, the sustainability of TPC was reconnoitred. It should be noted that the information recorded in this tool was based on what I observed during lesson presentations.

The semi-structured interviews were conducted during Phase 2 of data collection. Each interview sheet was then interpreted and summarised to give an overall understanding of professional collaboration by Grade 9 NS teachers as posed in the first research sub-question of this study which is outlined in Chapter One.

3.9 MEASURES FOR VALIDITY AND TRUSTWORTHINESS

This research study strived to maintain high credibility and objectivity as much as possible. Connely (2016) opines that the trustworthiness of a study denotes the dependability of the collected data, interpretation, and methods used to ensure the quality of the study. Shenton (2004) identified the following four criteria that a qualitative

researcher can use to ensure the validity and trustworthiness of the study: credibility, transferability, dependability and confirmability.

Any research study needs to be credible. In qualitative research, one of the aspects that assure credibility is using well-established methods and when the researcher is familiar with the culture of participating within the context of the participants. Permission to conduct this research study was obtained from all designated levels, e.g., from the province, sub-district, school principals, and the participants themselves (Stahl & King, 2020). This research study was conducted using the existing participation culture. For instance, it is a norm to gather teachers (participants) within the same sub-district in one venue with the aim of conducting a workshop or training, therefore, it was easy for teachers to participate. I built a positive rapport with participants to ensure trust and mutual respect. This was done by assuring the participants that their identity would be protected and none of their personal information would be published as per the Protection of Personal Information Act (POPIA) of 2013. No participant was forced to participate in the study, it was on voluntary bases.

The concept of transferability taps into how the findings of a particular research study can be applied in other situations (Shenton, 2004). I fully concur with Stahl and King (2020), who argue that even though it might be fiddly to guarantee transferability, especially in qualitative research, some patterns and descriptions can be used in other contexts. This assertion is intensified by the fact that the data collection process used in this study can be replicated in any sub-district of any other province of South Africa.

Dependability anchors on the reliability of the research findings of the study. According to Guba and Lincoln (2005), the processes within the study must be reported in detail to ascertain dependability. There must be room for the research findings to be reused or repeated by other researchers or end users (DBE officials in this instance). The report and recommendations of this study will be accessible to any division/ component of the DBE, which means it can be used, reused, and scrutinised.

In qualitative research design, endeavouring to eliminate bias is almost compulsory. The importance of the researcher being as objective and close to reality as possible is of utmost prominence. This ratifies the confirmability of the research findings. I ensured confirmability by capturing the existing reality, rather than deriving it from the findings. For example, I established that some NS teachers lack specialisation in the subjects encompassed in NS. This information was there before I even commenced with the research process, which means that it was not emergent. This minimised the element of subjectivity. It should also be noted that the same Grade 9 Natural Sciences teachers were used throughout the research. This was done to increase the validity and trustworthiness of the study.

3.10 ETHICAL CONSIDERATIONS

Permission to conduct this research was sought from the DBE Bojanala District and Madibeng Sub-district of Northwest Province. I was transparent to the participants in all the activities they participated in. No activity was done without the permission of the school and the participants. This was done as per requirements of both the University of South Africa (UNISA) policy on research ethics as well as DBE.

I kept the original transcripts of the interview schedule and observation sheet. All these was done to ensure precise and exact records of dates, times, and persons. Ethical principles such as plagiarism, data falsification, informed consent, confidentiality, respect for the individual, and avoidance of misrepresentation of the collected data was absolutely considered throughout the data collection process. Moreover, this procedure was maintained throughout the research process. To guard against plagiarism, all sources consulted were acknowledged. The aim of the research was communicated to the participants. The confidential information provided by the participants in the research study were treated with privacy and anonymity i.e. their names were not included and their faces were concealed in all the pictures taken during data collection to protect their identities as suggested by Mouton (2011).

3.11 CONCLUSION

In this chapter, the details of the research methodology used in this study such as research paradigm, approach, sampling, and issues of trustworthiness and ethical considerations were discussed. How these concepts relate to each other is also explained in detail. Furthermore, the research methodology and paradigm adopted to achieve the aim and objectives of this study were expounded in this chapter. It is imperative that the research method should reverberate and answer the research questions of a study (Creswell, 2003) since it is the strategy or plan of action that lies behind the choice and use of methods. This chapter also elaborated that this research study was undertaken with a qualitative approach using the appropriate research instruments to collect data for analysis.

CHAPTER FOUR

PRESENTATION OF DATA ANALYSIS AND INTERPRETATION OF THE FINDINGS

4.1 INTRODUCTION

The primary aim of this study, as stated in Chapter 1 subsection 1.4.2 was to explore the teacher professional collaboration approach in developing Grade 9 NS teachers' subject content knowledge. The data gathered from the responses, comments, and inputs of the participants are presented in this chapter. Furthermore, this chapter presents data analysis, discussions, and interpretation of the findings. Data was analysed within the two phases, i.e., Phase 1 (planning stage) and Phase 2 (implementation stage). The analysis of data substantiated a complete cycle of CAR espoused in this study. I constructed a collative response for each of the research questions of this study using the data collected.

As stated in the chapter 3, the topic selected for Life Sciences strand was "*Circulatory Respiratory Systems"* while "*Chemical Equations to Represent Reactions"* was selected from Physical Sciences strand respectively. The topics were later swapped between the two groups whereby they planned the lesson and presented. During the lesson presentations, I observed the two groups during the first and second lesson presentations. Thereafter, I interviewed each of the participants in their respective schools. This chapter presented and analysed the data collected through lesson observations by the two groups and participants' individual semi-structured interviews.

4.2 DATA ANALYSIS

4.2.1 Phase 1: Planning stage

During Phase 1, the Groups (A and B) took turns to present their collaboratively developed lesson plans.

4.2.2.1 First lesson observation data

a) Group A first lesson presentation

The presenter engaged observing participants in the prior knowledge questions based on the periodic table, elements and their atomic numbers, chemical equations, etc. This led to a lot of questions such as the one posed by NSt2 as to what the atomic mass is and why the elements are arranged like that in the periodic table. Most of the observing participants confessed that they only relied on the textbooks to explain to these concepts to their learners which is often not enough. Some, such as NSt1 indicated that she did not even understand the periodic table itself, how and why the elements are arranged. I noticed that this participant was not so free to ask some questions at first, until NSt7 assured her that it was understandable and that he also often assisted his colleagues at his school on the very same concepts. This gave NSt1 more confidence to ask more questions. This confirmed that TPC is built on mutual trust and *Ubuntu* principles as indicated in the literature review of this study.

b) Group B first lesson presentation

The explanations of the circulatory and respiratory systems evoked a lot of questions from the observing participants, for example, NSt7 asked how he could explain to the learner that the circulatory and respiratory systems are not intertwined because even though the circulatory system pumps and circulate the blood throughout the body, and the respiratory system is responsible for gaseous exchange, it is the very same blood that transport oxygen gas around the body. The above question was responded to by NSt5, who explained that our whole body is a system and that these two above mentioned systems are different but they are dependent on each other, e.g., the respiratory system ensures that there is oxygen in the body and that the carbon dioxide gas is taken out of the body, but this system needs circulatory system to transport these gases in and out of the body system.

It was very interesting to see the participants interact with each other robustly during the lesson presentations. Most of the participants indicated that they understood the concepts discussed better. This corroborated the assertions of Philander and Botha (2021) in Chapter Two of this study that TPC is one of the most effective types of professional development strategies. The participants used the CAPS document and the curriculum

work schedule to know which concepts are for examination purposes and which ones are not.

The science process skills were inculcated in the lesson presentations as prescribed by the Grades 7 to 9 NS CAPS document, because the participants were able to list, name, explain them and so on. This is very important because it shows the level of understanding of the concepts taught by the participants. Both Groups A and B lesson presentations were interactive and informative because the observing participants were able to ask clarity-seeking questions which the presenting participants were able to respond to.

4.2.2.2 Lesson compliance with CAPS

One of the lesson observation criteria was to check the compliance of the lesson to CAPS the document. The CAPS document is very specific on which concepts should the teachers emphasise; therefore, the focus of my observation was on how the presenters unpacked the core concepts of the assigned topic. Even though the topics presented were CAPS compliant, I observed that the participants often discussed and debated at length the concepts that were above the level of Grade 9 but related to the lesson topic. For instance, during group A presentation, the participants discussed the chemical bonding which is a concept treated in Grade 10. At this point, I cautioned the participants that even though the information on chemical bonding is important for teachers to understand, it is above the Grade 9 level. The above criteria, therefore, foraged for the consistency and appropriate focus of the lesson. This is very important because sometimes a teacher may be carried away to emphasise the concept(s) that are not necessarily essential, which may emanate from various factors such as the area of specialisation or a lack thereof, the textbook used (especially when that teacher depends on the textbook rather than the Annual Teaching Plan (ATP), etc. This is because some textbooks include a whole range of concepts. During Group B's presentation, there was a lengthy debate on *why a dead body floats in water while the living one does not* and the topic for the lesson was *Circulatory and Respiratory Systems*. This was good since it related the lesson to the everyday life of learners, but it also derailed the lesson. I noted that it took the presenter

long to redirect the lesson. Both lessons had all the necessary localising information such as the topic, grade, time frame, aims, objectives, integration, assessment, skills, knowledge, values, etc. All three specific aims of NS which are 'doing science', 'knowing the subject and making connections', and 'understanding the uses of science' as stipulated by CAPS were included in both lesson plans.

4.2.2.3 The involvement and participation of the observing participants in the lesson

In the NS class, learner involvement is vital since the key element of the lesson is the acquisition of the science process skills that enable learners to think objectively and have diverse reasoning while using them. Most importantly, they stimulate curiosity which boosts confidence and creativity in learners. Science concepts demand active participation to be attained. Moreover, CAPS emphasises a learner-centred approach, therefore, learners do most of the work while teachers should play a facilitator's role. I observed that in Group B, in the beginning, the observing participants' involvement was only in answering questions posed to them. For example, the questions on respiratory and circulatory systems asked by NSt3 during group B presentation and the question on atomic number and the arrangement of elements in the periodic table posed by NSt2 during Group A presentation. The principles of '*ubuntu*' were displayed as articulated by Gumbo (2014) in Chapter Two of this study.

4.2.2.4 The unpacking of the concepts taught

This is one of the core criteria of the lesson observations since the aim of this study was to find out how the teachers' NS content knowledge can be developed through TPC. Here, I observed whether the lesson had the correct flow and concept progression, i.e., the concepts should be introduced from simple to complex and from concrete to abstract. This was displayed by both groups especially during the Group A presentation when they started their presentation on prior knowledge seeking questions on the periodic table, atomic numbers of the elements before they concentrated on balancing of chemical equations. This is important because some of the scientific concepts are abstract, so,

learners must understand the concrete concepts linked to them first for progressive learning. Both presentations included the science process skills.

Group B also exhibited this, for instance when NSt5 responded to the question posed by NSt7's question on the interdependence of the circulatory and respiratory systems, he referred him to the body as a system, which is entailed in the previous topics as outlined by CAPS. The science process skills were key here because they validate the learners' understanding of the concepts taught. This was also demonstrated during both presentations, for instance, during Group A presentation, the observing participants were able to locate the elements contained in the chemical equation on the periodic table and represent translate the word chemical equations to symbol chemical equations. During Group B's presentation on the other hand, the observing participants were able to tabulate the differences between the circulatory and respiratory systems; they also drew flow charts to show the how both systems are working in the body.

4.2.2.5 Teaching methodology and strategies used

While the emphasis of the study was more on the establishment of the subject content knowledge of NS in the Grade 9 teachers, it was imperative to look at the teaching methods and strategies used, because the subject content knowledge is for teaching. During both presentations, participants were able to share the teaching strategies to each other, for example, both groups agreed that it is best to engage learners into questions to check the prior knowledge on simpler concepts linked to the concepts to be taught. Furthermore, that engaging learners in hands on activities maximises their understanding of the concepts, for instance, allowing learners to write the chemical equations on the board and allowing the class to engage in the balancing of those equations, letting learners draw flow charts representing the circulatory or respiratory systems, etc.

4.2.2.6 The inclusion of science process skills

According to CAPS, it is compulsory for an NS lesson to include all three specific aims as prescribed by CAPS document, however, the appropriate process skills must be addressed. During Group A's presentation, the observing participants were asked to

name, draw, and write symbols of elements of the periodic table, draw chemical reactions, and translate them into chemical equations. During Group B's presentation, on the other hand, observing participants labelled, drew, and made a tabular comparison between gaseous exchange and respiration.

4.2.2.7 The assessment questions posed in relation to Bloom's taxonomy

The percentages of lower-, middle-, and higher-order cognitive levels have been weighted at 30%, 50%, and 20% respectively in the CAPS Section 4 on assessment for the NS CAPS (DBE, 2011). I observed that the participants did not really pay attention to how many abstract or simple questions were asked, rather they were more concerned about whether the observing participants understood the topic taught or not. Notwithstanding, I noticed that when both lessons were introduced the questions posed were low-order questions like "What is the periodic table?" "What do you understand by a system?" However, the bulk of the questions were in the middle cognitive level.

4.2.2.8 Usage of learning and teaching materials

The participants came with different textbooks from their schools which they used in the presentations, e.g., *Platinum, Spot-on, Platinum, Solutions, Viva,* etc. Fortunately, the hosting school provided the gaseous exchange charts, periodic tables, etc. In this criterion, my focus was on whether and how the learning and teaching materials were used, and most importantly, if they were used collaboratively. I believe that for a teacher to be able to use the teaching and learning materials appropriately, he or she should have the adequate content knowledge of the subject to be taught. Both groups were able to make use of the available learning materials. For instance, the observing participants were able to locate and identify the elements in the chemical equations in the periodic table, label both the circulatory and respiratory systems. This was exciting to observe because the participants debated about the labelling and at the same time referring to the textbooks.

4.2.2.9 Classroom management

Here, my observation focussed on the capability of the teacher to control the class. Even though interactive lessons may seem disruptive, especially during the debates and discussions, it is important that it is well managed and the time frames for the discussions are adhered to. Both presentations were well-managed. For instance, even though the challenges or questions that arose from the lessons were attended to collaboratively by group members, the individual participants were asked to demonstrate various methods of balancing chemical equations while others were observing. This curbed the disruptive discussions during the lesson. In addition, the presenters allocated time frames for the collaborative discussion on thought-provoking questions such as, “What causes the dead body to float and not sink in water?” which was posed during the lesson presentation of Group B.

4.2.2.10 Adherence to the lesson time frame

Time management in lesson presentations is paramount. It is important to conclude the lesson on time even if other aspects of the lesson should be deferred to the next lesson. In many instances, teachers decry learners’ different learning pace considerations. I observed that the participants were so absorbed in the discussions that they did worry less about time. Even when I informed them the time allocated is exhausted, they were reluctant to conclude. This showed that TPC should be allocated adequate time and that teachers are thirsty for it.

4.2.3 Phase 2: implementation stage

At this phase, the participants of Group A and Group B met to comprehend the knowledge attained from the first lesson presentations and put it into practice by collaboratively developing lessons plans on the topics they did not specialise in. For this reason, I termed this groups Non-specialist Groups). This was done by swopping the topics, i.e., Group A developed a lesson plan on *Circulatory and Respiratory Systems* (Physical Science) while Group B developed a lesson plan on *Chemical Equations to Represent Reactions* (Life Sciences). As stated in Chapter Three, Phase 2 was implemented after completion of Phase 1. The aim of this break was to increase the validity of the lesson presentations

since the same topics used during Phase 1, were used. This stage was important because it sought to indicate whether the NS subject content gaps in the participants has been mitigated or not.

The same challenges noted down during the Stage1 of Phase 1 was written on the white board and the participants reflected on them to check whether they have been addressed or not. What I observed during this meeting, was that most participants alluded to the fact that they understood some of the concepts they did not understand before they were engaged in the Phase 1 CAR activities. For example, NSt1 indicated that she now understood the periodic table and could teach the balancing of chemical equations better. She further indicated that she consulted NSt5 whenever she needed more clarity. What NSt1 and NSt8 did signify is that TPC has to be continuous and not once-off. As the participants engaged in lesson planning activities, my observations were as follows:

a) Group A second lesson planning activity

There were not many debates during this activity compared to the planning stage in Phase 1. The participants agreed that the lesson should start with questions that probed prior knowledge of the concepts to be taught in the lesson such as cells, tissues and organs that form the body systems. The participants agreed with the learner-centred cooperative teaching methods without any debate like in they did during Phase 1.

b) Group B second lesson planning activity

The participants of this group adapted the same teaching method that was used by Group A during Phase 1 wherein the observing participants would be asked questions on the concrete concepts that are linked to the balancing of chemical equations such as the atomic numbers of the elements and the periodic table. It was interesting to note that the participants agreed on how to develop the lesson plan quicker than during the first lesson planning activity.

4.2.3.1 Second lesson observation data (Non-specialists Groups)

Just like in the first lesson observations, the non-specialists' groups took turns to present the lessons they collaboratively developed. The same lesson observation criteria used in Phase 1 were used in this phase, however, I was keen to check, compare and contrast how the non-specialists' groups presented their lessons as compared to the specialist groups.

4.2.3.2 Lesson compliance with CAPS

I noticed with interest that during the Non-Specialist Groups' presentations, the presenting groups were able to respond to the questions asked by the observing participants, although in some instances they assisted each other. For instance, NSt9 asked that since the compounds are named according to their elements, was it correct to call CO_2 carbon oxygen? The presenter could not answer and had to resort to other group members for assistance. This showed interdependence among the participants which is one of the principles of TPC. I noted that the interactions and discussions did not extend beyond Grade 9 scope as they did during Phase 1 presentations. The participants were able to put more emphasis on the topics with confidence, despite their non-specialisation.

4.2.3.3 The involvement and participation of the observing participants in the lesson

The lesson presentations were interactive and interesting. The observing participants were involved in continuous formative activities throughout the presentations. In both presentations, the participants were actively involved. The questions posed were adequately responded to. The observing participants were involved in hands-on activities such as creating chemical equation models using play dough and toothpicks, labelling and drawing flowcharts of circulatory and respiratory systems (refer to Annexure G).

4.2.3.4 The unpacking of the concepts taught

This is the part I was most interested in since the aim of this study is to explore the usage of the teacher professional collaboration approach in developing Grade 9 Natural Sciences teachers' content knowledge. The participants were able to unpack the

concepts they referred to as their grey area before the first lesson presentations. This was displayed when NSt1 was able to explain the balancing of chemical equations with confidence, she even made some jokes about how she used to perceive this topic. Her presentation was so good that other participants clapped for her. This showed how TPC can foster motivation and confidence in teachers. NSt7 was also able to draw a mind map (as captured in Appendix F) showing how body organs are interconnected to create body systems, e.g., how the heart and lungs function together to formulate the respiratory and circulatory systems. This answered the main research question of this study.

4.2.3.5. Teaching methodology and strategies used

Both groups adapted collaborative learning in their presentations. It was interesting to note that the interactive and hands-on activities were even more than during the specialist groups presentations. More chemical equations were balanced, the organs involved in the respiratory and circulatory systems were labelled and their functions were stated.

4.2.3.6 The inclusion of the science process skills

As stated in 4.2.3.5 above, the participants were able to display the science process skills during the presentations.

4.2.3.7 The assessment questions posed in relation to Bloom's taxonomy

Like in the specialist groups, most of the questions posed by the two presenting groups were in the middle-order cognitive level.

4.2.3.8 Usage of teaching and learning materials

The participants used the teaching and learning materials such as coloured play dough, toothpicks, charts, textbooks, periodic table chart and even the CAPS document itself.

4.2.3.9. Classroom management

At the end of the lesson presentations, all the concepts to be covered in the lesson as stipulated in the lesson plans were treated. There were less interruptions or delays caused by the discussions that derailed from the concepts of focus.

4.2.3.10 Adherence to the lesson time frame

Both lesson presentations were concluded on time, hence, they adhered to the stipulated time. This gave room for more question-and-answer sessions about the concepts taught in the lessons.

4.2.4 Semi-structured interviews data

The data from the semi-structured interviews and lesson presentations are presented and discussed in this section. Ten Grade 9 NS teachers took part in the semi-structured interviews and the lesson presentations. The responses of the participants are categorised, classified under the research questions, and explained as outlined in the data analysis. The questions posed in these interviews sought to get the participants' views and reflections on the collaboratively developed lesson presentations conducted in Phase 1 and Phase 2. The intention was to check whether there was any impact registered by the participants before and after these activities.

It should be noted that all the semi-structured interviews were audio recorded to avoid information loss and to ensure meticulous capturing. Subsequently, I coded the data through the developed categories and related concepts that were grouped to make coding easier. The information segments pertinent to the research aim and objectives were coded with categories and concepts. The patterns identified from the responses in the collected data were then used to formulate the themes.

4.2.4.1 Identification of themes and categories

Several themes emerged from the data gathered. The main themes that emanated from the participant's responses to the research questions are outlined in Table 4.2 below.

Table 4.2: Themes and categories

THEME	CATEGORY	CODE
Professional teacher collaboration	• Sharing of good practices • Collaboration	Professional teacher development

THEME	CATEGORY	CODE
	• Sharing of ideas and challenges	
Content knowledge	• Areas of specialisation • Interactive workshops	Natural Science subject
Classroom practices	• Teaching methods • Teaching strategies	Natural Science pedagogy
Common Lesson planning	• Lesson plan material development • Common assessment tasks	Curriculum implementation
Sustainable professional teacher development	• Use of ICT • Fourth Industrial Revolution	Professional bodies

Table 4.3 summarises the themes and supporting categories that arose from the semi-structured interviews with participants. These are significant assertions and deductions. The participants' views of TPC and its impact on their NS content knowledge are reflected in the presentation and analysis of the empirical findings, which is buttressed by precise quotations. The questions which were used to generate analysis and reporting are presented in Appendix E.

a) Theme 1: Teacher professional collaboration

The data acquired indicated that all participants believed that TPC is the convergence of teachers of the same subject to share good practices and challenges. Nine participants viewed TPC as the discussions among teachers of the same subject wherein they share ideas or challenges they experience while teaching in class, rather than planning or developing any teaching materials together. Their shared sentiment is summarised by NSt8's response:

> *My understanding is that teachers come together to discuss various ideas and struggles that they are experiencing in terms of content and also relating or transferring the content to the learners. Teachers get together to*

discuss certain topics that they need to teach the learners in order to improve their learning.

On the other hand, NSt5 shared a slightly different view from other participants in that he did not only limit his understanding of TPC to teachers sharing experiences on subject content delivery only, but he included collaborative development of assessment tasks as well. His response was:

OK mam, for me neh, it is when teachers of a specific subject work together in finding better ways of delivering the content to learners, and sharing assessment skills, for example, developing common class tests, assignments, etc. I can now teach chemical equations with confidence after the collaborative activity.

b) Theme 2: NS subject content knowledge

Life Sciences is taught together with Physical Sciences under the subject heading NS in the CAPS curriculum in both the Intermediate Phase and Senior Phase. The CAPS presumes that teachers have a strong Life Sciences and Physical Sciences knowledge basis, as well as the ability to design and create their learning materials. An ideal NS teacher, according to the NS CAPS policy document, must be able to teach all core topics confidently and successfully, and formulate relevant assessment activities. Not all NS teachers have specialised Life Sciences and Physical Sciences expertise to expediently deliver the subject content to learners. For instance, two participants did not specialise in either of the subjects as indicated in Table 4.1. However, most participants indicated that they needed professional support in the subject content for better curriculum implementation.

In the same line of thought, nine participants believed that TPC is an effective type of teacher professional development. Most of the participants' suppositions gravitated around interactive workshops and the sharing of skills. Mostly, participants agreed that

TPC can be used to improve the teachers' content knowledge through the sharing of good practices. This notion is summarised in the following responses:

> *I believe that if we could have workshops, all teachers combined, and we share different ideas about various topics. We can also use a fully elaborated annual teaching plan (ATP) to share good practices* (NSt1).

> *In my view, teacher collaboration is the sharing of ideas and struggles, like they say, "Many hands together make the work light". Different people's understanding of topics and how they struggle with them differ and how they can teach them differ as well. In that way, we can learn from each other and improve our subject content knowledge. I used to think that this can be done through discussions alone, but after being engaged in the collaborative activities, I realised that there should be practical involvement* (NSt3).

c) Theme 3: Classroom practices

Teaching methods, approaches, and strategies are encompassed in the teaching practices. These are important in the curriculum implementation. Individual teachers opt for different teaching strategies and methods. These are often influenced by various variables such as the lesson topic, availability of teaching and learning materials, learning abilities of learners, etc. All participants indicated that TPC can positively impact their classroom practices since they use different methods and strategies in class and can learn from each other. This notion can be attributed to the specialisation (see Table 4.1). Participants complained about a lack of proper professional effective support from the Department. They also pointed out that the efforts to read more to complement their subject knowledge are not enough because the teaching methods or strategies need practice. The in-service training is developed without inquiring about the area of need from the teachers. NS is a science subject that needs a hands-on approach. All the NS-specific aims as outlined in CAPS dictate that teachers should have adequate knowledge and skills on the subject content. Based on their responses, most of the participants

believed that TPC could improve their classroom practices. The following are some of their responses:

> *Well, that is a very good question. I think it will give me different teaching strategies, and different ways of approaching different topics, e.g., the balancing of chemical equations, it seriously used to be my 'not-so-favourite' topic to teach but I learned a lot after observing my colleagues using different methods of balancing the chemical equations. I now realised that if we as teachers balance equations differently, then we will definitely learn from each other. This will improve our teaching methods since some learners understand* (NSt4).

> *Yes, definitely, what I do in my class may assist you in your class and what you do in your class may assist me in my class. After observing my colleagues' lesson presentation on Circulatory and Respiratory Systems, I can definitely say that I can teach the topic with confidence because I now understand the concept better. Teachers need to share their philosophies and, this assist. I believe as a teacher, you will always have to develop* (NSt8).

d) Theme 4: Common lesson planning

A lesson plan outlines the procedures and steps to be followed during the lesson presentation. It also acts as a guide for a teacher. It should, therefore, be compliant to CAPS. One of CAPS principles is that "the minimum standards of knowledge and skills to be achieved at each grade are specified and set high, achievable standards in all subjects" (DBE, 2011:4). In NS subject, for instance, each lesson must include science process skills as outlined in Section 3 of the CAPS document. The captured data showed that teachers preferred the collaborative development of lesson plans and other teaching materials such as formal tasks. Most indicated that this succors in blending the skills, knowledge, and approaches of teachers from different environments. This can accommodate various multiple intelligences of learners. Even narrowing it to the

individual concepts of different topics, teachers employ diverse methods. The overall expression that was given by most of the participants was that they were for the idea of collaboratively developed lesson plans for instance some responded this way:

> *Iyoh! I think that is a great thing because we are the ones in the classrooms. Doing it together will assist us to cover all the needed aspects of a lesson plan, and developing formal tasks will improve the learners' performances. I used to skip some of the chemistry-based concepts, because I had no clue about the periodic table or elements, but now it is my favourite topic, thanks to the colleagues who shared their knowledge on these topics with me. I wish we could have these kinds of activities regularly, this will assist us to be more free to share our challenges with our colleagues because I believe that many teachers have the same challenges like I had but they are ashamed to ask* (NSt1).

Another participant responded by saying:

> *It would be a great idea because one would be exposed to how other teachers are teaching in class and it will also assist in learners being exposed to different teaching approaches, after observing and engaging with my colleagues who specialised in Life Sciences; I can now confidently teach the circulatory and respiratory systems. I just relied on the textbook before I was engaged in this activity* (NSt7).

Meanwhile, NSt2 had a different view from other participants. According to her, common lesson planning is not convenient. This was her response:

> *So, lesson planning, I think that it should be done individually, preferably, I mean you can't set a common lesson plan, learners are different in each class. In terms of formal tasks, I think it may be a good idea as long as the tasks are formulated bearing in mind that learners are from different types*

of schools and backgrounds, e.g., rural schools, urban schools, and learners whose English is not their mother tongue. However, I believe that we can use some methods and tips from each other as colleagues and make them to suit the contexts of our learners I really learnt a lot form my colleagues, I realised that it is important to know different methods of balancing chemical equations.

e) Theme 5: Sustainable TPC

The teachers need to develop professionally continuously. This is also articulated by one of the seven teacher roles that demand that teachers should be lifelong learners. Throughout the past decade, DBE has formulated different policies as remedial actions to improve teacher performance through continuous professional teacher development (CPTD). However, this is more effective when it is done collaboratively as already indicated in Theme 1 above. The participants' views gravitated toward the use of ICT for a sustainable CPTD. Some cited the current era of the Fourth Industrial Revolution, technological tools such as virtual meetings, websites, and WhatsApp groups can enable that. One of the participants mentioned professional bodies such as the South African Association for Science and Technology Educators (SAASTE). This sentiment is also shared by Slater (2004), who asserts professional bodies are important for teacher professional learning. ICT proves to be cost-effective and convenient on time usage. It enables instant information access. Moreover, it makes the sharing of ideas very easy. While eight participants only referred to the use of Technology to sustain TPC, NSt4 and NSt2 included professional bodies such as SAASTE as a method of sustaining TPC. For instance, NSt4 responded as follows:

OK, I believe that if as teachers we were to meet maybe twice in a week. Now because we are in the Fourth Industrial Revolution (4IR), we can also meet virtually to discuss the challenges. For example, we can meet through video conferencing, or mam you know organisations like SAASTE was very helpful when it was still active because at least we could access any science subject materials from the portal (NSt4).

Some participants mentioned the use of technology as a method that can aid in the sustainability of the TPC activities:

> *Natural Science is about understanding, science is about understanding. Learners need to see and do, not only hear. Now that we are in the Fourth Industrial Revolution (4IR), teachers can work together through videos, websites, etc. We can also have workshops where teachers are taught how to use Integrated Communication Technology (ICT), especially in rural areas. We can even record our lesson presentations and use them later as reference, because I really learnt a lot from the presentations of my colleagues* (NSt2).

Generally, the semi-structured interview data indicated that the collaborative lesson planning and presentations contributed positively to the development of the participants' content knowledge. They were now more motivated and confident to teach the selected topics they did not specialise in better. These claims corroborated with the lesson observation data I gathered before the semi-structured interviews.

4.3 DISCUSSION OF THE FINDINGS

In this section, data is interpreted, and the findings are discussed and evaluated against the aim and objectives of the study that emanated from the research questions. Furthermore, whether the problem statement postulated by this study is addressed is also discussed and assessed.

As stated in Chapter One, the objectives underpinning this study are as follows:

a) To establish Grade 9 Natural Sciences understanding of teacher professional collaboration.
b) To explore the usage of professional collaboration by Grade 9 Natural Sciences teachers to improve their subject content knowledge.

c) To assess the Grade 9 Natural Science teachers' usage of professional collaboration for effective teaching of the subject.
d) To suggest ways through which teacher professional collaboration can be sustained among Grade 9 Natural Sciences teachers.

According to the data gathered, it is quite clear that teachers understood TPC as teachers coming together in the form of workshops or meetings wherein, they learn from each other by actively sharing knowledge and various skills such as lesson planning and assessment tasks development which would better their curriculum delivery in their respective classrooms. This notion corresponds with the assertion of Roselli (2016), that collaborative learning encourages dialogue, listening to others, and mutual assessment; collaboration for negotiation and consensus-building work; organisation of activities; conceptual elaboration and collective writing through the collaboration of colleagues.

From the findings of the observations and semi-structured interviews conducted in this study, it is clear that TPC aids the classroom practices of teachers, for instance, the second lesson presentations which were done in the second phase of the data collection further regurgitated that TPC has a positive influence on both the development of subject content knowledge and curriculum delivery in Grade 9 NS teachers. The participants were more confident and displayed more knowledge and skills despite their non-specialisation in the topics they presented. Their collaboration boosted their confidence levels and knowledge. This affirmed the principle of *Ubuntu* as stated by Gumbo (2014), that through it, teachers can show commitment and care for each other. Moreover, this showed that TPC is beneficial to NS teachers, which affirms Butera *et al* (2013) definition of knowledge as a process of negotiation or joint construction of meanings. The continuous engagement of Grade 9 NS teachers can bridge the subject content gap.

The findings of this study support the opinions of both the collaborative and critical theorists upon which this study is rooted, as indicated in Chapter Three of this study. Critical theory promotes emancipation and is more concerned with what is wrong than what is right, and what changes should be made to correct the wrong identified (Niehaves

& Bermd, 2006). In light of this, the teachers were emancipated in as far as their understanding and teaching of the subject owing to the TPC activities that they engaged in. In this study, the NS teachers need to be emancipated from the vertical intervention programmes administered to them by the Departmental officials which often lack the diagnostic element and are preemptive according to Buthelezi (2018) as indicated earlier in Chapter Two of this study. This emancipation can be achieved through TPC.

During Phase 2 of data collection, it was clear that the participants had a better understanding of the concepts they considered difficult to teach before the CAR activities. This was affirmed by their responses to the questions posed during the semi-structured interviews. Collaborative theorists believe that effective collaboration can take place when there is relational trust, collective responsibility, clear purpose, time allowance and effective communication (Benade, 2011). The participants were free to share their content gaps, which affirms mutual trust and effective communication; furthermore, the collaborative lesson planning also promoted collective responsibility. All these factors boosted the participants' morale and motivation. This corroborated with the findings of System Approach for Better Education (SABER) (2014) when they researched Mozambique teachers that lack of motivation is one of the factors that hampers teacher performance.

As far as sustaining the TPC application is concerned, according to these findings, the use of Technology such as virtual meetings (zoom or Microsoft Teams and WhatsApp groups) could assist. This could aid teachers in accessing each other easily. In the same line of thought, professional bodies or associations such as SAASTE are seen as the means to sustain TPC in schools. DBE (2015) shares the same sentiment; hence, it developed a Guideline in Professional Learning Communities (PLCs) for South African schools as part of its role and responsibility to support the provincial education departments and other stakeholders to set up, maintain, and ensure that PLCs work effectively.

The content gap in Grade 9 NS teachers emanating from non-specialisation on the subject as articulated in the problem statement of this study, often results in teachers avoiding teaching certain content areas of the NS subject due to their limited scientific skills and content knowledge in the subject (Magano, 2009). This assertion was also confirmed by NSt4, who indicated that chemical equations to represent reactions used to be her grey area, but after the CAR activities, she could confidently teach it. Thus, the findings of the study show that TPC responded well to the above-mentioned problem.

The challenges emanating from the NS subject content gaps identified by the participants and how TPC addressed them are outlined in Table 4.3. These challenges were only contextualised to the assigned topics which are *Circulatory and Respiratory System* and *Balancing of Chemical Equations*.

Table 4.3: Challenges addressed through TPC

Challenges pointed out by participants	**How TPC addressed the challenges**
The periodic table of elements.	The participants were able to explain how the elements are arranged and classified in the periodic table.
Symbols of elements and their atomic numbers.	The participants were able to locate the elements in the periodic table through their symbols and explain what is comprised in the atomic number of an element.
Balancing of chemical equations.	• The participants were able to demonstrate their understanding of how to balance the chemical equations, how to write word chemical equations to symbol chemical equations. • They also shared the knowledge of using different methods of balancing chemical equation.

Challenges pointed out by participants	How TPC addressed the challenges
Difference between breathing and respiration.	The participants were illustrated the knowledge of how to explain these two concepts to during lesson presentations.
The difference between circulatory and respiratory systems.	The in-depth explanations of these concepts were demonstrated by the participants.
Usage of learning and teaching materials when teaching the selected topics.	The participants interchanged the skills of how to select and use relevant learning and teaching materials when teaching the concepts infused in the selected topics.

4.4 CONCLUSION

With the deductions drawn from the findings of this study, I can safely say that collaboration among the Grade 9 NS teachers' fosters professional growth, otherwise, professional teacher development is limited to mere assertions and perceptions. Most teachers specialised in either one or two subjects infused in NS, therefore, they need TPC to augment their subject content knowledge. This is corroborated by Mji and Makgatho (2006), who indicated that NS teachers in South Africa are not qualified to teach this subject either by subject content training or professional qualifications. Nevertheless, TPC can alleviate some of the plethora of challenges experienced by NS teachers. It can also motivate and boost the confidence of teachers when teaching the subject as Philander and Botha (2021) emphasised. Therefore, making TPC mandatory, particularly in subjects like NS, should be one of the considerations to be made by DBE. The summary, conclusion and recommendations of this study are discussed in the following chapter.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In this concluding chapter, I provide the summary of the core research findings of this study in line with the research questions and objectives, and how these findings contribute to the body of knowledge. Furthermore, I make the necessary recommendations and acknowledge the limitations of the study.

5.2 SUMMARY OF THE STUDY

In Chapter One, I orientated the reader into the study. The problem that needed investigation in reference to TPC was introduced and motivated. This was done through the coverage of the introduction, background, problem statement, research questions and objectives. In the chapter, I also motivated the study and gave a brief overview of the research methodology.

Chapter Two presented a review of the literature relevant to the study. It provided the international perspectives on TPC down to the local. This assisted in developing the global perspective about the importance of TPC as a new paradigm that could be embraced to augment the traditional teacher professional development workshops. I also discussed and motivated the context, theoretical, and conceptual framework that I chose for the study.

In Chapter Three, I discussed in detail the research methodology used and its relevance to this study. The chapter covered the research paradigm, approach, methods used for data collection and issues of trustworthiness, reliability, and ethical considerations. An effort was made to motivate the decisions and choices made pertaining to the methods employed. These decisions and choices were backed up with the relevant literature.

Chapter Four presented data analysis and interpretation of the core research findings of this study. The aim of this study was to explore the usage of the teacher professional collaboration approach in developing Grade 9 Natural Sciences teachers' content knowledge. This aim was addressed by achieving the following objectives:

- To establish Grade 9 Natural Sciences teachers' understanding of collaborative professional development.
- To explore the usage of professional collaboration by Grade 9 Natural Sciences teachers to improve their subject content knowledge.
- To assess the Grade 9 Natural Sciences teachers' usage of professional collaboration for effective teaching of the subject.
- To suggest ways through which teacher professional collaboration can be sustained among the Grade 9 Natural Sciences teachers.

An account of how these objectives were achieved through the findings is given below.

5.2.1 First objective: To establish Grade 9 Natural Sciences teachers' understanding of collaborative professional development

The research findings revealed that Grade 9 NS teachers viewed TPC as a teachers' meeting, who work together to share good teaching practices to improve their curriculum delivery in their respective classrooms. The findings further indicated that some teachers believed that teacher-professional collaboration is affiliated with the professional bodies.

5.2.2 Second objective: To explore the usage of professional collaboration by Grade 9 Natural Sciences teachers to improve their subject content knowledge

According to the research findings of this study, the usage of TPC by Grade 9 NS can improve their subject content knowledge. All the participants in this study demonstrated a better understanding of the NS concepts which they did not specialise in after Phase 1

of CAR activities. The teachers were able to explain the NS concepts better during the second phase of CAR as compared to before they were involved in the CAR activities.

5.2.3 Third objective: To assess the Grade 9 Natural Sciences teachers' usage of professional collaboration for effective teaching of the subject

The findings of this study also established that the TPC motivated the Grade 9 NS teachers, improved their confidence and enhanced their teaching. This was demonstrated in the second phase through the CAR activities. The teachers were able to present the lesson plans that they developed collaboratively. These presentations assisted them to augment their NS teaching methodology and strategies.

5.2.4 Fourth objective: To suggest ways through which teacher professional collaboration can be sustained among the Grade 9 Natural Sciences teachers

According to the findings of the study, most Grade 9 NS teachers indicated that TPC can be sustained by using Technology, for example, creating WhatsApp groups and regular virtual meetings. Some teachers like NSt8 believed that professional bodies such as SAASTE can be used to sustain TPC.

5.3 RECOMMENDATIONS

5.3.1 Teachers

Professional interventional programmes for NS teachers should prioritise TPC as a mode of teacher development. Learning along with peers in a group context can be more effective as the findings suggest. NS teachers' subject content knowledge and teaching strategies can vastly improve by working together. In addition, the NS teachers' subject content gaps emanating from non-specialisation can also be mitigated through TPC. The findings also showed that professional collaboration improves teachers' motivation and confidence level in teaching the subject. When teachers are confident in the subject content, they will be motivated and perform better in the curriculum delivery.

5.3.2 Department of Basic Education

This study also recommends that Departmental officials should develop interventional programmes that espouse TPC to achieve their envisaged purpose. The Department should create a conducive environment for TPC activities to take place, e.g., one hour of the notional teaching time per week can be dedicated to TPC, and this can be made compulsory to all schools. This will eradicate 'cocooned' teaching practices among teachers and foster collegiality and mutual trust among them, fanned by the principles of *Ubuntu*. Furthermore, this study recommends that the Department must consider consulting and involving teachers when developing interventional programmes for them, rather than basing them on assumptions. This was stated in the literature review of this study and was subsequently confirmed in the findings. Therefore, this study advocates that when such programmes are implemented, they must be teacher-driven and collaborative in nature.

5.3.3 Further Research

This study also recommends further research on how TPC can be effectively infused in the school hours for better implementation; this will also assist in making teacher professional development to be constant, rather than a periodic or an occasional occurrence. The study discovered that teachers believe that they can constantly communicate through technological applications such as WhatsApp groups and Zoom or Microsoft Teams virtual meetings. This study, therefore, advocates the need to research further the use of technology and technological applications and gadgets for a sustainable TPC, and their implications relative to the inclusion of all schools despite their geographical location, i.e., either urban or rural locations.

5.3.4 Limitations of the study

This research study was qualitative with a sample of ten Grade 9 NS teachers only. Therefore, the findings, though their parts may be widely relevant (King, 2020), they are context-depended. Other contexts may not find it easy to apply them as is. Moreover, the study's scope was limited to a geographical context (Bojanala) in Northwest province,

hence, the findings may not make an obvious fit in other provinces. Pilot and mixed-method studies could help advance research on this phenomenon.

5.4 CONCLUSION

As I conclude this study, I can proclaim that all the research questions of this study were satisfactorily answered. This was done through achieving the research objectives. The importance of TPC in teacher development programmes cannot be ignored. This fosters mutual trust, collegiality, and respect among teachers. Teachers can be resourceful and empower each other by following the principle of *Ubuntu* which can also translate to “each one teaches another”. When teachers work in isolation, they end up competing against each other, which is an undesirable and selfish approach – they may also hide their ignorance under individualism. This study proved that TPC promotes mutual trust among teachers; it is always easier to share one’s professional challenges with trusted colleagues. TPC advocates for interdependence among teachers for better curriculum implementation.

A personal reflection on the study journey

I was a senior education specialist (SES) for Grade 4 to 9 NS teachers in DBE in Northwest Province for eight years. My work was to support teachers and conduct interventional workshops for them, to improve their curriculum implementation. The Department organised content workshops for all the SESs in the province, which we conducted for all the NS teachers in our respective districts in turn. I found out that these interventional workshops were not as effective as intended because the teachers' performance did not improve. Some teachers opted not to attend the workshops and most teachers indicated that these workshops were irrelevant. Due to the large scope of teachers assigned to me to support, I could not reach other schools adequately. I then decided to formulate NS teacher committee groups which I called Professional Support Forums (PSF) wherein teachers were grouped according to their school clusters. Each PSF met once a week and conducted content workshops among each other collaboratively, based on the topics I assigned to them. By the time I met them, I received very positive reports, and the teachers began to perform better in teaching NS, despite their non-specialisation in some NS topics. This inspired me to research TPC. Most importantly, one of the services that the educational service provider of which I am a co-founder gives is professional teacher development, which accentuated my need to research more on using TPC for effective professional teacher development.

The journey of my study was a real rollercoaster. I registered for my master's degree for the first time in 2012 when it was still a limited scope, not a full research master's. I passed all my modules but could not complete them due to personal and financial reasons. I then re-registered in 2020 and then applied for a master's and doctoral University of South Africa bursary. Unfortunately, I was not credited with the modules I passed in the limited scope master's studies; this meant that I had to start again with the full master's degree studies from the beginning.

This was not easy because, at that time, I resigned from the Department of Education in 2017 and was now a full-time entrepreneur, engaged fully in the educational service

provider cited above. I struggled with balancing the time between my studies, the company and taking care of my family.

I am however grateful to my pastor and colleague, Dr. Obilana who was the source of my inspiration in this journey. My family, whose time was sacrificed most, also gave me support and motivation, especially my children, who always teased me and reminded me that I must not fail because I always tell them that I do not have a child who repeats a class.

I am also, thankful for my supervisor, Professor Mishack T Gumbo, who literally took me through my studies step by step. His supervision was so intense such that he would even guide me in the academic language, technicalities and even simple issues such as referencing. He was very prompt in attending to any correspondence or work I sent to him, in some instances he would push me to submit the work or corrections on time.

All in all, finishing this study will mean a lot to me. Firstly, completing this study will be a big motivation since I will finally complete a long journey that I started in 2012. Secondly, many academic opportunities require a master's degree as a minimum requirement that I will be able to take. This degree will be a great achievement for me since I can now enrol for my PhD degree and research further on professional teacher development matters such as TPC usage as I recommended in this study. My family and colleagues, who have been my inspiration and motivators, will also appreciate that the time I spent on writing this research was not in vain.

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Annexure A: Permission letter from North West Education Department.

education
Department:
Education
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

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OFFICE OF THE SUPERINTENDENT-GENERAL

Enquiries: **Mr P Kgatitsoe**
Telephone: **018 388 1046**

TO: **MS KEITUMETSE ELIZABETH MOLOSIWA**
University of South Africa

DATE: 31 MAY 2023

PERMISSION TO CONDUCT RESEARCH: **MS KEITUMETSE ELIZABETH MOLOSIWA**

Permission is hereby granted to you, **MS KEITUMETSE ELIZABETH MOLOSIWA** to conduct research titled "***Developing Grade 9 teachers' Natural Sciences content knowledge through Professional*** *Collaboration*" in the Department as requested, subject to the following conditions:

- Collection of data be accompanied by approval letter as signed by the HOD
- Data collection process should be in compliance to the Covid 19 rules and regulations (if any) as would be proclaimed as at the time of conducting research.
- The Principals of participating schools should be approached with the permission letter signed by the HOD.
- Considering that that your research will involve the educators in the schools as identified, it is required that the general functioning of the school should not be compromised by the research process but instead qualitatively gain the school and system.
- Participation in the project will be voluntary for the 10 educators from the five school as would be consented.
- The principles of informed consent and confidentiality will be observed in strictest terms
- The findings of your research should be made available to the North West Department of Education
- The Department reserve the right to monitor the project at any time when it deems it fit and this
- Including requesting for the findings and information about the project anytime as it would be found necessary and fitting
- The Final Report of the research will be made available to the Department as soon as project comes to an end
- The dissemination of the results shall be to the benefit of the Department and yourself and the institution.

Best wishes

DR SH MVULA
SUPERINTENDENT-GENERAL (ACTING)

31/05/23
DATE

Let's Grow North West Together

Annexure B: Ethical clearance certificate

UNISA university of south africa

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2023/05/10

Ref: **2023/05/10/35212179/31/AM**
Name: Ms KE MOLOSIWA
Student No.:35212179

Dear Ms KE MOLOSIWA

Decision: Ethics Approval from 2023/05/10 to 2026/05/10

Researcher(s): Name: Ms KE MOLOSIWA
E-mail address: 35212179@mylife.unisa.ac.za
Telephone: 078 1477 408

Supervisor(s): Name: Prof Mishack T Gumbo
E-mail address: gumbomt@unisa.ac.za
Telephone: 012 429 3339

Title of research:

Developing Grade 9 teachers' Natural Sciences subject content knowledge through professional collaboration

Qualification: MEd Curriculum and Instructional 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 2023/05/10 to 2026/05/10.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2023/05/10 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 will ensure that the research project adheres to the relevant guidelines set out in the Unisa Covid-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

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3. 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.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. 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.
6. 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.
7. 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.
8. No field work activities may continue after the expiry date **2026/05/10**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2023/05/10/35212179/31/AM** *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 Mpine Makoe
ACTING EXECUTIVE DEAN
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Annexure C: Semi- Structures interview sheet

ANNEXTURE C: SEMI – STRUCTURED INTERVIEW SHEET

Participant: **NSt4**

1. What do you understand by teacher professional collaboration?
My understanding is that when teachers get together to discuss certain topics that they need to teach the learners to improve the learners' understanding and performance.
2. How do you think Grade 9 Natural Sciences teachers can develop and improve their content knowledge through teacher – professional collaboration?
Well, I believe that if we were to have a workshop, all teachers combined, we share different ideas about various topics. We can also use fully elaborated Annual Teaching Plan to share good practices.
3. Do you think that sharing your Natural Sciences teaching experience with your colleagues who are teaching Natural Sciences will improve your classroom practices?
Well, that is a very good question, I think it will give me different teaching strategies, different ways of approaching the balancing of chemical equations, we as teachers balance chemical equations differently, then we will definitely learn from each other. I mean after the CAR activities, I strongly believe that collaboration among teachers is a good thing.
4. What are your views on the idea of Natural Sciences teachers working together to develop lesson plans or learners' formal tasks?
Iyoh! I think that is a great thing because we are the ones in the classrooms. Doing it together will assist us to cover all the needed aspects of a lesson plan, and developing formal tasks will improve the learners' performances. I used to skip some of the chemistry based concepts, because I had no clue about the periodic table or elements, but now it is my favourite topic, thanks to the colleagues who shared their knowledge on these topics with me. I wish we could have these kind of activities regularly, this will

assist us to be more free to share our challenges with our colleagues because I believe that many teachers have the same challenges like I had but they are ashamed to ask. (NSt1).
5. What can you recommend as a sustainable and suitable method that Natural Sciences teachers can use to work collaboratively?
Ok, I believe that if as a teachers we were to meet, maybe twice in a term it will be better. You see, now we are in the fourth industrial revolution era, we can use Technology mediums, maybe virtual meetings to discuss challenges, video conferencing and even WhatsApp groups to actively keep in touch with each other.

Annexure C1: Semi-Structured interviews sheet

ANNEXTURE C: SEMI – STRUCTURED INTERVIEW SHEET

Participant: **NSt1**

1. What do you understand by teacher professional collaboration?
My understanding is that when teachers get together to discuss ideas and struggles that they are experiencing in terms of content and also relating or transferring the content to the learners.
2. How do you think Grade 9 Natural Sciences teachers can develop and improve their content knowledge through teacher – professional collaboration?
Well, like I said, teacher collaboration is sharing of ideas and struggles, like they say, many hands together make the work easier. Different people's understanding of topics how their strategies differs and how they can share them.
3. Do you think that sharing your Natural Sciences teaching experience with your colleagues who are teaching Natural Sciences will improve your classroom practices?
Yes, definitely, what I do in my class may assist you in your class and what you do may help me in my class and what I do in my class may assist you in your class. We as teachers can develop better when we interact. I have seen it in in the CAR activities that I was engaged in.
4. What are your views on the idea of Natural Sciences teachers working together to develop lesson plans or learners' formal tasks?
I believe that lesson planning is ideally an individual task, but however, I now realised that collaborating in lesson planning is also a great thing. There are topics that I now understand better.

5. What can you recommend as a sustainable and suitable method that Natural Sciences teachers can use to work collaboratively?
Natural Sciences is about understanding, science is about understanding. Learners need to see, not only hear. Now that Technology is in an advance stage, we can use them to sustain the collaboration activities.

Annexure D: Lesson Observation sheet

LESSON OBSERVATION SHEET

Lesson features	**Descriptive Evidence**
Lesson introduction and establishment of the learner's prior knowledge.	
Compliance of the lesson to CAPS.	
The involvement and participation of learners in the lesson.	
The unpacking of the concept/s taught and relevance to the grade level.	
Teaching methodology and strategies used.	
The inclusion of science process skills during the lesson.	
The assessment questions posed in relation to Bloom's taxonomy.	
Usage of learning and teaching materials (LTSM).	

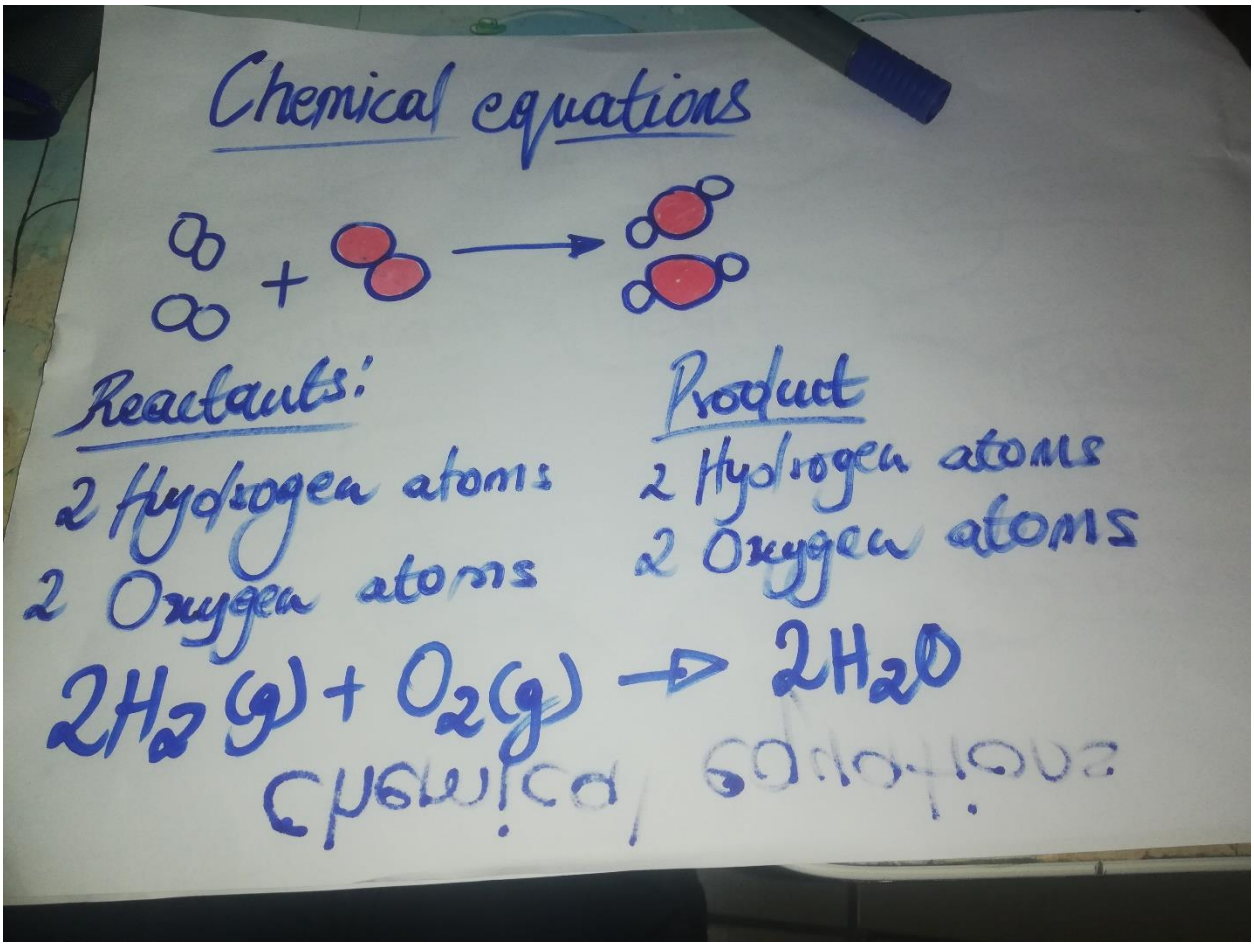
Classroom management.	
Adherence to the lesson time frame.	

Annexure E: Semi-structured interviews questions

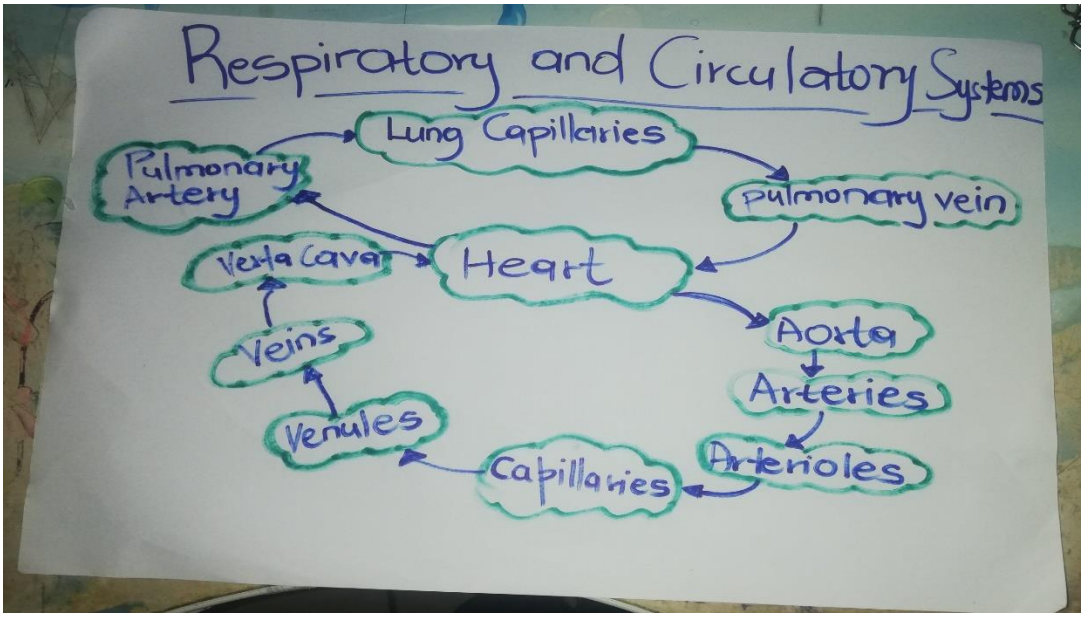
SEMI- STRUCTURED INTERVIEWS QUESTIONS:

1. What do you understand by teacher – professional collaboration?
2. Do you think Grade 9 Natural Sciences teachers can develop and improve their subject content knowledge through teacher – professional collaboration?
3. Do you think that sharing your Natural Sciences teaching experience with your colleagues who are teaching Natural Sciences will improve your classroom practices?
4. What are the views on the idea of Natural Sciences teachers working together to develop lesson plans or learner's formal assessment tasks?
5. What can you recommend as a sustainable and suitable method that Natural Sciences teachers can use to work together?

Annexure F: Chemical equations. (Group A)

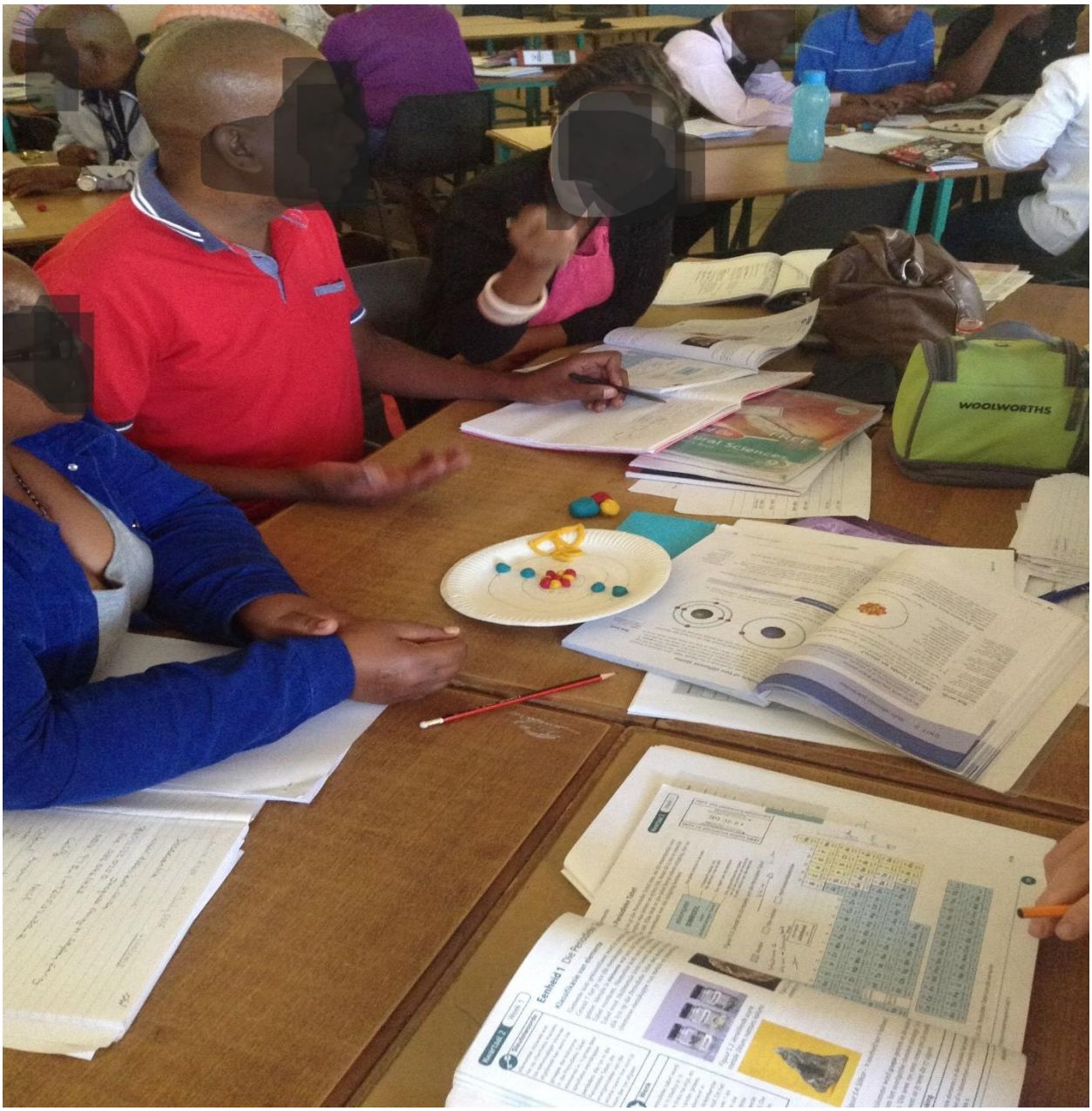


Annexure G: Mind map of Respiratory and Circulatory Systems (Group B)



Annexure H: Body systems fun Activity (Group B)

Annexure I: Group A first lesson planning



Annexure J: Group A – Chemical reaction models

Annexure K: Group B second lesson presentations