THE ROLE OF PROFESSIONAL LEARNING COMMUNITIES (PLCs) IN THE TEACHING OF PHYSICAL SCIENCES PRACTICAL WORK IN DIVERSE HIGH SCHOOL SETTINGS OF THE FREE STATE PROVINCE

SIMON MPHO NDESI

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Supervisor: Dr M.A. Lekhu

Co-supervisor: Prof G.A. Alexander

Dr R.W.Thabane

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Declaration

"I hereby declare that the dissertation submitted for the degree M. Ed: **The role of Professional Learning Communities (PLCs) in the teaching of physical sciences practical work in diverse high school settings of the Free State province**, at the Central University of Technology is my own original work and has not previously been submitted to any other institution of higher education. I further declare that all sources cited or quoted are indicated and acknowledged using a comprehensive list of references".

Ndesi S.M

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Dedication

I would like to dedicate this dissertation to my mother, in recognition for her love, understanding and endless support throughout my studies.

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Acknowledgement

I would like to express my heartfelt appreciation and gratitude to the following people for the invaluable contribution towards the success of this study:

- The almighty God who has given me strength and an opportunity to finish this study.
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Abstract

Researchers have argued for many years that science teaching without hands-on practice in the school science laboratory is useless (Hofstein & Mamlok, 2007). However, practical work has been and continues to be hampered by a variety of contextual variables that prevent productive practical work sessions. Practical work is a very important part or aspect of science education. The current challenge facing Physical Sciences in South Africa, is poor learner performance in especially historically disadvantaged school settings. In the diverse high school settings of the Thabo Mofutsanyana District in the Free State, this study aimed to provide information on the potential contribution that professional learning communities may make to learners' success in physical sciences practical work. In order to frame the participatory research strategy, the study was carried out using a mixed research methodology, an interpretivist research design, and a case study. The study's target group for the physical sciences was the teachers and principals of public schools in the Thabo Mofutsanyana District of the Free State. Within the aforementioned educational district, 8 teacher participants and 2 principal participants made up the final sample after systematic and purposeful sampling approaches were used to try to elicit the qualitative and quantitative information. The process of data production included focus group interviews, semi-structured interviews, direct observations, debriefing sessions, and the distribution of structured or closed-ended questionnaires in order to ensure that both the qualitative and quantitative datasets were acquired. The study was divided into two phases, with the first part focusing on generating the quantitative data through the use of structured or close-ended questionnaires and the second phase involved in collecting the qualitative data through focus group interviews, direct observations and debriefing sessions with teacher participants and semi-structured interviews with the principal participants. While the quantitative section was analysed descriptively, the qualitative data was analysed using a thematic method. Among the key conclusions of the study was that as teachers participate in professional learning communities, they become members of a community that is aimed at supporting their development. At the same time professional learning community as a teaching and learning strategy, its benefits and characteristics discussed in this study will enable teachers to encourage learners to achieve higher levels of success in physical sciences practical work.

Keywords: Learners' academic performance, physical sciences practical work, professional learning communities, science laboratories, teacher continuing professional development

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List of Acronyms

ACE	**Advanced Certificate in Education**
APPs	**Applications**
ATP	**Annual Teaching Plan**
B. Ed	**Bachelor of Education**
CAL	**Computer Assisted Learning**
CAPS	**Curriculum Assessment Policy Statement**
CUT, FS	**Central University of Technology, Free State**
DBE	**Department of Basic Education**
DH	**Departmental Head**
DO	**Direct Observations**
DoE	**Department of Education**
FET	**Further Education and Training**
FGAP	**Focus Group A Participant**
FGBP	**Focus Group B Participant**
FGI	**Focus Group Interviews**
FRIC	**Faculty Research and Innovation Committee**
FS	**Free State**
FSAG	**Free State Assessment Guideline**
FSDoBE	**Free State Department of Basic Education**
ISPFTED	**Integrated Strategies Planning Framework for Teacher Education Development**
NCS	**National Curriculum Statement**
NRC	**National Research Council**
NSF	**National Science Foundation**

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PD	**Professional Development**
PGCE	**Post Graduate Certificate in Education**
PhET	**Physics Education Technology**
PLCs	**Professional Learning Communities**
SA SAMS	**South African School Administration and Management System**
SASA	**South African School Act**
SBA	**School-Based Assessment**
SES	**Subject Education Specialist**
SMT	**School Management Team**
SQ	**Structured Questionnaire**
TMED	**Thabo Mofutsanyana Education District**

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List of Tables

Table 2.1 School-based practical assessment tasks prescribed as formal assessment in the FET band ……30
Table 2.2 Practical skills in physical sciences……34
Table 2.3: Sub-categories of manipulative skills……38
Table 2.4 Differences between the old and new educational approaches in South Africa……45
Table 3.1:Distribution of questionnaires to teacher participants in the four selected schools of Thabo Mofutsanyana district……95
Table 3.2: Participant's code……95
Table 4.1: Gender of teachers (n=8) ……115
Table 4.2. Class size (n=8) ……117
Table 4.3 Highest level of teaching qualification (n=8)……117
Table 4.4: Teachers' viewpoints regarding developmental workshops on practical work……123
Table 4.5 Participants' views on how PLC can be implemented in the FET phase ……129
Table 4.6: Schedule of Focus Group Interviews (FGI) ……135
Table 4.7: Participant's code……136
Table 4.8: Summary of practical experiments together with sessions observed and demonstrated per participant and grade……151
Table 4.9: Practical session performed and demonstrated by the first participant (FGAP1) for the researcher to observe:……153
Table 4.10: Practical session performed and demonstrated by the second participant (FGAP2) for the researcher to observe……155
Table 4.11: Practical session performed and demonstrated by the third participant (FGAP3) for the researcher to observe……157
Table 4.12: Practical session performed and demonstrated by the fourth participant (FGAP3) for the researcher to observe……158
Table 4.13: Practical session performed and demonstrated by the fifth participant (FGBP5) for the researcher to observe:……159
Table 4.14: Practical session performed and demonstrated by the sixth participant (FGBP6) for the researcher to observe:……161
Table 4.15: Practical session performed and demonstrated by the seventh participant (FGBP7) for the researcher to observe:……162
Table 4.16: Practical session performed and demonstrated by the eighth participant (FGBP8) for the researcher to observe:……163

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List of Figures

Figure 4.1: Participants according to gender 115
Figure 4.2: Participants according to age 116
Figure 4.3: Teaching experience in Physical Sciences 116
Figure 4.4: Class size 117
Figure 4.5: Teaching qualification 118
Figure 4.6: Thematic data qualitative approach (model derived from Qualitative Analysis of a National Survey of Paediatric Residents Academic Medicine) 135
Figure 4.7: Framework for the utilization of plc for the development of teachers to improve learner performance. 166

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Contents

Declaration ii
Dedication iii
Acknowledgement iv
Abstract v
List of Acronyms vi
List of Tables viii
List of Figures ix
CHAPTER 1 1
INTRODUCTION AND OVERVIEW OF THE STUDY 1
1.1 INTRODUCTION 1
1.2 BACKGROUND OF THE STUDY 2
1.3 STATEMENT OF THE PROBLEM 3
1.4 SIGNIFICANCE OF THE STUDY 4
1.5 RESEARCH QUESTIONS AND OBJECTIVES 5
1.6 RESEARCH DESIGN AND METHODOLOGY 6
1.6.1 Research paradigm 6
1.6.2 Research Design 6
1.6.3 Methodology 7
1.7 THEORETICAL FRAMEWORK 8
1.7.1 Cooperative learning 8
1.7.2 Constructivist theory 9
1.8 CLARIFICATION OF KEY CONCEPTS 10
1.8.1 National Curriculum Statement (NCS) 10
1.8.2 Physical Sciences 10
1.8.3 Practical work 11
1.8.4 Professional Learning Community (PLC) 11
1.9 DATA GATHERING TOOLS 12
1.10 POPULATION AND SAMPLING 13
1.11 DATA ANALYSIS 14
1.12 MEASURES TO ENSURE TRUSTWORTHINESS, VALIDITY AND RELIABILITY 14
1.12.1 Reliability and Validity 14
1.12.2 Trustworthiness and Credibility 14
1.13 LIMITATIONS OF THE STUDY 15

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1.15 CHAPTER SUMMARY AND DIVISION 16
CHAPTER 2 18
LITERATURE REVIEW – THE ROLE OF PLCs IN PRACTICAL WORK TEACHING 18
2.1 INTRODUCTION 18
2.2 THEORETICAL FRAMEWORK 19
2.2.1 CONSTRUCTIVISM 20
2.2.1.1 Social constructivism 22
2.2.1.2 Cognitive constructivism 24
2.2.2 COOPERATIVE LEARNING 25
2.3 CLARIFICATION OF KEY CONCEPTS. 27
2.3.1 NCS/CAPS: Physical Sciences 28
2.3.2 Practical work in the Further Education and Training (FET) phase 32
2.4 THE ROLE OF PRACTICAL WORK IN PHYSICAL SCIENCES 33
2.4.1 Outcomes of Practical work 34
2.4.2 Skills for Physical Sciences as outlined in the Curriculum Assessment Policy Statement (CAPS) (DoE, 2012) 36
2.5 ISSUES AND CHALLENGES FACED BY PHYSICAL SCIENCES TEACHERS IN TEACHING PRACTICAL WORK 41
2.6 HANDS-ON APPROACH 43
2.6.1 What is a “Hands-on approach”? 44
2.6.2 Situation analysis of hands-on approach in developing countries 46
2.6.3 The hands-on approach in South Africa 49
2.6.3.1 Hands-on and Co-operative learning methods’ value and usefulness for diverse high school settings. 51
2.6.3.1.1 Student teams’ achievement division (PLC) 51
2.6.3.1.2 Team-Assisted Individualisation (TAI) 51
2.6.3.1.3 Teams-Games-Tournament (TGT) 51
2.7 PROFESSIONAL LEARNING COMMUNITIES (PLCs) AS A TOOL IN EXECUTING EFFECTIVE PRACTICAL WORK 55
2.7.1 The concept of Professional Learning Community (PLC) 55
2.7.2 Characteristics of Professional Learning Communities (PLCs) 57
2.7.2.1 Positive interdependence 58
2.7.2.2 Face-to-face promotive interaction 58
2.7.2.3 Individual and group accountability 58
2.7.2.4 Interpersonal and small-group skills 58
2.7.2.5 Group processing 58

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2.8 BENEFITS AND CHALLENGES OF PLCs 59
2.8.1 Supportive and Shared leadership capacity. 59
2.8.2 Collective learning 60
2.8.3 Shared personal practice 60
2.8.4 A commitment to continuous improvement 61
2.8.5 Shared vision 62
2.9 THE ROLE OF A TEACHER AS PART OF PLC 63
2.10 ROLE OF SCHOOL MANAGEMENT TEAM (SMT) REGARDING PLC 68
2.11 CONCLUSION 71
CHAPTER 3 73
RESEARCH PARADIGM, DESIGN AND METHODOLOGY 73
3.1 INTRODUCTION 73
3.2 RESEARCH PARADIGM 73
3.3 INTERPRETIVE RESEARCH DESIGN 75
3.4 PARTICIPATORY APPROACH 79
3.5 CASE STUDY DESIGN 80
3.5.1 Benefits of a case study 81
3.5.1.1 Studies the immediate context 82
3.5.1.2 Allows for Qualitative and Quantitative data analysis 82
3.5.1.3 Explanation of real-life situations 82
3.5.2 Negative aspects of the case study 82
3.5.2.1 Little base for generalisation 82
3.5.2.2 The length of case study design 83
3.5.3 Types of case study designs 83
3.5.4 Characteristics of a case study 84
3.6 RESEARCH DESIGN 85
3.6.1 Qualitative Research Method. 86
3.6.1.1 Advantages of qualitative research approach 90
3.6.1.2 Disadvantages of the qualitative research approach 90
3.6.2 QUANTITATIVE RESEARCH APPROACH 91
3.6.2.1 Advantages of quantitative research approach 92
3.6.2.2 Disadvantages of the quantitative research approach 92
3.7 MIXED METHOD APPROACH 93
3.8 POPULATION AND SAMPLING 93
3.8.1 Sampling 93

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3.8.2 Purposive convenient sampling 94
3.9 DATA COLLECTION TECHNIQUES 97
3.9.1 Focus Group Interviews (FGI) 98
3.9.2 Teacher's workshops (Information sharing sessions) 101
3.9.3 Direct Observations (DO) 101
3.9.4 Structured Questionnaires (SQ) 103
3.10 THE PILOT STUDY 104
3.11 TRIANGULATION 105
3.12 DATA ANALYSIS 107
3.12.1 Qualitative data analysis: Thematic analysis for the qualitative data section 107
3.12.2 Descriptive data analysis for the quantitative section 109
3.13 QUALITY CRITERIA 109
3.14 ETHICAL CONSIDERATIONS 111
3.15 CONCLUSION 112
CHAPTER 4 113
DATA ANALYSIS AND INTERPRETATION 113
4.1 INTRODUCTION 113
4.2 ANALYSIS, INTERPRETATION AND DISCUSSION OF FINDINGS FROM THE QUANTITATIVE SECTION OF THE STUDY 114
4.2.1 Introduction 114
4.2.2 Frequency and percentage distribution of biographical information of teacher participants 114
4.2.2.1 Teacher participants according to gender 115
4.2.2.2 Teacher participants according to age 116
4.2.2.3 Teaching experience in Physical Sciences 116
4.2.2.4 Class size taught 117
4.2.2.5 Highest level of teaching qualification 117
4.2.3 Quantitative analysis of biographical information 118
4.3 FREQUENCIES AND DESCRIPTIVE STATISTICS FOR STRUCTURED QUESTIONNAIRE QUESTIONS (Section B of the questionnaire) 120
4.4 ANALYSIS, INTERPRETATION AND DISCUSSION OF FINDINGS FROM THE QUALITATIVE DATA SECTION. 134
4.4.1 Thematic approach for qualitative data analysis 134
4.4.2 Data from the Focus Group Interviews (FGI) discussion 135
4.4.3 THEME 1: Self-perception on practical work (confidence in using equipment and materials). 137

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4.4.4 THEME 2: The motivation for using Professional Learning Community (PLC) to improve learners' performance..... 139

4.4.4.1 Subtheme 2.1: The use of applications (APPs) or programs to improve learner performance...... 141

4.4.4.2 Subtheme 2.2: Obstruction to the implementation of APPs/programs and their 142

influence on improving learners' performance on practical work. 142

4.4.5 THEME 3: Professional development strategies necessary for the implementation of PLC and improving learners' performance. 143

4.5 DATA FROM SEMI-STRUCTURED INTERVIEWS WITH THE PRINCIPAL PARTICIPANTS 145

4.5.1 Leading in schools 145

4.5.2 Leadership approach 146

4.5.3 Improvement and sustainable academic improvement 148

4.5.4 How to lead to positively affect academic improvement..... 148

4.6 FINDINGS FROM DIRECT OBSERVATIONS 149

4.7 PRESENTATION AND INTERPRETATION OF DIRECT OBSERVATIONS..... 153

4.8 MEASURES TO ENSURE TRUSTWORTHINESS 165

4.9 PROPOSED FRAMEWORK FOR THE ROLE OF PLC IN TEACHING 165

PRACTICAL WORK TO IMPROVE LEARNER PERFORMANCE. 165

4.9.1 Discussion for the framework for the role of PLC in teaching practical work to improve learner performance (Fig. 4.7) 166

4.10 CONCLUSION..... 167

CHAPTER 5..... 168

DISCUSSION OF FINDINGS, RECOMMENDATIONS AND CONCLUSION 168

5.1 INTRODUCTION 168

5.2 RESEARCH FINDINGS..... 168

5.3 RESEARCH QUESTIONS' FINDINGS 169

5.3.1 MAIN RESEARCH QUESTION FINDINGS: How can PLCs be used to improve the learners' performance in practical work of physical sciences?..... 169

5.3.2 What notions do FET teachers attach to PLCs, specifically in the South African context? 170

5.3.3 Findings regarding research question 2: What are the issues and challenges faced by teachers when attempting practical work in FET science? (cf. 2.5, 2.8, 4.3.1 and 4.3.5) 173

5.3.4 Findings concerning research question three: Which strategies for processing may be used to implement PLCs for practical work in FET science? 174

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5.4 RECOMMENDATIONS FOR THE STUDY 175
5.4.1 Recommendations for the Free State Department of Basic Education (FSDoBE) (cf. 2.10 and 4.3.3). 175
5.4.2 Recommendations for the Principals and SMT (cf. 2.10). 176
5.4.3 Recommendations for physical sciences teachers (cf. 2.9). 177
5.5 LIMITATIONS OF THE STUDY 177
5.6 RECOMMENDATIONS FOR FURTHER RESEARCH 178
5.7 CONCLUSION 178
REFERENCE LIST 179
ANNEXURE A 211
A letter to the Principal asking permission to conduct research 211
ANNEXURE B 212
INVITATION LETTER TO ALL PARTICIPANTS 212
ANNEXURE C 213
INFORMED CONSENT LETTER TO THE TEACHERS IN THABO MOFUTSANYANA DISTRICT 213
ANNEXURE D 218
STRUCTURED QUESTIONNAIRE COVER PAGE 218
ANNEXURE E 219
Questionnaire (A1) 219
ANNEXURE F 222
QUESTIONNAIRE (A2): STRUCTURED QUESTIONNAIRE 222
ANNEXURE G 228
FOCUS GROUP INTERVIEWS: DISCUSSION QUESTIONS 228
ANNEXURE H 229
OBSERVATION SHEET AND NOTES 229

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CHAPTER 1

INTRODUCTION AND OVERVIEW OF THE STUDY

1.1 INTRODUCTION

In this study, professional learning community (PLC) is used as a cooperative learning technique to investigate its impact on improving learners' weak performance in physical sciences practical work in diverse high school settings in Free State Province, South Africa. Investing in its teachers' professional learning communities (PLCs) will help the Department of Education (DoE) improve success in physical sciences practical work. Ineffective learner success in physical sciences practical work in grades 10–12 has been linked to a number of factors (DoE, 2013).

For a number of factors, South Africa needs to increase the success rate of physical sciences practical exams. One significant concern is that a high percentage of physical sciences graduates will result in more educated fields like engineering and medicine, and thus a more productive workforce (Van der Wende, 2015). The best indicators of learner success are teachers and the quality of their teaching, so investing in PLCs may improve learner performance (Fraser-Abner, 2012).

In the context of this study, a PLC is described as a collective learning process that occurs in a school setting where teachers have a mind-set about their teaching as well as contributing to the organization's shared goals in cooperation with colleagues (Huijboom, Van Meeuwen, Rusman & Vermeulen, 2020). PLCs in education operate in complex and dynamic contexts, and by participating in PLCs, teachers actively engage in improving their teaching practise, which can ultimately lead to learner achievement (Sleegers, 2013 & Hairon, 2015). Chetty, Friedman, and Rockoff (2014) assert that teachers influence the achievement and lifelong success of their learners. Therefore, the researcher is of the opinion that PLC can enhance learners' success in physical science practical work in the South African province of the Free State.

A few factors that limit learners' ability to improve their performance in physical sciences practical work include a lack of resources, inadequate time to complete the curriculum, the exclusion of practical work, and learner involvement (Pretorius, 2013). Teachers significantly influence what learners learn in terms of knowledge and skills, and they also help learners get over hurdles so that they can thrive in science-related hands-on work (Rice, 2003). As a result,

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professional learning communities are essential for teachers to join if they want to advance professionally and work together to find solutions to issues that arise in the classrooms.

“Hands-on” practical work, often defined as typical laboratory work where learners are exposed to ideas and principles first-hand (Yager, 2011), is rarely done in various school settings and therefore contributes to limited understanding of physics concepts (Johnstone & Letton, 2011). Van der Linde, Van der Wal, and Wilkinson's (2004) research demonstrates that technical and other scientific careers are underrepresented in schools in developing nations, including the South African context. In this sense, creating learners for technical and other scientific careers should be primarily dependent on effective physical science practical work teaching at the school level.

1.2 BACKGROUND OF THE STUDY

How South African teachers conceptualize teaching practical work is impacted by the lack of physical science laboratories. (DoE, 2013). Since practical work is primarily taught and promoted in rural areas where the researcher did the investigation, the majority of underprivileged schools lack laboratories, which results in ineffective teaching and poor learner performance. Other factors that influence how poorly learners perform in physical sciences include inadequate infrastructure in various schools, a lack of suitable apparatus and equipment, and ineffective teaching and learning methodologies for practical work.

South Africa's Republic is experiencing a very dire scenario. Numerous studies have demonstrated that learners struggle with practical work in the physical sciences (DBE, 2012), and official provincial assessments that evaluate learners based on their practical work frequently produce poor results from the first to the last term. The Curriculum Assessment Policy Statement and the Action Plans to Realize Schooling in 2025 and 2030, among other policies, have been implemented by the South African Department of Basic Education (DBE), according to Spaull (2013), to address some of the main reasons for the educational system's underperformance (CAPS).

This study may have a social impact on society at large since the role of practical work in a social sense develops the “scientific literacy” of all learners (Abungu, Okere & Wachanga, 2014). Noting the issues around active citizenship, employment, holistic development, socio-economic development, and environmental development in South Africa, this study will assist in providing the foundation for the further study of science for those learners who wish to follow careers that require scientific knowledge.

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1.3 STATEMENT OF THE PROBLEM

This research was motivated by the low percentage of learners passing physical sciences practical exams in the Further Education and Training (FET) band (grades 10–12), which has a negative impact on learner' lowest-ever School Based Assessment (SBA). According to previous research, South Africa was the country that performed the worst globally in terms of the standard of mathematics and sciences teaching (Gernertzky, 2012). Many European and African nations, including Tanzania, that did away with practical exams at one time had poor performance in science and mathematics (Punch, 2015).

Despite this, South Africa does not plan to phase out practical work because laboratory work is valued highly, which is why PLC is being used to address this issue. In the South African setting, prescribed practical tasks are examined at the district level even though they are not evaluated at the national level. Can the professional learning community be used as a strategy to boost learners' poor performance, where teachers' cooperation and exposure to scientific tools may be a remedy to ease this issue? How much of an effect might the PLCs have? These questions were looked into and addressed in this study.

According to the researcher, all learners of physical sciences, particularly those who intend to continue their education in higher education institutions' engineering, science, and technology departments, require a foundational understanding of practical work. Practical work is fundamental and necessary to the teaching and learning of physical sciences (Koponen & Mantyla, 2016). Practical work helps learners build their knowledge and apply their understanding of the physical sciences by fostering scientific inquiry and problem-solving skills in them (DBE, 2017). It can direct learners toward constructive and conceptual growth while also assisting in their development as informed and skilled scientists (O'Brian, 2015). It was also discovered that learners who had hands-on experience performed better and had superior knowledge (Ma & Nickerson, 2016).

South African School Administration and Management Systems (SA-SAMS, 2018), in the school where the researcher works, indicates that poor learner performance in physical sciences grades 10-12 remains a critical factor in the provision of quality teaching and learning of physical sciences practical work. The researcher has seen poor learner achievement in physical sciences practical work generally for quite some time as a seasoned physical sciences teacher for more than ten years. Quarterly tests and half-year exams account for 40% of learners' final School-Based Assessment (SBA), while practical work makes up 60%. Although learner performance in most subjects has improved, it has remained poor in the

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physical sciences because of the practical work, which is a major contributing factor to learners' SBA (DBE, 2017).

The Curriculum Assessment Policy Statement (CAPS) document for physical sciences in South Africa highlights that the teaching time for both the theory and practical part of physical sciences grades 10-11 is 75% of 160 hours per year and 65% for grade 12, there is no specific time assigned for practical work only. In order to include practical work, teachers will need to come up with creative methods to divide the time allocated for the subject. However, many teachers have voiced serious concerns about the usefulness of practical instruction for imparting science knowledge when coupled with an already dense theoretical Annual Teaching Plan (Millar, 2014).

The study focused on Professional Learning Communities (PLCs); a cooperative learning strategy used by teachers to assist learners in enhancing their success in physical sciences practical work. Physical sciences practical work in the FET phase has been the focus of the researcher's investigation into the efficacy of PLC as a teaching and learning strategy. The investigation looked into how PLC can help learners perform better on practical assignments. The researcher believes PLC might be a good way for teachers with widely disparate academic backgrounds and cultural, racial, or ethnic backgrounds to cooperate. Professional Learning Communities (PLCs) have hardly ever been researched as a substitute method of teaching practical work as a component of physical sciences in South Africa. Therefore, it is crucial to look into and consider how PLC might help to raise learner achievement.

1.4 SIGNIFICANCE OF THE STUDY

This study intended to observe how teachers developed through interactions in the professional learning community and how this might improve learners' poor performance in practical work in the physical sciences. The study's objective was to assess the efficiency of PLC for imparting practical knowledge at secondary schools that had been hand-picked in the Thabo Mofutsanyana Education District (TMED) of the South African Free State province. The study also attempted to identify any deficiencies and offer suggestions on how these problem areas could be resolved if it was found that the practical work method of the physical sciences needed to be given more attention.

Teachers of physical sciences who are working in the classroom today and in the future—possibly unsuccessfully—after years of trying to complete practical work—might find this study to be helpful. Teachers could describe the kind of extra assistance that is needed in the

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province for them to successfully teach practical work in the physical sciences. Additionally, the results of this study may be very helpful in determining the merits and shortcomings of their PLC-based teaching strategies.

Teachers who participated in the study may think about the relationship between their teaching methods and that of others. This could influence how they present the physical sciences, especially practical work. The social impact of this study was to increase all learners' scientific literacy as a means of preparing them for careers that demand civic responsibility as well as for employment, holistic development, socioeconomic development, and environmental development. It also laid the groundwork for further study in the field of science for those students who might be interested in doing so.

1.5 RESEARCH QUESTIONS AND OBJECTIVES

The purpose of this study was to address the following primary research question:

- How can PLCs be used to improve learners' performance in the practical work of physical sciences?

To make the research question more flexible, the researcher divided the topic into smaller questions (Leedy, 2016). The following sub-questions were the most effective in expressing the main focus of the study topic under the inquiry because resolving them will ultimately address the main problem.

- What notions do FET physical sciences teachers attach to PLCs, specifically in the South African context?
- What are the issues and challenges faced by physical sciences teachers when attempting practical work in Further Education and Training (FET) science?
- Which strategies for the process may be used to implement PLCs for practical work in FET physical science?

This study aimed to make use of the physical sciences PLC that is currently in place for teachers in the researcher's region, which is circuit 6 of TMED in the Free State. To help learners perform better on practical work in the physical sciences, teachers can offer strategies, teaching and learning techniques, or ideas.

Along with the main goal, the following secondary goals and targets were carried out:

- To ascertain the notions FET physical sciences teachers attach to PLCs when attempting practical work.

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- To investigate the issues and challenges faced by physical sciences teachers when attempting practical work in FET science.
- To suggest strategies to possibly be used to implement PLCs for practical work in FET physical sciences.

1.6 RESEARCH DESIGN AND METHODOLOGY

A particular paradigm determines the type of research questions asked at the onset of the study, that which can be observed or investigated, the methods of data collection suitable for the study and, finally, how the findings will be interpreted. In the next section, the methodology and design of the study will be presented.

1.6.1 Research paradigm

A paradigm is a perspective on the universe (Mertens, 2015). In this research, the interpretive paradigm—which is based on the social constructivist worldview—was employed. Participants are supposed to be able to interpret the phenomenon. The description of a paradigm is aided by three concepts, claim Denzin, Lincoln, and Guba (in Brownwyn, 2011). Methodology, theory, and ontology are these. The following provides a brief explanation of each of these ideas:

- Ontology explains how we view the nature of reality.
- Epistemology discusses the best methods for examining the nature of the world, what knowledge is, and its sources and boundaries.
- Research access and reporting procedures are described in the methodology.

This study's case study methodology allowed for the gathering of qualitative data. Understanding a specific social circumstance is the goal of qualitative research (Creswell, 2016). The goal of qualitative research is to comprehend or interpret phenomena in terms of the meanings that people assign to phenomena as they occur in the real world. In this study, the researcher had direct interactions with the participating physics teachers and also watched their behaviour. Additionally, Creswell (2014) emphasizes that the researcher must depend as much as possible on the participants' point of view.

1.6.2 Research Design

The study's explanatory sequential mixed-methods design was built on case studies. A mixed-methods research design is defined by Creswell (2015) as "a research approach in the social, behavioural, and health sciences in which the researcher collects both quantitative (closed)

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and qualitative (open) data, integrates the two, and then draws interpretations based on the combined strengths of both data sets to understand research problems." The second qualitative method of data collecting was developed by the researcher using quantitative survey tools or questionnaires in the initial part of the study. The questionnaires given to physics teachers provided the majority of the quantitative data. A qualitative technique was adopted in the second phase of the study. The majority of the qualitative information came from interviews with four selected secondary schools' teachers and two principals. According to Gay, Mills, and Airasian (2016), qualitative research is conducted in the setting where the event under study manifests itself. Creswell (2016) and Grey (2009) both claim that a variety of underlying philosophical presuppositions, research methods, and techniques are used in qualitative research in order to collect, analyse, and evaluate data. Qualitative research seeks to gather comprehensive descriptive information about a particular phenomenon or setting in order to better understand what is being seen or examined.

Qualitative study is also a way to discover and comprehend the significance that individuals or groups attribute to a social or human issue. Accordingly, the researcher assumes that he will follow the guidelines of the latter authors to elicit the views and opinions of the participating teachers in the established professional learning community for physical sciences in the FET phase in the hope or possibility of improving the performance of the learners.

1.6.3 Methodology

The methodology is a well-coordinated collection of complimentary techniques that are properly arranged to communicate data and outcomes (Leedy & Ormrod, 2010). A sequential mixed methods research strategy was used in this study. By looking at what PLCs can do to help teachers who are struggling with teaching physical sciences practical work, mixed methods not only enable the researcher to comprehend the processes and sociocultural contexts. Participants in the qualitative sample were able to respond to the qualitative questions, and the results from the quantitative phase also aid to answer the questions posed in the qualitative sample (Creswell, 2015). Research methodology, according to Newby (2014), is defined as "the assembling of research instruments and the application of appropriate research rules."

An interpretive and methodological participatory research strategy was used because the researcher had prior experience working as an in-service teacher (FET) in the science field. These techniques were used to give learners an in-depth knowledge of the PLC's function in the teaching of practical work in the physical sciences classroom (Creswell, 2012). Additionally, the researcher was interested in investigating the use of an interpretive study, comparable to other PLC research studies. In order to better understand how PLC can be

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used as an instructional strategy to enhance practical job performance, qualitative inquiry was used.

1.7 THEORETICAL FRAMEWORK

The fundamental theory that informs the study's point of view is known as the theoretical framework (Niss, 2016). It is the structure that can sustain or support the theory of a research investigation because it introduces and specifies the theory that explains how and why the research issue emerges. Theories assist in comprehending social methods, performance, relationships, and behaviours as well as the duties of teachers at the workplace to realise and attain institutional goods or objectives. A theoretical framework, according to Henning, Van Rensberg, and Smit (2015), is a perspective that the researcher uses to situate their study. It mimics the point of view the researcher adopted, framing this effort and establishing a conversation between the study and the literature.

The following theories, which have previously been employed to enhance learners' academic performance, are referenced in this study. Cooperative learning theory and constructivist theory, which each explain various parts of the study, served as the study's theoretical guiding principles. While constructivist theory is used to acquire insight into the efficient teaching of practical work, cooperative learning theory is used to evaluate PLC effectiveness. The extensive review of the literature in chapter 2 provides a more in-depth explanation of the theories as they are intended to be applied in this research.

1.7.1 Cooperative learning

Cooperative learning is described as group effort toward a common goal (Snowman, 2013). This definition is also supported by Lemmer, Meier and van Wyk (2012) who argue that it occurs when teachers in small groups work together and assist each other in instructional activities. This view of cooperative learning is expressed differently by Zraa, Kavanagh and Morgan (2013) who suggest that cooperative learning is all about teacher empowerment and that teachers who have been properly empowered and developed do not only achieve greater content learning but also demonstrate competencies such as communication, teamwork and problem-solving.

The core of cooperative learning is that it provides real-world, purposeful interaction to help teachers learn how to work with and learn from a diverse group of people within a learning community. Similarly, Khan, Murtaza and Shafa (2012) point out that this strategy also

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regularly produces new ideas and solutions; teachers develop high levels of reasoning and the transfer of knowledge and information occurs more effectively from individual teachers to the group and *vice versa* than can be achieved by any other type of learning.

The use of cooperative learning as a teaching strategy significantly affects learner motivation. In eleven studies that assessed the effect of cooperative learning as a teaching strategy on the motivational levels of elementary-grade learners, Ginsburg-Block et al. (2008) found moderate to strong effects. These studies included 73.33% of the study sample. As a result, regardless of what the lesson plan calls for, teachers should be able to modify and tailor their pedagogical approaches to the circumstances at hand and the requirements of their learners.

The building concept used in both cooperative learning and PLC is relevant to the framework selected for physical sciences PLC. Snowman et al (2009) postulate that PLC is one of the simplest and most effective methods of co-operative learning that has been used in Grades 2-12 in various subjects in the United States of America. This is further substantiated by Anto, Padmadewi and Putra (2013) who acknowledge that PLC is the simplest cooperative learning strategy that can improve learners' motivation to actively engage in learning. It is in light of this discovery that Anto et al (2013) recommend PLC for learners' performance improvement.

In the same breath, the researcher considers teacher collaboration and productive interaction among teachers as integral parts of a teaching strategy which is based on cooperative learning. Cooperative learning encourages the development of teachers' self-esteem, positive interdependence and sharing. Teachers can easily develop high self-esteem when they know that their contributions, ideas and opinions are just as valuable as every group member.

1.7.2 Constructivist theory

As a theoretical framework to teach practical work in this study, constructivism has also been used. A learning theory known as constructivism is based on the notion that learners actively create information (Chinn, 2009). It appears to place more emphasis on the involvement of the learner in formulating, deliberating, and using reasoning to analyse material (Kalpana, 2014). Constructivist theory is founded on the idea that learners develop their conceptual knowledge and domain-specific expertise through their actions (Fleury, 2008).

The researcher contends that it is the duty of physical sciences teachers to promote a learning atmosphere that is conducive to absorbing scientific knowledge. The purpose of this setting is for learners to link their information, use tools, make assumptions, and experiment in order to develop practical knowledge. The theory that seems to be most appropriate for this aspect of education is constructivism. According to Williams and Chinn (2009), the central concept of

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constructivism is that learners actively construct their own knowledge and meaning from their experiences by observing various things around them and making sense of those things in a particular learning context. In an attempt to explain new findings and progress, this study aims towards the development of strategies to be used for implementing PLCs in the physical sciences.

1.8 CLARIFICATION OF KEY CONCEPTS

The following key concepts are defined briefly to help readers comprehend this study's main points:

1.8.1 National Curriculum Statement (NCS)

The NCS Grades R-12 serves as a policy statement for learning and teaching in South African schools and consists of the following documents: Curriculum Assessment Policy Statement (CAPS) for all subjects approved for South African schools; National Policy regarding the programme and promotion requirements of the NCS Grades R-12; and National Protocol for Assessment Grades R-12 (DBE, 2011).

In the NCS Grades R–12, emphasis is placed on the development of the knowledge, skills, and principles that are recommended for learning in South African classrooms. It also aims to make sure that learners acquire and apply knowledge and skills in a manner that is pertinent to both local and global standards. The NCS Grades R–12 is further based on the tenets of social transformation, active and critical learning, increased knowledge and skills, progression of content and context for each grade, inclusivity, environmental and social justice, value of indigenous knowledge systems, and credibility, quality, and efficiency (DBE, 2011).

1.8.2 Physical Sciences

In contrast to the life sciences, the study of non-living processes is covered by the physical sciences, which is classified as natural sciences. It is the area of study that examines the fundamental nature and characteristics of energy in relationship to any non-living substance. The physical disciplines include physics, chemistry, geology (earth science), and astronomy (Imperial, 2013). Physical sciences is a field that examines physical and chemical events, according to the South African CAPS document.

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In order to use and responsibly maintain the physical environment, society must have a working knowledge of how it works. All available scientific and technological knowledge is used to handle societal problems, including Indigenous Knowledge Systems (IKS). IKS is the knowledge that communities have held, used, or are still using. It has been passed down through generations and has been a source of several discoveries and breakthroughs, including scientific advancements.

1.8.3 Practical work

Many times, practical work is compared to traditional laboratory work, where learners are exposed to concepts and principles first-hand. According to Yager (2011), a typical lab may not even be a laboratory. The phrase could be used to represent a setting where learners can put their theories and/or explanations for what they have seen to the test as they pursue their curiosity about the universe they are currently living in. According to Tamir (2008), science learners should use the lab to do practical tasks like observations and experiments, not just to confirm but also to find information.

In FET physical sciences classes, "practical work" can apply to both hands-on and mental activities, like laboratory experiments. In the event that learners engage in distant practical work, they would be able to watch practical work on film or television without getting their hands dirty. Additionally, the teacher might conduct a hands-on exercise in front of the class. Learners can participate by listening carefully, asking questions, and giving answers. Practical work could include a variety of experiments or studies carried out by learners alone or in groups, as well as teacher demonstrations (Van der Linde, Van Der Waal & Wilkinson, 2004).

1.8.4 Professional Learning Community (PLC)

A professional learning community is a collection of teachers who frequently congregate, exchange knowledge, and work together to improve both their instructional strategies and the scholastic performance of their learners (Barth, 2016). Additionally, it is viewed as a deliberate strategy for school improvement meant to encourage greater faculty cooperation, reduce professional isolation, and spread individual teachers' knowledge and perspectives throughout the entire organization (Hord, 2014). The expression is frequently used to characterize educational institutions or colleges that foster professional development through close collaboration in small groups.

PLC, according to Hargreaves and Fink (2006), has two main goals. By working together, sharing knowledge, and engaging in professional discourse, teachers can first advance their

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knowledge and abilities, and then learners' educational ambitions, performance, and attainment can be raised thanks to better teaching and leadership. PLC frequently serves as a type of action research, which is a way to continuously review, reassess, hone, and enhance teaching methods and knowledge. Teams in PLCs frequently have shared duties or responsibilities. The following are a few examples of typical activities that may occur at meetings, while the activities and aims of a PLC may vary depending on the PLC grouping:

- Discussing teacher work: Participants look over lesson plans or assessments that have been used in class and provide constructive criticism and suggestions for advancement.
- Talking about learners' work: Participants talk about learner work examples and make suggestions for how lessons or teaching methods may be changed to raise the calibre of learners' work.
- Discussing learner data: Participants examine learner-performance data from a class to spot trends, such as which learners are routinely failing or underperforming, and work together to devise proactive teaching and support measures to assist learners who may be having academic difficulties.
- Discussing professional literature: Participants select a text to read, such as a research study or an article about a specialised instructional technique and then engage in a structured conversation about the text and how it can help inform or improve their teaching.

1.9 DATA GATHERING TOOLS

According to Creswell and Plano Clark (2011), the phenomenological method calls for a direct approach to data collection; as a result, qualitative data-gathering tools were employed in this research. Open-ended qualitative grounded questionnaires for teachers were developed as a consequence. In addition to semi-structured interviews, focus groups, and observation schedules, the participants were also interviewed using open-ended qualitative surveys. In order to enable reflection and analysis, phenomenology seeks to identify the essence of lived events (Creswell, 2008).

To watch teacher participants' presentations as PLC members, the researcher created observation schedules. According to McMillan and Schumacher (2012), observation allows the researcher to hear and see what naturally occurs at the study location. In general, the

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nature of observation is comprehensive in that it is ongoing and open to anything that might be important, and field notes are documented and considered.

PLC groups' interviews were conducted using semi-structured interview schedules in order to gather statistics. The group interviews were used to acquire in-depth knowledge of their interpretation of the phenomenon, whereas the observation schedules were employed to obtain the opinions and views of other teachers regarding their experiences as they observed other teachers' presentations in teaching physical sciences practical work.

1.10 POPULATION AND SAMPLING

Sampling involves choosing a small part of the community to act as a representative sample for the study's overall population (Cohen, Manion & Morrison, 2013). A sample, in Robson's definition, is a group of individuals chosen at random from the complete population to allow for the development of fair generalizations (Robson, 2007). Purposive sampling, in the opinion of MacMillan and Schumacher (2012), selects cases with an abundance of data to enable a comprehensive analysis. The researcher employed purposive sampling in order to locate the most plentiful data source for this study (Yin, 2011).

In quantitative research, the sample must be impartial and accurately reflect the community from which it is taken, so purposeful sampling is crucial to the design of this study. The selection of a sample in qualitative research can be influenced by a variety of variables, such as how easy it is to contact potential participants, whether you believe the participant has extensive knowledge about the episode, event, or situation of interest, how typical the case is for the group of people it belongs to, or simply that it is completely unique from the others.

Homogeneous sampling, a type of purposive sampling relevant to this study, concentrates on the sub-group in which all sample members share a common trait, such as a particular profession or hierarchy level within an organization (Saunders, Lewis & Thornhill, 2012). Since the teachers chosen are always accessible and have a positive attitude toward this research, purposeful sampling is especially pertinent in this study.

It was impractical and unnecessary to measure every member of the target group due to the large number of secondary schools in TMED in the Free State, South Africa. For this research, eight physical sciences teachers (two from each school) were selected as a sample from four (4) schools.

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1.11 DATA ANALYSIS

Group and semi-structured interview recordings were transcribed, organized categorically, repeatedly evaluated, and continuously coded (Creswell, 2009). Written reports from participants were coded, then the results from the recordings were contrasted.

1.12 MEASURES TO ENSURE TRUSTWORTHINESS, VALIDITY AND RELIABILITY

It is important to mention that quantitative and qualitative research studies have different approaches to assess the quality of the study. Both quantitative and qualitative methodologies were used in this stud, and therefore the concepts of validity and reliability were considered and discussed in the following section.

1.12.1 Reliability and Validity

According to reliability, the researcher's methodology is constant across various study projects and studies, as a result researcher should record as many reliability procedures stages as they can (Creswell, 2009). The degree to which a questionnaire reliably measures what it is supposed to measure is known as reliability (Creswell, 2009). In this research, consistency related to the use of the same questions in a questionnaire for participants in order to measure the effect that interventions had on knowledge improvement.

When discussing validity, it's important to consider whether participants' statements could be used to derive meaningful and practical conclusions (Maree & Pietersen, 2010). In order to meet the requirements of various kinds of validity, the researcher made sure that the research questionnaires, interview schedules, and observation checklists covered all the aspects of the various variables of this study.

1.12.2 Trustworthiness and Credibility

The ability of the researcher to persuade readers that the study's results are significant and that the research is of a high calibre is how Maree (2007) defines credibility. In other words, the trustworthiness of a particular research study refers to the extent of its dependability and precision. Credibility and dependability are related in this situation. Credibility refers to the extent to which it is possible to state with certainty that a researcher's conclusions are supported by the data and should be presented and discussed precisely as they were gleaned from the participants.

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According to Kumar (2014), credibility also alludes to the situation in which the participants in the research study accept the findings from qualitative research. As a result, the researcher agreed to collect and present the participant data in this study in an ethical way without removing, altering, or adding anything without consent. As a result, it is feasible to present the results as true, reliable, and adaptable.

1.13 LIMITATIONS OF THE STUDY

The research was conducted at the four selected secondary schools in the Free State province of South Africa's Thabo Mofutsanyana District (TMED). Amongst other reasons, the research was conducted for the purpose of deeper understanding because of the learners' poor performance in the TMED district in physical sciences practical work, the school setting, the teachers, and the teachers themselves. Other provinces or districts are not affected by the circumstance. Because of this, the findings are specific to a small number of secondary schools in the TMED, circuit six area and are therefore not generalizable to other institutions or regions.

This research only focuses on the PLC approach to cooperative learning and teaching in the FET phase. The prerequisite for this research supports the notion that studying PLC as a cooperative learning strategy and teaching approach is limited to changing the methodology and giving physical sciences teachers FET training. The primary subjects of this research are the learners, teachers, and principals of the Free State Department of Education. The study's geographic scope is constrained to FET classes in the circuit where the researcher teaches physical sciences.

It is assumed that the participants (i.e., teachers and principals) responded honestly, correctly, and to the best of their knowledge to the open-ended questions on the questionnaires and during the interviews based on their own experiences. The research was conducted over 8 weeks in order to evaluate the variability and stability of effective physical sciences teaching in practical work by PLC. This was done to improve learner performance in the TMED area.

1.14 ETHICAL CONSIDERATIONS

Permission to gather data was sought from the Free State Department of Education, the principals, departmental heads and teachers at the chosen schools, and Central University of Technology, Free State.

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Prior to the distribution and administration of questionnaires, interviews and observations, each participant's informed consent was acquired.

Anonymity and Confidentiality: Participants were given verbal and written guarantees that the information would be kept completely private and confidential to maintain confidentiality. Despite asking participants to sign a consent form, the researcher did not use their names when disclosing study results (see Annexure C).

1.15 CHAPTER SUMMARY AND DIVISION

Background information on the study was introduced in this chapter (Chapter 1). Additionally, it included a description of the study's objectives, goals, and research challenge. The methods and research design for this study were also stated by the researcher. This chapter's primary goal was to give an enlightening and thorough overview of the study. The researcher's commitment to following the ethical guidelines and standards for carrying out academic research established by the Central University of Technology, Free State, was also stressed in this chapter to highlight the ethical issues covered in this study.

In Chapter 2, the literature on PLCs' usage in teaching physical sciences practical work in the diverse high school settings in the Free State is reviewed. To give the researcher a comprehensive understanding of PLC and practical work teaching, resources from the CUT, FS library, including journals, textbooks, virtual research protocols, and internet resources, were employed. As expressly mentioned in the CAPS agreement, the literature review also covers the physical sciences. More importantly, this chapter examines the theoretical underpinnings of the study that emphasizes the significance of PLCs in teaching practical work in the physical sciences and provides the theory by which the integration of PLCs in teaching practical work might be carried out.

The research paradigm, technique, and design are all covered in Chapter 3 of the study. The researcher defends his choice to employ a mixed research approach in this chapter. The researcher justifies his paradigm selection and why it is congruent with his research. The researcher discusses and explains how and why the sample was chosen for the study, as well as the sample that was used in the study.

The presentation, analysis, and discussion of the data are the main topics of Chapter 4. The data analysis and interpretation is organized in accordance with the sequence that it occurred and shows the study's findings.

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The study's conclusion is found in Chapter 5. In this chapter, the researcher summarizes all the earlier chapters as well as the research's findings and offers some suggestions.

The research problem and the recommended course of action were described in the first chapter, which laid the groundwork for the remainder of the study. This chapter also presented and covered the study's introduction, including the context, the driving force behind the study, the formulation of the research question, the study's goals and objectives, the researcher's presumptions, and the relevance of the study. In the preceding chapter, research technique and design were covered, the theoretical underpinnings of the investigation, ethical issues, study delimitations, and study constraints.

PLCs and practical work in physical science education are covered in detail in the following chapter of the literature review because they are crucial to the study.

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CHAPTER 2

LITERATURE REVIEW – THE ROLE OF PLCs IN PRACTICAL WORK TEACHING

2.1 INTRODUCTION

A professional learning community (PLC) and the teaching of practical work are two concepts that will be discussed in Chapter 2 in order to give a general overview of the corpus of knowledge in these areas. It gives a summary of the literature study on the application of PLC in teaching physical science practical work as well as associated factors that contribute to poor performance in physical science practical work. The purpose of the literature review in this study is to describe the factors that, according to research conducted both globally and within the varied South African school environment, contribute to the poor performance in physical sciences practical work.

According to Leedy and Omrod (2010), a review of the literature is a systematic, critical analysis and summary of the body of work that is pertinent to the topic under study. Neil et al (2014) state that a literature review is not simply a piece of discursive prose, nor is it a list providing a description or summary of different pieces of literature. To understand a literature review it is important to consider its perceived aims and purposes. In this regard, Gray (2014) suggests that a literature review serves to provide a detailed description and critical analysis of the current state of knowledge in the phenomenon under investigation.

To determine the aforementioned, a detailed analysis of the theoretical framework, which is used to provide a viewpoint on which the study is based (Niss, 2006), will be done. For the researcher, the theoretical framework serves as a road plan for analysing, defining, and interpreting the data. The topics mentioned in chapter one through the research methods are all impacted by the theoretical framework, according to Rakotsoana et al. (2007). This study is founded on two theories: constructivism in teaching and cooperative learning, which will be thoroughly discussed to show how they apply to the study.

The goal is to conduct a thorough investigation of the standards involved in understanding the phenomena linked to the professional learning community in order to address the challenges teachers face when attempting to teach practical work in the physical sciences in the diverse high school settings of the Free State. The next part discusses the study's theoretical foundations, along with the research questions and objectives.

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2.2 THEORETICAL FRAMEWORK

The constructivism theory and the co-operative learning theory, which provide the theoretical basis for the practical work improvement of performance as it is addressed in this study, are the two theories that serve as the theoretical foundation for the study's framework (Kumar, 2014). According to Rakotsoana (2007), the conceptual basis of a research investigation is the theoretical framework, which can be founded on a theory or a particular conceptual model. The definition of a theoretical framework given by Kumar (2014) is the process of assembling a collection of ideas that are pertinent to a particular subject.

The constructivist theory will be applied in order to conceptualize discourse, thinking, and the understanding of how the professional learning community functions in the Free State's diverse high school settings when teaching practical work. The researcher decided to use constructivist theory to frame this research because it considers teachers as active participants who contribute to their social setting and their integrated interaction as members of a professional learning community (Joubert, 2012).

Co-operative learning theory claims the cooperative interdependence of teachers in a group as a basis to improve both academic and social relations and that it is natural for teachers to grow and learn through social interaction and share a belief of creating more long-term benefits for the overall society (Miller, 2011). Co-operative learning as a teaching strategy has shown improvement in intercultural and social relations among teachers of different cultures. A co-operative learning PLC would be employed by the researcher to facilitate healthy cross-cultural relationships among teachers.

Therefore, PLC as a cooperative learning method of teaching and a community learning technique, developed by Robert Slavin (2014), is used to improve interpersonal and intercultural skills in schools in the United States of America – this learning technique is administered for the professional learning community and the teaching of physical sciences practical work (Schniedewind, 2004; Abuseileek, 2007; Coffey, 2008). PLC can be an effective instrument for fostering cultural blindness or bridging racial and cultural divides, according to studies (Abuseileek et al. 2007). This is in line with the descriptive strategy, where the validity of qualitative methods is what determines reliability.

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2.2.1 CONSTRUCTIVISM

This section reviews the constructivist learning theory, according to which learners build new knowledge from existing knowledge (Ausubel, 2008). According to the constructivist view, learners come into science classrooms with primitive and pre-conceived conceptions and with perspectives that may be related and applicable to what they are supposed to learn, but these ideas are often scientifically incorrect (Reddish, 2001). According to constructivism, learners should take an active role in their education so they can create their own knowledge of the topic (Horn, 2009). By creating their own knowledge, learners would critically apply the information they had already learned to make decisions that would demonstrate the expected competencies (Jansen, 2009).

The learner's abilities and hobbies are highlighted by constructivism. The theory of learning states that the learner creates meaning by processing new information in addition to previously learned material in order to integrate and progress previously acquired information and abilities (Krahenbuhl, 2016). Constructivist learning is indicated by both Taber's (2001) claim that the human mind only comprehends what the human mind has created and Pange's (2011) claim that students learn more effectively when they give personal significance to the material. It is often the method by which students build their knowledge by analysing their experiences. Thus, it is quite advisable and predictable that the installation of a teaching method like a PLC can best achieve the planned construction of information that learners consider as important.

According to Horn (2009), constructivism suggests that learners should actively engage in the learning process in order to build their subject-matter expertise. Schools still need to teach learners the skills they will need to be successful team players, critical thinkers, leaders, and members of society once they graduate from high school in addition to the prescribed content and material. Therefore, PLC as a social constructivist method of teaching and learning would be essential for academic and non-academic skills development. In this study, guided discovery and collaboration are encouraged to help construct knowledge and process the information acquired through physical sciences practical work lessons.

The major subjects to be examined - the key factors, constructs, or variables - and the assumed relationship among them - are all explained by the conceptual framework of this study (i.e., constructivist teaching), which is an explanatory tool in a narrative form (Miles & Huberman, 2004). It works well for gathering and condensing collected information (Bell, 2005). The conceptual framework of this study allows participant teachers, who are members of the PLC to air their views about their practices which influence their learners' learning. The research project attempts to facilitate teacher learning of practical work strategies through

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experiencing and working with a constructivist teaching approach supported through teacher collaboration within a PLC to facilitate the reconstruction of participants' views of a practice-based and deeper understanding of learners' learning of physical sciences practical work.

The fact that learners come to a class with different conceptions as part of their background information presents a significant challenge for the physical sciences teachers. Alternative conceptions cannot act as a suitable foundation for the development of scientific knowledge and understanding because they diverge from recognized scientific concepts. The researcher believes that learners' alternative conceptions must be shown to be unfeasible, and they must perceive the new concepts as plausible in order to accomplish conceptual development and potentially change in practical work performance towards correct scientific conceptions constructively.

According to White (2008), understanding is a necessary component of scientific learning, and the patterns of associations between its components are crucial. He defines understanding as the capacity to apply the appropriate knowledge, deal with novel circumstances, and/or form new ideas that relate to the prior knowledge. In that manner, concepts are built constructively, and learning becomes plausible. Everyday experiences are inadequately incorporated into teaching during learning, thus forming new concepts with no links to the existing knowledge.

When pre-conceived knowledge is not integrated with the new learning process, it will not make the learning experience relevant to the learner (Beer, 2010). The teaching sequence should lead to opportunities to connect the classroom experiences to outside-world practices and provide an opportunity to chain and string the information into a new conceptual framework in a constructivist manner. Teaching must be adapted and organized in accordance with the constructivist method for learning to occur effectively.

According to constructivism, learning is a process in which learners actively seek out new information and comprehend it (Woolfolk, 2010). According to the constructivist theory, learners build knowledge by connecting and associating what they already know to what they are learning. They effectively react to newly acquired facts using their prior assumptions (Reddish, 2001). According to the information processing perspective, knowledge construction represents the outside world and should do so. Direct teaching, feedback, explanations, and connections made between previously learned material and new information all have an impact on learning.

From the above views of constructivism, the researcher concludes that learning should consist of exploration, discovery and investigation (Woolfolk, 2010). Hence, constructivism is the relevant theory for this study since the PLC must be an ongoing collaboration which exists in

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all schools to enhance learning and professional development, particularly in physical sciences practical work which is more about testing scientific theories.

The researcher also believes that using teaching techniques like cooperative learning and PLC can help learners learn and improve practical work in the physical sciences because of the advantages of a constructivist approach to classroom education. Constructivist teaching and learning methods improve the salient features or elements of the socio-ecological paradigm. This viewpoint is backed up by a study by Rodovan et al. (2015) that advocated using social constructivist methods to create welcoming learning settings in the classroom.

2.2.1.1 Social constructivism

Social constructivism, according to Taole (2015), is the internalisation of information and skills gained through interactions with other people. According to Van Wyk (2016), the teaching and learning process is viewed by constructivism as a shared responsibility and experience. Constructivism's cornerstone is incorporating learner tasks into the teaching and learning process. Teachers also actively participate in a professional learning community as a result of the learner-centered teaching strategies used, which support learners' problem-solving abilities, improve both teachers' and learners' perceptions of the practical application of the physical sciences, and improve learner performance in the subject.

De Kock, Sleegers, and Voeten (2004) assert that social constructivism, which is based on Piagetian theory, challenges the notion that learning is an individual process that is affected by participation in social activities, such as team discussions during PLCs. Constructivism therefore supports theories that demonstrate how people and society construct knowledge (Sanchez & Loredo, 2009). Creswell (2013) asserts that social constructivism is frequently mistaken for interpretivism. It is a way of thinking that encourages people to always attempt to comprehend the environment in which they reside and operate. This claim also gives sufficient justification for advocating the use of phenomenological methods in such inquiries, such as the one under consideration.

Pouliot (2017) provides evidence for this by highlighting the constructivist meta-theoretical claim that knowledge is socially constructed, social reality is also constructed, and knowledge and reality are essential, interdependent components of one another. They continue by asserting that truth and the social construction of knowledge are two sides of the same coin. This epistemological claim is grounded in Vygotsky's theory that more knowledgeable community members act as social brokers and progressively assist less knowledgeable

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members of the group in expanding their knowledge. The "zone of proximal development" was how Vygotsky described this situation. “Zone of proximal development” is defined as the space between what a learner can do with adult guidance or in collaboration with more capable peers (Billing, E. & Walqui; 2017). In the case of PLCs, educators must collaborate in order to provide learners with appropriate learning experiences and support to help them realise their potential development.

According to Powell and Kalina (2009) and Palmer (2005), Piaget's theory is "cognitive constructivism," while "social constructivism" was developed from Vygotsky's sociocultural perspective and holds that learning occurs in a specific social context that instills in students the common ways of thinking of their community. According to the study, society, culture, and language all affect how learners construct knowledge. This process of knowledge creation is collaborative and active rather than passive or isolated (Kinniburgh, 2010; Sohel, 2010; Martin-Stanley & Martin Stanley, 2007).

During PLC meetings and practical work, teachers would experience social interactions as they work together within their teams, discussing, debating and arguing their standpoints concerning the content. Through these kinds of interactions, teachers formulate their understanding and knowledge that will assist them to improve on existing or develop counter facts that disapprove or disagree with the acquired knowledge. On this notion, the view of Vygotsky, insisting that social learning is crucial to individual learning that happens after social effect, plays a leading role (Hertz-Lazarowitz, Kirkus & Miller, 1992; Stears, 2009).

From the foregoing, it may be concluded that social reality and the social construction of knowledge are intertwined. In a social constructivist environment, learners and teachers collaborate to mutually create ideas and skills that can be understood. When there is no room for learners to express their worldview, the circumstance is considered behaviourist. According to Harkness (2009), learners can express views that are distinct from those of the teacher or the textbook in a social constructivist classroom by expressing how they perceive the world.

In physical sciences learners also need to link textbook material to the reality of their existence in the laboratory, like the smell of an ester during a reaction of carboxylic acid and an alcohol in the presence of an acid catalyst. Drawing from the existing knowledge about reality to construct one’s knowledge is imperative to learning as it develops inquiry skills, reasoning, critical thinking and competencies among learners as they get to sense the ownership of their knowledge (Blaik-Hourani, 2011).

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Therefore, constructivism perceives learning as more than just the receiving and dissemination of acquired information or content matter, but rather as an active and personal construction of knowledge. Primarily learning occurs during problem-solving and working with others and has little to do with the transmission of knowledge which is the case in the traditional or behavioural classroom (De Kock, Sleegers & Voeten, 2004).

Collaborative group talks in the physical sciences classroom, according to the researcher, are how teachers pick up on what might be called the "hidden curriculum." As demonstrated by cognitive constructivism in the section that follows in this chapter, the researcher also holds that teachers would be able to create mechanisms for learning new information as well as novel approaches to teaching practical skills in a setting or classroom environment that is different from their usual one.

2.2.1.2 Cognitive constructivism

The aforementioned also derives from the cognitive constructivism theory built on Piaget's idea and highlights internal cognitive processes in people. According to cognitive constructivism, children are scientists who make meaning of their surroundings by conducting their own research. These beliefs contend that physical, psychological, or social experience can serve as a learning catalyst. Physical experiences involve interacting with the environment, psychological experiences require thinking critically about what was learned and practiced, and social experiences involve interacting with peers and adults (Palmer, 2005; Powell & Kalina, 2009).

In the physical sciences class where the PLC is employed to improve performance, teachers are exposed to the practical work as subject matter, its application and easier ways to approach learners as a psychological experience, and as they interact with each other in a social situation, different world views would be tabled and looked at. Individual teachers would get opportunities to digest the experiences by analysing, synthesising and evaluating themselves to develop their knowledge.

The context would also be exposing Vygotsky's belief that learning is social and occurs in a specific social setting that instils in students a shared way of thinking and methods of learning. According to Palmer (2005), learners learn more in social environments, as they interact with people that are more competent and who slowly direct them towards constructing their understanding of the phenomena through personal interpretation. Cultural values, such as language and other practices used by specific communities from which learners come are learnt through interactions that give them a sense of belonging.

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Therefore, by basing the argument on the above perspective, the researcher contends that as teachers interact with one another during PLC meetings, less knowledgeable ones would be motivated to become valuable members. The more knowledgeable teachers with effective teaching practices could facilitate by helping weaker ones to contribute meaningfully toward the common goal of the group. By so doing confidence would be built among the struggling teachers.

The individual production of knowledge by critical and reasonable interaction with the information learnt and the experiences is acknowledged by both cognitive and social constructivism. Second, in order to develop coherent and organized information, students are treated as active participants rather than passive ones and are free to provide the worldview that makes sense to them. Constructivism's aforementioned characteristics are excellent for a cooperative learning setting where a teacher also participates in the learning community and where many interpretations and ideas emerge through team interactions (Cottone, 2007; Kinniburgh, 2010).

Additionally, the PLC, which is a cooperative learning technique of instruction, includes both the participants and the researcher and sees both as active participants in the decision-making used for this study.

2.2.2 COOPERATIVE LEARNING

The researcher discussed constructivism as one of the theories that support this study on the PLC as a group learning strategy. Constructivism was introduced as a belief that teachers who actively take part in group learning can make relevant meaningful usage of knowledge obtained from the discussion of the subject matter (Horn, 2009; Jansen, 2009). The researcher further alluded to theories of motivation to bring about intrinsic motivation to teachers in physical sciences meetings where a PLC is employed.

It is an important factor that teachers should enjoy the subject, and this can be achieved when teachers are internally influenced and convinced to direct their energy toward achieving the higher goals, they have set for themselves as individuals and PLC groups. In PLC, teachers are required to focus their energy and effort towards obtaining group and individual goals. In the study's subsequent part, the researcher provides a brief discussion of cooperative learning as a social constructivist methodology.

Cooperative learning is a teaching method where learners cooperate so that everyone can benefit from the group exercise (Van der Horst & McDonald 1997; Van Wyk, 2009). According to Slavin (2005), the word "cooperative learning" also refers to a set of instructional techniques

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in which learners take part in small groups of four or five people with a variety of academic abilities (one high achiever, two average achievers and one low achiever). Furthermore, Van Wyk (2007) contends that the opportunity to learn through the study and expression of various concepts and experiences in a cooperative team to achieve a group goal is the essential element of cooperative learning. He goes on to say that learners will be urged to collaborate rather than fight in the cooperative learning environment. This is pertinent to the study because the different ways that teachers in the physical sciences PLC view teamwork will affect how they respond to cooperative learning. They could meet the challenges of their leadership roles and conflict resolution abilities. Also, equal opportunity for success means that all teachers, regardless of their ability or background, can expect to be recognized for their efforts. Thus, heterogeneous groups characterize cooperative learning groups.

Cooperative learning is founded on social interdependence theory that emanates from social constructivism beliefs and principles discussed in the previous subsection of this chapter. Therefore, cooperative learning as a teaching strategy is also based on the cognitive development of learners, whereby individual learners' process of learning is taken into consideration. Social learning takes place where there is social interdependence through sharing views and ideas with peers and more knowledgeable others (Attle & Barker, 2007).

Therefore, cooperative learning is a system where teaching and learning take place in an environment that supports learners to become active participants in their process of learning, not just passive recipients of abstract knowledge. Thus, learners are guided to take ownership of the learning process through interactions with peers and posing questions to the teacher for the generation of their group and individual understanding and interpretation of the subject matter. Cooperative learning could induce internal influence (motivation) in learners to be proactive in the meaningful contribution of knowledge to peers and oneself through a supportive and less intimidating situation (Laing, 2002; Messerschmidt, 2003; Johnson & Curtis, 2009; Panitz, 2011).

The definitions of cooperative learning make it abundantly clear that teachers require training in the use of these methods in order to meet requirements for planning and preparation in order to achieve desired processes and end-results like positive interdependence and group goals. Cooperative learning can occur in three distinct ways, according to Johnson, Johnson, and Smith (2004): formal cooperative learning groups (important to this study), informal cooperative learning groups, and cooperative base groups. The biggest difference between these kinds is how long the groups collaborate for.

Literature suggests that formal cooperative learning is achieved when learners work together for one or several class sessions to reach a shared goal and in one accord complete a task at

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hand. When conducting a class using formal cooperative learning, a teacher must specify the plans for the lesson, make several pre-instructional decisions, monitor learners' progress and intervene within the groups, and lastly evaluate learners' progress and process how well they functioned as a group (Johnson & Johnson, 2004). Steps for the physical sciences teacher to administer during cooperative learning include specifying the objectives for the lesson, making several pre-instructional decisions, explaining the task and positive interdependence, monitoring students' learning and intervening within the groups to provide assistance and to evaluate students' learning. The steps indicated are to provide a clear direction when employed in FET physical sciences PLC since teachers interchangeably took the leadership role in different sessions to prepare the content to be presented and arrange the classroom accordingly to provide the atmosphere for cooperative groups. Efficient preparations and organisation enabled the researcher to set clear objectives for the lessons and explain the material accurately for other members of the PLC to understand. It is also easier for the researcher to effectively evaluate group processes during group interventions.

2.3 CLARIFICATION OF KEY CONCEPTS.

Neethling and Smit (2012) assert that it is critical to acknowledge that the teacher has borne the bulk of the responsibility for modifying the classroom in a way that meets the requirements of all students. Many teachers believe they lack the abilities and resources needed to handle many of the difficulties brought on by the different learning demands of the learners in their classes.

The purpose of this study was to examine how professional learning communities may be used to teach practical work in the diverse high school settings throughout the Free State. The literature on practical work in the physical sciences curriculum is reviewed in light of the part that the PLC should play in the teaching of practical work. Furthermore, PLC as one of the cooperative learning and teaching techniques will be discussed as a way of bearing positive results in terms of achievement, attitudes and social skills development for teachers (Agasha, 2004 as cited in Muraya and Kamimo, 2011; Wan Mohamed & Jaarfar, 2009; Michael, 2006; Oakley et al. 2004).

The study's current section describes the function of practical work in physical sciences, problems and difficulties physical sciences teachers encounter when teaching practical work, and PLC as a tool for carrying out successful practical work teaching. It will also be necessary to discuss opinions on what practical work involves in order to put the role and purpose of practical work in context.

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Moreover, among the cooperative learning techniques, PLC is reported to be the most researched technique. The researcher assumed that the above notion resulted from the thorough discussion of the benefits and challenges of PLC. The role of the teacher as part of PLC is explained in this chapter. PLC is perceived as the simplest of the cooperative learning techniques, it could therefore be presumed that PLC is suitable to help teachers effectively teach practical work and improve learners' performance on practical work. The latter discussion would aid in the role of the School Management Team (SMT) in supporting PLC, useful reform types and techniques, and improving effectiveness and learner performance through PLC for practical work in physical sciences. Lastly, the methods of teaching practical work in PLCs will be examined.

2.3.1 NCS/CAPS: Physical Sciences

The classification of evolving knowledge about the physical universe, acquired through experience and verified via experimental research, is known as the physical sciences (Jain, 2006). According to Van Aarde (2009), physical sciences also include chemistry, biology, applied sciences, agriculture, medicine, and research on how the human body perceives the outside world. The goal of science is to understand the nature of facts, how scientists obtain them, and how laws and theories influence our knowledge, which is based on facts (Chalmers, 2013). Science has roots that date back more than three thousand years (Lindberg, 2007).

Using scientific laws, theories, and models to explain and forecast environmental occurrences is encouraged in South Africa's FET phase by the Physical Sciences CAPS (Department of Basic Education, 2012). Therefore, it is expected of teachers to provide learners with opportunities to improve their investigative skills so they can create their own investigations. The Department of Basic Education (2012) states that the observable skills expected of physical science learners in the Further Education and Training band include classifying, measuring, formulating models, hypothesising, communicating, analysing conclusions, recognizing and monitoring variables, as well as interpreting, comparing, inferring, reflective solving of problems, and predicting (Grades 10-12).

Physical sciences is defined as "fields of study that research the non-living components of the universe" by Grayson, McKenzie, Dilraj & Harris (2005) as a definition and conceptualization. They also describe physical sciences as "the study of what everything is made of, the structure and properties of matter, the interactions between different kinds of matter, and various forms of energy" (Grayson et al., 2005). The National Curriculum Statement (2011) emphasizes that physical sciences look into chemical and physical phenomena. Through scientific investigation, which uses models, hypotheses, and laws from the scientific community to

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explain and forecast events in the physical world, this is accomplished. It also addresses the necessity for society to comprehend how the physical environment functions in order to utilize and properly maintain it.

The DBE National Curriculum Statement (2011) states that the six knowledge areas that make up Physical Sciences (grades 10–12) are Matter and Materials, Chemical Systems, Mechanics, Wave, Sound and Light, Electricity, and Magnetism. The National Curriculum Statement (2011) mandates that physical science education should last 4 hours per week during the FET phase in order to meet the curriculum's required material. To guarantee that the time is used effectively, this necessitates appropriate weekly planning.

Physical sciences CAPS policy document (a work schedule, which is an annual teaching plan that indicates the topical sequencing); programme assessment; practical work, experiments, and projects to be assigned to learners for the year; necessary textbooks, equipment, lesson preparation, and assessment tasks; are all required for effective planning. Once this planning is finished, the finest teaching methods should be chosen.

According to the South African Department of Education, the study of physical sciences is primarily focused on examining molecular and physical processes and conducting scientific inquiry. (DBE, 2011). How it should be carried out is also specified in an overview of practical work as mentioned in the CAPS. In order to strengthen the ideas being taught, practical work must be integrated with theory, according to the physical sciences CAPS document from 2011. These could take the form of simple experiments, practical investigations, or even plain practical demonstrations.

Along with the content, ideas, and abilities covered in the FET curriculum, a number of practical activities are also listed. Some of these practical activities are completed as part of formal evaluation tasks, while others are completed as part of an informal assessment (physical sciences CAPS, 2011). Experiments, real-world study, projects, and the creation of scientific models all fall under the category of practical work in South Africa. The CAPS document backs up the claim that teaching in the physical sciences must include real experience (physical sciences CAPS, 2011). Table 2.1 lists the practical evaluation tasks done at schools that are required as part of the formal assessment for the FET band.

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Table 2.1 School-based practical assessment tasks prescribed as formal assessment in the FET band.

PRACTICAL TASK 1 (MARCH)							
Grade 10							
PAPER	CONTENT	TOTAL	DURATION	Weighting of questions across cognitive levels			
One paper	Experiment 1–6 skills	40 Marks	1 hour	15	35	40	10
Grade 11							
One paper	Experiment 1-4 skills	40 Marks	1 hour	15	35	40	10
PRACTICAL TASK 2 (JUNE)							
Grade 10							
PAPER	CONTENT	TOTAL	DURATION	Weighting of questions across cognitive levels			
One paper	Experiment 7-11 skills	40 Marks	1 hour	15	35	40	10
Grade 11							
One paper	Experiment 5-9 skills	40 Marks	1 hour	15	35	40	10
Grade 12 Practical work							
Term 1							
CONTENT	TASK	MARKS	TOTAL	DURATION	Weighting of questions across cognitive levels		
Experiment 1: Conservation of linear momentum	Part 1: conduct an experiment and complete worksheet.	Converted to 10					
Experiment 2: Preparation of esters	Part 1: Conduct an experiment and complete worksheet.	Converted to 10					
Experiment 1 & 2	Part 2: Test based on experimental procedure,	Converted 20	40 Marks		15	35	40	10

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	apparatus and data interpretation							
TERM 2								
CONTENT	TASK	MARKS	TOTAL	DURATION	Weighting of questions across cognitive levels			
Experiment 3: Titration of oxalic acid against NaOH to determine the concentration of NaOH	Part 1: Conduct an experiment and complete worksheet	Converted 20						
	Test based on experimental procedure, apparatus and data interpretation	20	40 Marks	45 minutes	15	35	40	10
TERM 3								
CONTENT	TASK	MARKS	TOTAL	DURATION	Weighting of questions across cognitive levels			
Experiment 4: Internal resistance of the battery & equivalent resistance of the resistors in series & parallel	Part 1: Conduct an experiment & complete worksheet	Converted to 20	40 Marks	45 minutes	15	35	40	10
	Part 2: Test based on experimental procedure, apparatus & data interpretation	20						

The current curriculum (CAPS) combines theory and practice to support the material being taught. Each year, learners in grade 10 and 11 complete the required practical work as part of a formal assessment (one formal experiment per quarter and several informal practical tasks). Three specified practical tasks, either one from chemistry and two from physics, or one from chemistry and two from physics, must be completed for grade 12 courses.

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Outlined in physical sciences CAPS document, practical work is integrated into all curriculum areas and accounts for 40% of school-based assessments (SBA). Considering the researcher's concern over learners performing poorly on practical tasks, it is crucial to offer learners the opportunity to develop and enhance their practical knowledge of the physical sciences. As a result, it is crucial to give teachers the opportunity to develop their practical abilities in teaching physical sciences practical work (DoE, 2011), which is why teachers should be involved in the professional learning communities.

2.3.2 Practical work in the Further Education and Training (FET) phase

This part of the study focuses on ideas about what practical work is because it can mean various things to different people. In addition to laboratory work experiments performed as teacher demonstrations, practical work can also include hands-on experimentation by learners in a lab or classroom. According to Omiko (2015), the meaning of "practical work" could be broadened to include activities like project work, library research, fieldwork, site visits, environmental monitoring, or technology exploration. Actual work could be completed anywhere; it is not necessary to do it only in the classroom.

In accordance with the idea that people learn best through direct experiences, Olutola, Daramola, and Bamidele (2016) discuss any learning method that calls for the learners to be active rather than passive. Ramnaraind and Kibrige (2015) classified practical work in terms of either the intended outcomes or its form. Outcomes may relate to content knowledge or process skills. Practical work outcomes are to assist the learners to identify and recognize phenomena to become conversant and knowledgeable with them. Furthermore, it assists learners to learn facts, concepts, relationships and theories. Process outcomes entail, amongst others, the handling of apparatus, performing of measurements, collecting and interpreting of data and compiling of reports.

Practical work is frequently contrasted with traditional laboratory work, where learners first meet concepts and principles. A laboratory, in the words of Uzezi and Zainab (2017), is any setting where learners can try a theory. The phrase could be used to describe a setting where learners can test the hypotheses and justifications, they have for things they have observed and events they have experienced as they explore their curiosity about the world they are currently living in. According to Ural (2016), the laboratory should be used as a setting where science learners can participate in hands-on activities like experiments and observation, that is, not just to verify but also to discover.

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In the physical sciences disciplines, "practical work" includes a variety of tasks, such as laboratory experiments. When learners have the chance to do remote practical work, they can watch real-world work on video or television without getting their hands dirty (Omiko, 2015). When the learners are in the classroom, they can observe the teacher illustrate the concepts. By hearing, seeing, and asking and answering questions, learners can be engaged. It is possible to create assignments for both group and solo practical work so that learners can complete practical work in the classroom. Learners can take part by producing, acting, measuring, observing, asking questions, and responding to them (Orimogunje, 2014; Pavesic, 2008).

In addition to teacher demonstrations, practical work could consist of a variety of investigations or experiments conducted by learners either alone or in groups (Van der Linde et al. 2004; Yitbarek, 2012; Temechegn, 2012). Collen (2013) says that practical work should always incorporate learner participation, even though there are many different definitions of what practical work entails and that individuals may have different ideas about how much learner participation is appropriate (Bradley & Maake, 2008).

2.4 THE ROLE OF PRACTICAL WORK IN PHYSICAL SCIENCES

In secondary schools, particularly those that provide physical sciences, practical work exercises have long played an important role in industrialized countries (Okere & Wachanga, 2014). The provision of the necessary resources is fully warranted, and it is widely agreed that secondary scientific curricula should include a sizable number of practical exercises. The investigation strategy was complemented by theoretical reasoning. The only way to offer this learning opportunity was thought to be through practical exercises.

The researcher contends as a result that for learners to successfully complete practical work in the physical sciences, they must be taught the scientific principles, basic information, skills, and values required to handle real-world issues. This calls for a brief discussion of the outcomes of practical work. Additionally, learners should be able to use the theoretical knowledge they have gained in physical science classes to answer problems in science by applying the right techniques and principles.

The learners' decision should also consider how resources used in doing practical work could suit the solution based on properties that can be affected by external conditions. An understanding of the apparatus used in doing practical work plays an important role that would help learners to remember the environmental impact of the chosen materials for the solution

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(Muhammad, 2014). Following is a description of the cognitive requirements for practical work assessment, as it is crucial to note the consequences of practical work.

2.4.1 Outcomes of Practical work

In order to properly develop the idea being taught, the 2020 FSAG mandates that practical work for physical sciences in the FET phase be properly integrated with the theoretical. These could come in the form of simple trials, in-depth research, or exhibits. Even though the Curriculum Assessment Policy Statement (CAPS) makes a distinction between them in terms of assessment, experiments and practical studies come under the category of practical activity. A collection of precise instructions or methods known as an experiment must be followed by learners in order to produce results or to validate or test a priori hypotheses. Practical research, in accordance with the scientific method, must test a hypothesis because the conclusion cannot be predicted in preparation (Achimugu, 2019).

The table below (Table 2.2) illustrates the starting point for the intended results of the learning experience in practical work.

Table 2.2: Practical skills in physical sciences

PRACTICAL SKILLS IN PHYSICAL SCIENCES		
Skill Number	**Skill**	**Description** **Learners need to be able to:**
1	Write an investigative question/aim	• Write an investigative question
2	Formulate a hypothesis	• Formulate a hypothesis from an investigative question/problem/aim
3	Identify and describe variables	• Identify and describe the dependent, independent and controlled variable.
4	Collect apparatus	• Retrieve appropriate apparatus. • Identify appropriate apparatus from diagrams/displays. • List appropriate apparatus.
5	Assemble apparatus	• Set apparatus correctly.

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		• Draw a diagram (with labels and/or symbols) of a set of apparatus to conduct an experiment.
6	Use apparatus	• Correct and safe handling of apparatus in conducting a practical investigation. • Describe the correct and safe use of the given apparatus. • Describe the correct and safe use of the apparatus as a part of the stepwise method. • Take readings from an apparatus. • Take readings from diagrams.
7	Take measurements	• Make observations from experiments/animations/demonstrations/videos.
8	Make observations	• Draw and label a table to record data. • Complete a table using the given data.
9	Recording & Data handling	• Draw and label a table to record data. • Complete a table using the given data.
10	Analyse and interpret data using graphs and calculations	• Draw graphs, take readings from the graphs, and identify patterns and trends. • Perform calculations. • Interpret data from a table. • Compare or classify data.
11	Test hypothesis	• Create an experiment (skills 1-6) to evaluate a hypothesis. • Create and carry out an exercise to verify a theory. • Put a theory to the test using data from an experiment.
12	Draw conclusion	• Use the findings' interpretations to show the hypothesis is true or false and to respond to the research question. • Analyse/synthesize the findings, determine their validity, and provide justifications for any deviations (if any), as well as suggestions for ways to make the exercise better.

The aforementioned 12 mental abilities (listed in table 2.2) for learners in grades 10–12 should focus on the practical components required for scientific research and problem-solving, and they should be planned/selected in such a way that all necessary practical skills are acquired.

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Activities should emphasize process skills, critical thinking, scientific reasoning, and methods for researching and resolving issues in a variety of scientific, technical, environmental, and everyday settings. They should also evaluate performance at various cognitive levels (Hofstein & Lunetta, 2008).

2.4.2 Skills for Physical Sciences as outlined in the Curriculum Assessment Policy Statement (CAPS) (DoE, 2012)

The focus of outcomes-based teaching and learning in South Africa according to CAPS is on what learners need to know and can do at the end of their learning experience in practical work, in that practical work should:

- Outcome 1: Reinforce the understanding of scientific concepts and principles, making abstract concepts more understandable and supporting theoretical learning.
- Outcome 2: Develop practical skills and techniques.
- Outcome 3: Introduce learners to the scientific method, problem-solving skills, and a way of reasoning that mimics a scientist.
- Outcome 4: Encourage learners to realize that science is enjoyable by piquing their curiosity.

The outcomes, which are based on cognitive levels, make the learning experience's objectives clear so that both the teacher and the learner are aware of them right away. The outcomes serve as a roadmap for the learning process and a measurement of how well trainees are doing both during and after their learning experience. These findings are used to verify the quality of the practical work at the conclusion of each phase and form the basis for evaluation (Van Rensburg & Potloane, 2004). To make clear what is being taught and the goals for each class, it is essential to emphasize and talk about the practical work outcomes outlined in the National Curriculum Statement (NCS, R-12).

Cognitive level 1: **Process skills**: By making abstract ideas easier to understand and promoting theoretical learning, this strengthens our comprehension of scientific concepts and principles. In order to support the application of process skills and the achievement of the intended results, practical work in the FET phase of diverse high school settings should support idea exploration, manipulation, and development and make concepts manifest, understandable, and usable.

Learners should engage in the conceptual comprehension of scientific theory because practical practice may give the conceptual core of learning. In FET school science, practical activity was historically thought of as a way to gather data or information, but it should actually

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be a chance to explore and deepen conceptual knowledge (CAPS, 2015). Learners should take part in the conception and design of experimental studies. Lack of theoretical comprehension may result in inappropriate observations, which could lead learners to look in the wrong locations and at the wrong things, leading to inaccurate conclusions (Barely & Brigham, 2008; Chemistry, 2012). The learners should plan the experiments, and the teacher should act as a facilitator. Learners should consider any conceptual difficulties before starting the practical exercise.

According to Bentley and Watts (2009), learners could develop transfer skills and thus be able to transfer knowledge from one context to another different context. Active learners may have a feeling of ownership of information, data, interpretations and understandings, which means that they may judge the worth of facts and opinions. Ownership can be important because it can be an indication that learning may be intelligible, credible, fruitful and relevant to the learners concerned.

Process skills are appealing and consistent with the findings of the present research, and PLC as a cooperative learning method can be very helpful in developing the skill of social cohesion. As a result, PLC can be used to turn traditionally diverse classrooms into a socially integrated and coherent learning community that aims to promote fair and equitable educational development for its residents.

Cognitive level 2: **Critical thinking**: The goal of this skill is to improve practical abilities and methods. At this stage, practical work is credited with helping learners develop their practical skills and techniques. When compared to non-practical experiences, practical experiences—whether manipulative or intellectual—are fundamentally different and crucial for the development of skills and strategies that have a variety of effects that can be generalized (Zengele, 2016).

Eglen and Kempa (2004) further assert that the standard of experimental results usually provided to the teacher by learners in the form of laboratory reports and practical scripts has been used to infer mastery of manipulative abilities. They further support the view that the objective of an introductory science course is aimed at the acquisition of the necessary skills and acceptable working habits in the laboratory. Hence, they suggest that the acquired skills should be assessed, not the outcomes of sequences of operations (Curtis & Smith, 2016).

The researcher believes that critical thinking is an important skill since NCS (R-12) seeks to produce the kind of learners which can be best produced through the infusion and incorporation of social constructivism principles and the use of cooperative learning strategies such as PLC as used in this study. According to the CAPS document for Physical Sciences

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(Final Draft, Section 1, 2015), the National Curriculum Statement strives to produce learners that can solve problems through critical thinking, work effectively both individually and collectively, responsibly and effectively organize and manage themselves and their activities, communicate effectively and demonstrate an understanding of the world as a set of related systems in which problem contexts exist.

Additional abilities can be learned during science lab sessions. If learners have the chance to work with lab tools to develop knowledge of their observable facts and scientific concepts in relation to their intended, planned goals, Millar (2009) claims that practical learning goals can be met. For instance, learning organizational skills could help learners better organize both themselves and others. Learners had the option of learning the material both individually and cooperatively in a group. Small-group collaboration may require certain skills and abilities. They might be able to join the society cooperatively with the help of these abilities. Learners could also become aware of the time requirements of different tasks and may be capable of pacing themselves to meet deadlines. In other words, learners may develop the skill of time management (Bentley & Watts, 2009).

Manipulative abilities are divided into sub-categories by Eglen and Kempa (2004) and Trowbridge et al. (2000). Table 2.3 lists these subcategories as well as overall performance standards.

Table 2.3: Sub-categories of manipulative skills

COMPONENT	GENERALISED CRITERIA/PERFORMANCE FEATURES
Methodical working	• The operation's overall duties should be completed in the correct order. • Ability to use equipment effectively and purposefully and to create a workable process based on limited instructions
Experimental technique	• Managing equipment and chemicals properly • Safe performance of a test process • Taking the necessary safety measures to guarantee accurate observations and results
Manual dexterity	• Swift and assured performance of practical duties • Accomplishment of an operations or its individual subtasks
Orderliness	• The organization of the workspace • Good use of the bench space that is provided. • Organisation in the placing of equipment used

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Cognitive level 3: **Scientific reasoning**: This seeks to impart problem-solving skills, the scientific method, and a manner of thinking that exposes students to the way a scientist works. This level's objectives are founded on the notion that science instruction should give students a hands-on introduction to the entire scientific method, which includes recognizing a problem, outlining potential solutions, and creating tests to evaluate the veracity of a given explanation.

According to Herga and Dinevski (2012), the concepts of discovery and inquiry are combined in practical work. The use of practical investigations, the application of procedural knowledge and skills, and their growth may be crucial elements of learning science as an inquiry. Learning through practice may enhance learners' ability to solve problems, analyse information, generalize, and comprehend the scientific method (Shitaw & Birhan, 2017). According to the 2015 CAPS document, learners learning physical sciences in the FET phase should develop their analytical, logical, and critical thinking abilities as well as their capacity to apply their knowledge in both familiar and unfamiliar situations. All these significant social constructivism principles can be fulfilled by a PCL.

According to Curtis et al. (2016), learners may have a more accurate understanding of the trial-and-error process that confronts experimentalists in many scientific inquiries if they have first-hand practical experience. Through this real-world exposure, they get first-hand knowledge of the meticulous observational techniques and collaborative abilities necessary for reliable data collection. This practical approach seems to stimulate the brain activity required to integrate the abstract ideas related to the chemical interactions being studied in science.

Learners could initiate their activities and thus learn to take responsibility for their learning. This could often come from within learners themselves, that is, from their need to know or find a solution. It may be that the motivation or suggestion comes from the teacher or from outside the classroom. Nevertheless, physical sciences teachers may want learners to shape it themselves so that it becomes their task and they thus become accountable for its outcomes. Hence learners may feel in control and fully involved in their learning (Bentley & Watts, 2009).

Learners can develop decision-making and problem-solving skills. Active learners can recognise the demands of tasks, take responsible decisions and seek ways to solve problems. Learners can judge the task for what it is worth, and thus tackle it appropriately even when it derives from outside, from a scheme of work, from the teacher or from some other source. Decision-making skills may be important when learners must make decisions with a view to the solution of a problem and take ownership of the problem for themselves (Bentley & Watts, 2009).

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While some confirmatory practical work that aims to build self-confidence as well as fundamental processes and techniques may be required, Herga et al. (2012) contend that most of the practical work should require learners to engage in actual problem-solving investigations, under different levels of guidance, according to goals and local conditions.

Cognitive level 4: **Strategies to investigate and solve problems in a variety of scientific, technological, environmental and everyday contexts**: The purpose of this is to spark learners' curiosity and help them discover the joy that science can be. This level makes the argument that engaging learners with real-world applications of science encourages learning. Positive experiences with practical applications may promote feelings of self-worth, self-confidence, and resolve that may be transferable to a wider setting outside of the laboratory. It gives learners the opportunity to act like real scientists, which enables them to develop critical traits known as scientific attitudes, such as honesty, being willing to accept failure, and critically assessing outcomes and constraints (Ural, 2016).

Positive attitude development among learners is one goal of practical work (Bradley & Maake, 2008). Research conducted by White (2008) indicates that school children begin the study of science with a favourable attitude to it, although they gradually come to regard it less positively. This may suggest that direct experience may be one of the causes of unfavourable attitudes to school. While it is an indication of the way science is taught, this may be a relief because it could mean that teachers could do something about it without having to change the views of the whole community.

A desirable way of facilitating inquiry could be to assign individual research projects that learners do on their own under the guidance of the teacher. Positive outcomes of the enquiry done by learners could lead to a positive attitude, thus learners could be motivated to perform advanced enquiries (Omiko, 2015). Learners could develop self-esteem, and hence believe in themselves and grow enthusiasm for what they are doing. They could develop an understanding that learning is an emotional business, which may involve excitement, disappointment, sudden “eureka” moments, and periods of perseverance. Success could mean confidence, and confidence could mean positive feelings and motivation (Bentley & Watts, 2009).

One of the main goals of science education is the formation of a positive attitude toward science and scientific inquiry (Woolnough, 2001), which further supports the idea that practical work is a good setting for fostering learners' attitudes toward and motivation in learning science. The attitudes of learners toward practical work tasks and science as it is practiced in the laboratory as a learning environment are crucial areas that teachers and researchers

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should focus on in their assessment and monitoring of the science practical experiences (Sharma & Bansal, 2017).

The principles of social justice, environmental justice, and human rights as outlined in the Constitution of the Republic of South Africa are infused into this ability. It also takes diversity problems like poverty, inequality, racial and gender discrimination, language barriers, and disabilities seriously (Physical Sciences CAPS document, 2015). Contextually, the implementation features of cooperative learning and the principle of PLC can thus ensure that inclusive education and other purposes are realized. The infusion of social constructivism and the use of PLC will ensure that learners occupy and share a similar learning environment while having equal learning and competing opportunities, regardless of diversity variables.

2.5 ISSUES AND CHALLENGES FACED BY PHYSICAL SCIENCES TEACHERS IN TEACHING PRACTICAL WORK

It is critical now more than ever to understand instructors' concerns about practical work in a wide range of nations due to recent developments in curricula (Centikaya, 2012; Ramoutar-Bhawan, 2013). Beliefs and modes of thinking that discourage participation in the transformation process are referred to as concerns. According to research, efforts to change the curriculum would undoubtedly fail if teacher efficacy suggestions were disregarded. (Christou, Eliophotou-Menon & Philippou, 2004; Charaloumbous & Philippou, 2010).

One important finding of the extensive literature on practical work is that teachers' dedication to curriculum innovations is influenced by their worries about their access to programs that support professional development, their teaching methods, and their knowledge of the subject matter (Torres & Vasconcelos, 2016). Even though there are many other factors that affect practical work, teacher beliefs are among the most significant personal determinants of reform execution.

Hall and Hoed (2014) assert that because of the high expectations for innovations, new users may experience uncertainty, making information and a better understanding of their problems crucial. The learner-centred and constructivist methods to practical work in the physical sciences have received a lot of attention since the Curriculum Assessment Policy Statement (CAPS) was first implemented in South Africa twelve years ago. Most teachers would find it challenging to satisfy this demand for practical work and inquiry skills, even in the best-case scenario.

Due to a lack of tools, such as laboratories and supplies, the South African environment makes it more difficult to execute practical work in schools (Tytler, 2012). According to research,

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teachers have trouble planning and coordinating the tasks necessary to carry out and monitor practical work in order to meet CAPS standards. The aim of this section is to introduce the functions of PLCs in the teaching of practical work because there is little shared vision and little participatory decision-making among physical sciences teachers.

A significant part of the science education curriculum in many nations emphasizes the development of practical abilities (Rogers et al., 2011; Stickles, 2011; Ryder & Banner, 2013; Kapanadze & Eilks, 2014). An active learner-cantered laboratory method of practical work in the Further Education and Training (FET) band is given a lot of attention in South Africa's new CAPS. Laboratory tasks are essential for the physical sciences curriculum because of their special position and importance.

Because of this, teachers must carry out the practical job while promoting active learner participation (Department of Basic Education, 2011). For some teachers, who might worry about doing practical work, this could be difficult. Science education has begun to pay attention to teachers' worries about doing practical work as a potential element that can hinder successful implementation (Luft & Roehrig, 2007).

Teachers may have varying levels of self-concern depending on how they interpret the innovation due to various practical work-related issues (Bartos & Lederman, 2014). Some teachers may be more concerned about their ability to successfully execute the reform. Other teachers might be more interested in the tools and techniques needed to implement the innovation than the underlying concept due to task or impact concerns (Hall & Hord, 2014). For instance, some teachers never complete all of the tasks during the session, despite the fact that they may engage in laboratory work more frequently. Due to these challenges and a lack of time and resources, practical work in schools is not done effectively (Tytler, 2012).

The literature on teachers' worries about practical work reveals a range of teacher worries, including management worries, worries about how to maximize practical work for learners, working with other teachers to use efficient lab methods, and occasionally worries about the task refinement with learners' abilities in mind. In order to better understand how science teachers use the lab, the National Science Foundation (NSF) conducted surveys of science and math teaching in the United States of America. Students participated in investigations once a week or more on average for 71% of high school teachers with major management problems (Banilower, Green & Smith, 2004).

Teachers who had these administrative issues spent a lot of time setting up and getting their tools ready. Teachers frequently stayed late or arrived early to keep up with their workload because the recommended school hours didn't leave enough time for them to evaluate

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students. The schedule does not account for the fact that many practical tasks require more time than is stated. When schools can't afford laboratory equipment, teachers might be prevented from conducting practical work due to financial constraints (Kelly, 2017). Facilities like brand-new, up-to-date equipment and enough space are needed for successful participation in practical investigations in order to implement practical work.

Some experienced teachers are conscious of how practical experience affects learners to the point where they begin to question the protocols that learners have been taught over time. These teachers were worried that while detailed directions enabled learners to "perform the lab work well" (Olsen, Hewsin & Lyons, 2006), they failed to assist learners in comprehending the purpose of experiments. Instead of just having learners follow the instructions in the laboratory handbook, the teachers were more interested in how well they understood laboratory reasoning. Another research found that less experienced teachers focused on the time-consuming planning requirements while more experienced teachers focused on assisting learners in developing scientific thinking as they gathered and interpreted their data (NRC, 2006).

A total of 55% of science teachers used laboratory simulations, according to Smith et al. (2002), because they were concerned about how various teaching strategies might benefit their learners. For problem-solving activities, 45% of the teachers used models, and for data collection, 45% of the teachers used hands-on activities involving sensors or probes. A total of 43% of the teachers in that research contributed to the improvement of the innovation by encouraging teachers to acquire or exchange data online. The researcher's collection of challenges encountered by teachers in classrooms suggests that these problems persist today, which is why this study was carried out.

2.6 HANDS-ON APPROACH

This section of the study intends to investigate how the "hands-on approach" might be utilized to improve learners' capacity for learning practical work and critical thinking in the diverse high school settings of the Free State. Considering the potential role that a hands-on approach could play in the teaching of practical work in the physical sciences, an overview of the literature on a hands-on approach in the curriculum is provided. The hands-on method, which is learner-centred and promotes active involvement in the learning process throughout the entire learning phase, places the learner at the centre of the learning process. In order to

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balance teacher-centred strategies in South African schools, Jacobs et al. (2012) note that several learner-centred approaches should be implemented.

To put the role and purpose of the hands-on approach in perspective, it is necessary to discuss the views held on what the hands-on approach is. The latter discussion would aid in the benefits of the hands-on approach, the educational implications of a hands-on approach and its applicability to this study. Moreover, this section will investigate cooperative learning and the hands-on approach as a learner-centred strategy. The hands-on approach is dependent on the successful implementation of the co-operative learning approach. It is thus necessary to discuss the hands-on approach to place it into context with the latter approaches.

2.6.1 What is a “Hands-on approach”?

Similar to many other frequently used words and phrases, "hands-on learning" has many distinct meanings (Haury & Rillero, 1994 cited by Mabalane , 2019). Instead of attempting to provide a precise operational definition of what is meant by hands-on learning in practical work in the physical sciences, this section provides a variety of interpretations of what is meant by the term. The PLC will then consider whether experiential learning is a recent development and whether hands-on approaches will continue to influence physical sciences practical work teaching and learning in classrooms.

People naturally learn about the world around them through "hands-on" activities, which helps them connect what they learn in science class to real-world situations (Motlhabane, 2004). It has developed into a catchphrase and is frequently used to describe any classroom activities that involve using materials. Hands-on learning, according to Haury and Rillero (1994), involves conducting in-depth research on things, materials, phenomena, and ideas and deriving meaning and understanding from such encounters.

Involving students in a comprehensive learning experience that develops their capacity for critical thought, hands-on learning is learning by doing. Learners must design a procedure to test a hypothesis, start the procedure using a variety of practical tools, see the procedure through to completion, and then be able to explain the outcomes. The hands-on method is crucial for this study since PLC participants must actively participate in carrying out the practical task by interacting with the materials and using the theories learned in the classroom.

The hands-on method calls for active participation from learners rather than passive reception; as a result, it is known as a "learner-centred teaching approach." Moving away from the transmission technique of teaching, in which the teacher is the only person participating in class, is emphasized as being important in a learner-centred approach (Huba & Freed, 2015).

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Therefore, the only method for learners to supervise their learning through direct observation and comprehension of science is through hands-on learning. Instead of seeing teachers as the active means and learners as passive vessels, a professional learning community emphasizes the formation of new knowledge through interaction, idea discussion, deliberations, and collaborations (Kahl & Venette, 2010). The PLC members need to learn how to teach practical work by focusing on the learners, allowing for more hands-on learning, and just facilitating the process.

Learners should build knowledge by gathering and condensing information and combining it with various skills, including practical, communication, critical thinking, and problem-solving abilities. The focus should be on the efficient application of abilities to resolve issues and difficulties that emerge during learning and from real-world data. While the learner is actively engaged in the learning process, the teacher's role should be to support and enable it. The teacher and learner should then jointly assess what they have learned. For the teacher and the learners to be able to learn together, the learning procedures should have a collaborative, supportive, and collective learning endeavour as their ethos. These are the advantages in favour of the practical strategy (Huba & Freed, 2012).

In his study, Kotoka (2012) backed the use of hands-on activities and reported further on the expected increase in knowledge retention. He thought that the practical method, such as using some equipment, was exciting because it reflected the learners' interest. A shift from a teacher-centred to a learner-centred approach is what the National Department of Education in South Africa views as occurring with hands-on learning. By comparing the old and new educational approaches in South Africa in the accompanying table 2.4, the researcher examines various ways in which he can implement PLCs to address the challenges faced by teachers.

Table 2.4 Differences between the old and new educational approaches in South Africa

OLD APPROACH	**NEW APPROACH (CAPS)**
Non-active learners	Engaged learners
Exam-driven	Continuous evaluation of learners is conducted.
Syllabus is content-based and broken down into subjects	Knowledge integration and learning that is pertinent to and connected to real-world circumstances

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Textbook/worksheet-bound and teacher-centred	Learner-centred, acting as a guide, and frequently using teamwork and groups to solidify new approaches
Sees syllabus as rigid and non-negotiable	Learning curricula are viewed as guidelines that enable teachers to create innovative and creative curricula.
Teachers are responsible for learners' learning; the motivation of learners is dependent on the teacher	Learners assume ownership of their education, and they are encouraged by ongoing criticism and affirmation of their value.
Emphasis is put on what the teacher hopes to achieve	The learner's progress, what they comprehend, and the results are the main focus.
Content is placed into rigid time frames	Learners can work at their own speed with flexible time constraints.
Rote learning	Promotes logical thought, action, reflection, and critical thinking

Gawe (2012) argues that CAPS should enable learners to engage in all facets of society because it is built on the principles of collaboration, critical thinking, and social responsibility. The Curriculum Assessment Policy Statement can only be successfully implemented if cooperative learning is used as a strategy to advance these ideals (CAPS). The concepts of cooperative learning include the improvement of cooperation, the growth of critical thinking, and the development of social skills. Many South African classrooms have been dominated by instructional approaches that were teacher centred (Gawe, 2012). These approaches should be replaced by hands-on co-operative learning. There are different methods of co-operative learning, namely, student team learning methods that consist of teachers' professional learning community (PLC), Student-Team-Achievement Divisions (PLC), Team-Assisted Individualisation, and Teams-Games-Tournament.

2.6.2 Situation analysis of hands-on approach in developing countries

Although the use of hands-on activities in science classes is generally accepted in industrialized countries, Bradley et al. (2008) note that questions have been raised about the activities' effectiveness and the lack of evidence for the benefits they are supposed to produce.

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Many of the activities that take place in school labs, in the opinion of some researchers, appear to be of little value, are ill-planned, and are unproductive (Treagust & Thair, 2009).

In developing countries, the practical method is commonly used to support theory (Welford, 2013). Some learners may see this as a competition where clever learners solve the problems. The main components of most classrooms are chalk, conversation, and experimental approaches that are frequently guided by processes. This is because teachers frequently lack the abilities necessary to organize, carry out, and evaluate actual work (Bekalo & Welford, 2013).

The latter may be partly due to difficulties in accessing information, as well as a lack of access to libraries, computer networks, periodicals, and textbooks. Many of the educational systems in developing countries are descendants of those of the previous colonial powers, and in some instances, outside experts still have an influence on the curricula in these systems. The most current instructional trends from developed countries, whose approaches were based on the idea that learners should be more hands-on, were frequently adopted by these educational institutions (Hamisi, 2011).

Aadland (2017) asserts that there is insufficient evidence to make a clear determination regarding the viability of the hands-on approach in developing countries. She goes on to say that scepticism about the benefits that can be measured will continue if science achievement tests do not take into consideration the skills acquired through hands-on activities. Other authors (Hodson, 2012; Van der Linde et al., 2004; Bradley et al., 2008) have remarked on the lack of research as well as its inconclusiveness regarding the outcomes of the hands-on approach in developing countries. They caution against extrapolating developed countries' values from the importance of hands-on activities in advanced countries.

There are distinctions in context between the two sorts of cultures, according to Yitbarek (2012) and Gupta (2016) (industrialised or developed countries). For many learners in underdeveloped nations, their first exposure to mains electricity and manufactured technical objects may take place in a school science laboratory. This is an illustration of how education functions and what it does. Consequently, unlike learners in an industrialized nation, these learners may benefit differently from hands-on activities.

In developing countries where curricula call for the use of hands-on activities, there may be several barriers preventing their application in the classroom. Lack of resources (Waterman & Thompson, 2015), large class sizes (Bradley & Maake, 2008), an overburdened Annual Teaching Plan (ATP), and an examination system that prioritizes factual recall over formal evaluation of practical outcomes and the application of scientific reasoning to solve problems

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are some of the most frequently mentioned barriers (White, 2008; Treagust & Thair, 2009; Welford, 2013).

Some of the studies on the hands-on approach that were located by the researcher globally are, for example, Alijanian (2012): The effects of the hands-on approach on English of Iranian third-grade junior high school students in Iran; (Adesoji & Ibreheem, 2009): Effects of the hands-on approach on mathematics knowledge and senior secondary chemistry students' outcomes in chemical kinetics in Nigeria. The finding of Yeung (2015) justifies the need for research into the efficiency of a hands-on method as a teaching and learning strategy in practical work in the physical sciences.

By identifying five global investigations into the hands-on approach, Yeung (2015) alludes that even at a global scale, not very much research has been done on the effectiveness of the hands-on approach as a teaching and learning strategy. These interactions include Ghazi (2001) who explored the experiences of students using a hands-on approach in an English class in Lebanon. Ghazi (2004), investigated teachers' opinions on the practice of a hands-on approach and Khan and Inamullah (2011) explored the variations in the effectiveness of the hands-on approach between control and experimental groups.

Adesoji and Ibraheem (2009) investigated the effects of a hands-on approach on the mathematical aptitude of senior secondary school chemistry students' learning outcomes in chemical kinetics. The results showed some noteworthy differences and suggested applying a hands-on method to the topic. Their findings provide support for the effectiveness of a hands-on approach as a cooperative learning strategy in teaching. Omoshehin (2004), concluded that the superiority of the hands-on approach as a cooperative learning method over conventional methods is attributable to the fact that it makes students develop more positive attitudes towards themselves, peers, adults and learning in general. Cameron et al (2013), later reinforced this conclusion, while Khan et al (2011), emphasized the role of motivation on learners' performance.

Khan et al (2011), carried out a study which was meant to investigate the effects of the hands-on approach on learners' academic performance in Grade 12 Chemistry in a government secondary school. The findings substantiated those made by Anto et al (2013), where students taught through a hands-on approach performed better than those exposed to the traditional method. In their study to identify the effects of a hands-on approach towards students' reading competence, Anto et al (2013) registered some significant differences between students who were taught using a hands-on approach and those taught using traditional methods. Like in other research studies, the students who were exposed to the hands-on approach achieved

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significantly higher marks and demonstrated higher levels of motivation to succeed as opposed to their counterparts who were exposed to the conventional method.

Recent research by Glomo-Narzoles (2015) attempted to determine the impact of the hands-on method on the academic performance of English language learners who are not native speakers. According to the findings, a practical approach improved students' academic performance in the topic. Given the compelling nature of the research evidence regarding the hands-on approach, it is reasonable to assume and propose that its adoption will help teachers and learners achieve better academic results in practical work in the physical sciences.

2.6.3 The hands-on approach in South Africa

In South Africa, the FET phase (Grades 10–12) is when physical science education starts, and it demands that learners put in actual work. However, learners are introduced to the natural sciences as a learning area and independent learning area in the intermediate phase (grades 4-7) through the senior phase (grades 7-9), where they participate in hands-on work and numerous experiments. The objective of the physical sciences and the natural sciences is to foster experimentation among learners while fostering critical and innovative thinking. The practical approach aims to offer learners the chance to develop and apply specific scientific skills to address scientific problems.

Furthermore, it is desirable and applicable when the teacher wants to promote positive learner interaction, an engaging and facilitative learning environment, a variety of cognitive and effective outcomes and positive relations among the learners themselves and the teacher. The South African NCS (R-12) and the CAPS physical sciences document (2015) are very outspoken, specific and clear about the educational and social imperatives that formal instruction must produce and provide. Included in these educational goals, objectives and imperatives are the ones referred to by Johnson et al (2012) as a basis for the use of cooperative learning and the hands-on approach. To add to this, most of the learning topics and practical work covered in physical sciences as stipulated in the CAPS document (2015) are complex, which is an essential justification and requirement for the use of a hands-on approach.

Learners' persistently poor performance in physical sciences practical work in South African schools over the past ten years has led to an increased interest in understanding the potential role of the hands-on approach, pedagogical practices, and content knowledge, and how they may figure within these patterns of poor academic performance (Taylor & Taylor, 2013; Carnoy

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et al., 2012). The lack of a fundamental knowledge of physical sciences practical work by many South African teachers is a recurring finding in the literature (Nomlomo & Sosibo, 2016).

Alternatively, even if teachers lack the necessary training, the presence of classroom laboratories may not be a factor in determining how successful a teacher is (Van der Linde et al., 2004); however, it may be an important tool if the teachers opt to use a hands-on strategy. The results of the Mokima's (2014) study shows that most teachers have a limited understanding of how to use the tools, according to research done in South Africa on how teachers use laboratory tools for a hands-on approach, which has caused them to adopt teacher-centred approaches to science teaching. Even less satisfactory, according to reports, were the instruments used in conventional classrooms for a hands-on approach (Van der Linde et al., 2004).

The choice of a hands-on approach among other approaches and forms of cooperative learning has further been motivated by the researcher's sufficient familiarity with it. It has also been supported by the lack of and the inconclusiveness of literature on the degree of success and efficiency that the hands-on approach has on the academic performance of learners in physical sciences practical work. A survey of literature in a South African context has offered very limited research into the effectiveness of a hands-on approach towards improving learners' performance.

The selection of a hands-on approach as a proposed and suitable strategy applicable to performance improvement in physical science practical work is also based on the literature review conducted on cooperative learning in conjunction with an investigation into its different techniques. The social constructivism theory, which serves as the foundation for this research, is consistent with the hands-on approach used in teaching practical work. Since learner collaboration is essential to achieving the learning outcomes and objectives of physical sciences practical work in the FET, cooperative learning is the most effective way to develop practical skills and techniques and reinforce scientific ideas and principles.

The hands-on approach is also chosen due to its iterative features. Although primarily learner-centred, its practical application combines both a teacher- and learner-centred strategy. This gives teachers the chance to fulfil their customary responsibilities in the classroom. The teacher can combine a learner- and teacher-centred strategy in a single lesson by using a hands-on approach. This will improve the effectiveness, interest, and efficiency of teaching and learning, particularly in South Africa's diverse school setting.

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2.6.3.1 Hands-on and Co-operative learning methods' value and usefulness for diverse high school settings.

All cooperative learning methods support the collaborative learning philosophy, which holds students responsible for both their own learning and that of their teammates. In addition, professional learning community strategies emphasize or focus more on the use of team targets and team success, which can only be achieved if all PLC members understand the lesson's goals. Three additional PLC method pillars include team rewards, individual accountability, and equal chance for success.

2.6.3.1.1 Student teams' achievement division (PLC)

In the student teams' achievement division method, one teacher as a group leader in the PLC presents a lesson followed by study worksheets for other teachers set up in pairs. Teachers in pairs are heterogeneous in terms of ability and ethnicity. Therefore, learners may participate in individual quizzes on the material presented by the group leader (Kuntz & McLaghlin, 2001; Slavin, 2010). For this study, physical sciences teachers continue to work in pairs to drill and tutor one another to prepare in their diverse classroom spaces where the real teaching of physical sciences practical work must take place.

2.6.3.1.2 Team-Assisted Individualisation (TAI)

Slavin (2010) asserts that team-assisted individualisation also uses four or five-member mixed-ability learning teams and rewards high-achieving teams. Team-assisted individualisation, however, fuses co-operative learning with individualised instruction. For this study, PLC members observe other teachers' presentations of practical work to improve on their own. As a result, teachers have equal opportunity for success, because they can trace where they have not been doing it right in their diverse classroom set-ups.

2.6.3.1.3 Teams-Games-Tournament (TGT)

A team game tournament is like student teams' achievement in rationale and method. In team game tournaments instead of quizzes, students play academic games to show their mastery of materials. For this study, in this kind of competition, the high achievers of one team compete with those of other teams and low achievers compete with other low achievers from other teams, ensuring equal opportunities for success. Individual accountability is ensured when competitors are not helped by their teammates (Kuntz & McLaughlin, 2001; Slavin, 2010).

It is crucial to remember that the hands-on approach grew out of and is impacted by the cooperative learning process, particularly in South Africa's various classroom contexts. The significance of cooperative learning in the study comes from how well it will enable teachers in the PLC ensure that their learners perform better in practical work in the physical sciences.

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According to Jacobs and Ward (2012), co-operative learning can be described as ideas and techniques for maximizing the value of learner engagement in a variety of school settings. Cooperative learning, as defined by Gawe (2002), is a method of teaching where learners collaborate to make sure that every member of their groups has learned and absorbed the same material.

Moving forward to employing PLC in the improvement of physical sciences practical work performance, Acikoz (1992), as cited in Nejadghanbar & Mohammedpour, (2012) advised that certain components should be taken into consideration for co-operative learning, more specifically, in diverse high school contexts of South Africa.

- Group rewards are essential for PLC members to understand that individual success is dependent on the success of a group.
- Positive interdependence is an environment where mutual efforts are applied by individual members toward achieving team goals.
- Individual accountability refers to each member's contribution to obtain the group's success.
- Face-to-face promotive interaction where members motivate one another by encouragement or assistance to learn the content.
- Social skills must be taught to learners to cultivate an appropriate learning environment with groups.
- Group processing helps PLCs to identify behaviours that bring dysfunction and should be discarded for those that promote effectiveness which should be encouraged in a group.
- The opportunity for equal success is achieved when members of the group align their behaviours accordingly to allow a fair opportunity for all members to learn.

The hands-on approach to teaching physical sciences practical work in South Africa is project-based with an emphasis on learner-centeredness to inculcate active participation of learners. Learners work in groups to do projects that solve real-life context problems or meet the need or opportunity arising. Therefore, the acquired knowledge is complemented by practical work that needs the implementation of the knowledge obtained (NDE, 2002; NDE, 2003; Raucsher, 2010; Rohaan, Taconis & Jochems, 2010; DBE, 2011; Hong et al. 2011). The researcher, however, asserts that for physical sciences teachers to be able to master teamwork and be "hands-on" in successful implementation for their learners during the practical assessment task, they need to learn how to work in teams employing PLC during the delivery of physical sciences practical work in diverse high school settings.

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Teachers of physical sciences who use a hands-on approach in their classroom may recognize some desirable outcomes and support learner-centred teaching strategies. Numerous advantages of hands-on learning that appear obvious have been supported by research. According to Rohaan, Taconis, and Jochems (2010) and Hynes (2012), physical sciences teachers should have knowledge of pedagogical approaches and teaching strategies that are applicable to hands-on learning in teaching practical work. Some of the teachers' comments on the advantages of the hands-on approach include the following:

Science learners who participate in hands-on programs retain the information better, enjoy a greater sense of success upon finishing a task, and are better able to apply their learning in subsequent contexts (Adebayo, 2018). Information has a better chance of being organized in memory for practical retrieval when many learning methods are assessed, such as in hands-on learning. Those learners who struggle in the classroom due to behavioural disruptions or auditory problems because they participate in the learning process rather than merely observe it, it is discovered that they are more frequently on task (Colen, 2013). To be successful in this study, the PLC's physical sciences teachers must have confidence in their ability to handle materials.

All of the most recent method studies and research serve as the foundation for defending the usage of hands-on science. The idea of a multifaceted barrage of experiences and information to increase retention is supported by current research. The laboratories and activities provide learners more control over their learning. For this study, for one to be in charge of “their own learning”, is one principle that is regarded as a core component of PLC. Here, members of the PLC are assigned the responsibility of ensuring that all parties apply concerted effort for the benefit of the whole group (Laing, 2002; Johnson, Johnson & Smith, 2012). Members of the PLC should be trained to become accountable and submissive to one another in cultivating positive learning within their groups, even more so in the diverse high school settings in South Africa.

For learners who are either less "talented" intellectually or who have not demonstrated "interest" in school, hands-on learning in the classroom has many advantages. In contrast to "normal" show-me-how-to-do methods, this approach (hands-on learning) tends to compel these types of learners to participate and ultimately absorb information (Aadland, Espeland & Arnesen, 2017). The researcher believes that individual and group accountability in PLC discourages the “free riders” spirit among the members. Each member is encouraged to bring his/her contribution to the table for discussions or give feedback on the task that was assigned to him/her. By doing so, the team is allowed to identify a member or members that may need

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extra help from teammates to obtain the stipulated group goals (Johnson & Johnson, 2006; Johnson & Johnson, 2009).

The single most significant advantage is that, once a system has been created, hands-on teaching makes teaching enjoyable. "I hear and I forget, I see, and I remember, I do and I comprehend," is a saying that is often used in relation to learning (Haury & Rillero, 1994; Yitbarek, 2012). The researcher believes that face-to-face promotive interaction where teachers become more hands-on and interact with other PLC members could be observed when PLC members work together, promoting each other's success. The goals are achieved through the honest sharing of resources, correct information and helping one another to comprehend the work at hand. Supporting each other instrumentally, and encouraging and applauding one another's efforts, promote cognitive development and the construction of knowledge from experiences (Gupta, 2016).

These words may not exactly translate, but they highlight the necessity of a practical approach to science education. Without it, students are forced to depend on abstract thought and memory, two techniques that limit learning for most students (Ndihokubwayo, Uwamahoro & Ndayambaje, 2018). Learners learn to think critically as well as find scientific ideas by engaging in and experiencing science (Ochonogor, 2012). While memories diminish, this self-discovery remains with learners throughout their lives. For this study, the researcher believes that interpersonal and small group skills are acquired during the face-to-face interaction processes of the PLC group. These skills do not just happen, but learners need to be guided by the physical sciences teacher showing them acceptable ways of conveying information to other members, resolving conflicts within the group and acquiring good leadership qualities, to mention but a few of these skills (Ndihokubwayo et al., 2018).

For these benefits of hands-on learning to be evident in the PLC, the researcher recommends that physical sciences teachers, more specifically those in diverse high school settings, should be trained in PLC meetings for the following reason. It would be hard for physical sciences teachers to implement hands-on learning in their classrooms if they do not have the "know-how", as they would not be able to assess if the previously mentioned characteristics of PLC exist in the groups. If the teachers are not trained, they may assign learners to groups and expect them to be functional, although research has proven the necessity of training learners as well.

The researcher therefore thinks that physical science teachers would be able to share their knowledge and skills required for their learners to understand information in various learning environments if they were included in PLCs. It would be practical to instil the advantages among the group of learners after PLC teams have combined.

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2.7 PROFESSIONAL LEARNING COMMUNITIES (PLCs) AS A TOOL IN EXECUTING EFFECTIVE PRACTICAL WORK

The researcher covered the hands-on method as a collaborative teaching strategy and a learning technique in the part before this one. The researcher goes into detail about the PLC's different aspects and how they relate to the study in this section. The PLC serves as the contextual foundation for teaching and learning practical tasks in the physical sciences. The PLC will be described in terms of its idea and scope as an operational tool to reduce difficulties encountered by both teachers and students during practical work. It will be discussed why a PLC was used as a teaching and learning strategy in this research.

2.7.1 The concept of Professional Learning Community (PLC)

According to Park (2008), scholars and researchers studying learning communities often describe PLC in terms of their own experiences since each learning community under study has unique traits and circumstances that force it to create its own definition of a learning community. A learning community, in the words of Garvin, Edmondson, and Gino (2008), is "a place where employees succeed at producing, gaining, and transferring knowledge."

Kim (2008) asserts that a learning group enhances its capacity for taking effective action. Mulford (2010) defined a learning community as a group of people who are dedicated to regularly assessing the value of their shared goals, making changes to them, and continuously coming up with new, more efficient ways to accomplish those goals. Senge (2012) defined a learning community as one in which members are constantly enhancing their ability to produce the outcomes, they truly desire, are encouraged to think in novel and expansive ways, are free to pursue group aspirations, and are constantly learning from one another.

In PLCs, adaptive learning adheres to social conventions and assures survival, whereas generative learning fosters the growth of fresh knowledge and skills that increase people's "capacity to create" (Coster & Westelius, 2016). The ability of the learning community to alter and improve system processes and structures is increased by generative learning since it results in a shared vision. Building the conditions that inspire people to do great things for themselves and their society is the focus of such a learning community. According to Retna and Ng (2016), the way learning groups function is a result of how its participants communicate and collaborate.

The idea that PLCs foster the ability to learn, reflect, and create underlies their significance. These skills are used by a professional learning community to effectively mobilize and utilize

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resources and to complete the greater work of managing the changing environment both within and outside, particularly in different educational settings to enhance the effectiveness of teaching and learning (Williams et al., 2012). There is evidence in the literature that learners perform well in environments where schools are viewed as professional learning communities. One of the reasons is because everyone in these learning communities is dedicated to lifelong learning, and there, individuals are always learning how to study alongside one another (Moloi, 2010).

People are naturally inquisitive and enthusiastic about learning, so Cardenas-Robledo and Pena-Ayala (2018) contend that learning communities are feasible. He continues by stating that in learning communities, the leaders are the designers, teachers, and stewards who direct each member of the organization in managing the ambiguous connection between vision and reality while promoting the notion that people can learn. The learning community is an effective tool for improving teaching and learning in schools and for facilitating knowledge management (Moloi, 2010). Senge et al. (2012) claim that the five disciplines of "personal mastery," "mental mode," "shared vision," "team learning," and "system thinking" may be able to assist schools in meeting the demands of educational changes and performing better.

An "innovation in human behaviour" is what the word "discipline" denotes (Clara, 2015). In addition, according to Kelchtermans (2012), it incorporates several characteristics such as "a body of theory and method that must be mastered," a "developmental route for learning certain abilities or competencies," and the idea that one is constantly "in the condition of practicing." When the PLCs theory is used in the setting of a school, the institution is referred to as a learning school (Ng & Feldman, 2009). In particular, in the diverse high school setting in South Africa, the institution develops new capacities for in-depth learning and adaptation to social changes.

According to Senge et al. (2012), a learning community can only be "re-created, made vital, and consistently renewed" by implementing a PLC. This necessitates involving everyone in the system in the dissemination of their objectives, the creation of awareness, and the co-creation of their capabilities. Teachers who may have once harboured animosity toward one another now acknowledge their common interest in the advancement of the educational system and the things they can learn from one another in a physical sciences PLC (Kessels, J. 2012).

According to Yurtseven Avei, O'Dwyer, and Lawson (2020), a PLC group is a learning community that can adapt creatively to environmental changes in the context of the varied schools in South Africa. Such a learning community has developed the continuing school assessment process and implanted capabilities for staff development and curricular

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adjustments at the school level (Al Mofarreh, 2016). High school PLC groups must continue to study and develop their talents on a personal and a collective level in order to advance professionally.

Only if school SMTs are committed to transforming their institutions into stronger ones can teachers progress the work of the professional learning community (Maeland & Espeland, 2017). It is the responsibility of the leaders in the learning community to promote learning chances for both teachers and learners. Community leaders should show a very strong commitment to teachers' continuous learning by giving them opportunities for personal and professional growth, fostering a culture of collaborative learning, embracing a shared vision, and assembling a committed team dedicated to achieving the PLC's goals of improving the academic performance of learners in various high school settings (Otor, Ogbeba & Ityo, 2015).

2.7.2 Characteristics of Professional Learning Communities (PLCs)

When the SMT and teachers work together to develop a common set of benchmarks and measures that are understood by all parties, including the learners, a professional learning community is created (Kukulska-Hulme & Viberg, 2018). To ensure transparency about what learners and teachers must comprehend and be able to do, teachers should hold a common mission, vision, values, and goals in professional learning communities (DuFour & Eaker, 2006). The following characteristics of PLCs are listed by Brandt (2003):

- They share difficult but attainable objectives.
- They have members who can recognize the organization's developmental stages with accuracy.
- They gather, analyze, and act on information in the most effective manners for their objectives.
- They have a system in place for developing new ideas and a knowledge base.
- They continuously improve their fundamental procedures. • They receive feedback on their goods and services.
- Because they are "open systems," they are responsive to changes in the social, political, and economic environment.

Furthermore, communities or groups of learning are comprised of elements such as cognitive, social and teaching presence. Therefore, when implementing PLC in the physical sciences practical work component of diverse high school settings, most of the above-mentioned characteristics are expected to be evident (Garrison & Kanuka, 2004):

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2.7.2.1 Positive interdependence

Positive interdependence is said to be noticeable when teachers in the physical sciences PLC realise that every member is putting in an expected amount of energy for the success of the team. Secondly, all PLC members are working together in peace toward set group goals, such as completing a task outstandingly and on time (Jalilifar, 2009). Most importantly, each member could only be able to achieve personal goals in the physical sciences practical work PLC class if goals are reached (Finelli, Bergom & Mesa, 2011; Tanner, Chatman & Allen, 2003, Jensen, Moore & Hatch, 2002).

2.7.2.2 Face-to-face promotive interaction

This characteristic is resembled by members of a group sitting together, who can communicate with each other and interact at close range using acceptable voice levels in a classroom (Finelli, Bergom & Mesa, 2011). Thereby teachers in the physical sciences PLC class could share their opinions, give inputs and solve problems as a unit.

2.7.2.3 Individual and group accountability

In simple terms individual accountability could be explained as a state whereby each member of the group acts responsibly, taking the learning process seriously and earnestly putting in a concerted amount of energy for the group to obtain its goals, whereas PLC accountability would be seen when all group members put in an expected effort and at the same time share group obligations. All members of the physical sciences PLC are expected to be faithful to the task entrusted to them by the team. It would also direct group energy to produce reporting and feedback other than wasting energy on negative situations (Finelli, Bergom and Mesa, 2011; Muraya & Kimamo, 2011).

2.7.2.4 Interpersonal and small-group skills

These skills could be explained as the use of appropriate communication methods and values when working with other people. Small-group skills include portraying acceptable behaviours and communication (verbal and non-verbal) cues, such as keeping eye contact when talking to others. PLC members are also expected to be able to uphold other teammates' inputs and accept criticism and correction positively. Each member should actively take part in arriving at group decisions and conclusions (Muraya & Kimamo, 2011; Tanner, Chatman & Allen, 2003).

2.7.2.5 Group processing

At this level, members of the physical sciences PLCs are expected to have matured in a cooperative learning environment and are therefore able to assess the group proceeding constructively. Thus, they should be able to indicate each member's contribution and dedication based on the quality of work produced by the respective member. Secondly, the team should also be in a state where they can confront unwanted behaviours and culprits must be willing to take the blame and accept correction. Lastly, the team should be able to identify

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their strong and weak points so that they can use their strong points more effectively in the future (Muraya & Kimamo, 2011).

2.8 BENEFITS AND CHALLENGES OF PLCs

The Professional Learning Community as an active learning method adopts a constructivist approach and should have the above-mentioned characteristics. Thorough discussions on the benefits of PLC are going to be done in this section of the chapter. The researcher will define PLC through its components as a way of addressing challenges faced by teachers in teaching physical sciences practical work effectively to ensure better performance in physical science practical work.

PLC is the continuous learning process which involves teachers engaging in conversations about the challenges for teaching and learning, relationships, structures, functions and assumptions that are part of the organisational climate (Easton, 2008; Thiessen & Anderson, 2009), particularly in diverse high school settings. PLCs are effective because they support the development of leadership, learning, and growth skills. They also work under the premise that teachers' ongoing, job-integrated learning is the key to improving learner performance (DuFour et al., 2008; DuFour & Eaker, 2008). The advantages of PLC are covered in the part that follows, with emphasis on diverse high school settings.

2.8.1 Supportive and Shared leadership capacity.

One of the advantages of PLCs is their capacity for supportive and shared leadership (Annenberg Institute for School Reform, 2013; Belinger-Gustafson, 2004; DuFour & Eaker, 2008; Hord, 2007; Patterson & Rolhiehieser, 2004). In the physical sciences PLC, for instance, shared leadership capacity enables all members to contribute to school progress. Personal mastery, one of the five fundamental disciplines described by Senge (2012) for a learning organization, is correlated with the capacity for leadership and assistance. Senge (2012) asserts that developing one's own capability requires having a cogent personal vision. It is regarded as a unique form of competence.

The researcher strongly believes that shared leadership structures are important for the functioning of physical sciences PLC. It is common practice that both principals and individual teachers find it difficult to share power and authority within a school (Hord, 2007; Sommers, 2008). It is also a common understanding that teachers, particularly in diverse high school settings, find it difficult to propose new ways of thinking and doing when the school or Head

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of Department/principal is viewed as unwilling to share power. However, PLCs are places where both the principals and teachers are learners and distributed shared leadership positively impacts the situation (Hargreaves & Fink, 2006).

2.8.2 Collective learning

A PLC is a setting where colleagues can study and work together (Hord & Sommers, 2008). Because of their collaborative work, teachers anticipate that all learners will be able to learn at a reasonable high level. Due to the challenges that learners encounter outside of the educational setting; it does not actually happen. However, these chances enable them to engage in lifelong learning and integrate what they have learned into a variety of teaching methods. Such a collaborative procedure emphasizes the necessity of collectively seeking out new knowledge (Hord, 2014).

Based on the above explanation of collective learning, the researcher is of the view that teachers like to base their learning on collegial inquiry and their dialogues about their reflections. Collective learning is one of the benefits of PLC in that; it helps teachers to pay attention to ways of improving their instruction by focusing on student learning. For teachers, it has been suggested that attention may need to be devoted to learning new strategies, new curriculums and assessment policies (Hord, 2014). In the physical sciences PLC, there may also be a need to plan for collaboration to incorporate the new learning into practice to revise, strengthen, change or continue the agreed new approach which may be beneficial for members of the professional learning community, especially those who function in diverse high school settings in South Africa.

Socialization is considered an important factor in collective learning (Kruise, 2014). This is very important for how a newly recruited teacher might adapt to the vision of the community. Physical sciences teachers need to communicate a sense that all members of the PLC are a productive part of a meaningful collective. Members of the PLC need to know that the learning of physical science practical work is for the wellbeing of a community to assist learners to improve performance.

2.8.3 Shared personal practice

Teachers, like learners, require a suitable setting for their professional development (Hord, 2014). Such an environment values and promotes hard work, undertaking challenging tasks, taking chances, and fostering growth (Midgley & Wood, 2013). It is acceptable to consider shared personal practice to be one of the benefits that supports the professional learning

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community because it contributes to the setting for teachers' professional development (Hord, 2014).

In PLCs, especially in diverse school settings, teammates talk about the circumstances and unique difficulties they encounter on a daily basis in their academic endeavours (Kruise, 2014). They create a set of common standards, viewpoints, and values that serve as a foundation for behaviour (Hord, 2014; Kruise, 2014). Teachers compare techniques and behaviours with one another for this reason. Instead of evaluating teachers' learning or teaching method, the emphasis is on a process called "peers supporting peers" (Hord, 2014). Teachers do this evaluation through staff meetings, specially created planning sessions, and frequent visits to one other's classrooms to observe, take notes, and discuss what they observe (Patterson & Rolhiehieser, 2004).

The researcher believes that the classroom peer observation process as it is done in the PLC supports teachers in different ways and may be beneficial for all teammates. Although it might be sensitive, it has a foundational purpose of gathering information that teachers can use to learn, reflect on and improve their instructional behaviour (Roberts & Pruitt, 2003, 2009; Sullivan & Glanz, 2010). It fosters a culture in which teachers collaborate, learn from one another, and construct shared pedagogical beliefs and strengths (Roberts & Pruitt, 2009). The researcher strongly believes that through collaboration teachers can do self-introspection and unearth internal pictures of an individual’s activities.

Supporting the implementation of innovative teaching strategies is another goal of shared personal practice. Teammates support one another in using a new teaching technique through action research, coaching, mentorship, feedback, and collegial and collaborative decision-making, especially in diverse high schools (Alberta Education, 2006). Typically, they take notes during feedback in order to facilitate dialogue. Therefore, teachers of physical sciences use these talks to assess and criticize themselves.

2.8.4 A commitment to continuous improvement

The general culture of all school beliefs, attitudes, and behaviours includes school progress in a variety of educational settings (Alberta Education, 2016). In essence, it emphasizes the need of gathering data as a foundation for decision-making, problem-solving, and research. Internal community support from other individuals is crucial to consider (Annenberg Institute for School Reform, 2003; Morrissey, 2010). If teachers of physical sciences are going to experiment with new methods and concepts, they need the backing of the school community.

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Additionally, this is a prerequisite for achieving any significant, long-lasting change in their approach to teaching (Kruise, 2014)

This benefit is important, particularly for this study, in that if teachers feel that they are supported in this goal of improving learners' performance in physical sciences practical work, it will encourage teachers to learn new knowledge about practical work and help them to make decisions for the benefit of the learners.

Teachers of physical sciences collaborate to create a process for identifying, gathering, and analyzing instances of practice adjustments. They take part in meetings for their grade level or topic area, talking with colleagues about decisions and procedures related to teaching and learning (Morrissey, 2010). These ultimately have an impact on culture, norms, and results, providing proof that the professional learning community strives to enhance teachers' educational experiences. A PLC within the confines of a varied educational environment, however, also needs the proper assistance to be successful.

2.8.5 Shared vision

A shared vision is an all-encompassing perspective that provides guidance in terms of what one already knows, what they still need to learn, and what they should value (Wallace et al. 2008:20). A common vision is described as a coherent, reliable depiction of the desired future by Moloi et al. (2006). Senge (2012) continues by stating that certain skills are necessary to cultivate shared future visions that promote involvement and commitment rather than conformity. Leaders who have mastered this practice understand that dictating a vision—no matter how sincere it may be—is ineffective (Senge, 2006). In order to achieve the PLC's objectives, leaders and staff must share their perspectives, particularly in schools with a diverse learner body.

Personal visions within the PLC remain the views of lone individuals unless they are shared to help construct the vision of the future the PLC aspires to (Bui & Baruch, 2011). Personal visions gain strength from the individual's intense care for the vision, but shared visions gain strength from shared caring (Senge, 2006). People succeed and learn when there is a sincere goal because they want to, not because it is required of them (Senge, 2006). There is proof that PLCs can be successful in coordinating individual and group goals (Adair, 2005).

For all the reasons mentioned above the researcher believes that shared vision is one of the greatest benefits of the professional learning community in that the teachers in the physical sciences PLC may develop the following attitudes, according to Senge (2012):

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- Commitment: The will to put in place whatever framework is required for the achievement of the vision.
- Enrolment – the person is motivated by the vision and will go above and beyond what is necessary within the framework already in place to make it a reality.
- Sincere compliance — the person follows instructions without question since they recognize the vision's advantages.
- Formal compliance — the person complies with the requirements in full and acknowledges the vision's overall benefits.
- Grudging cooperation - the person just complies because they do not want to lose their job; they do not recognize the value of the vision.
- Non-compliance — the person refuses to comply since they do not see the value in the vision.
- Apathy – the individual is neither for nor against the vision and has no interest or energy in working towards fulfilling the vision.

From the above-given benefits, Hord (2007) asserts that involvement in PLC helps to reduce isolation and encourages collaborative structures between teachers. It also encourages teachers in making major changes in how they interact with their colleagues in school. This process leads to an increase in conversations between colleagues to demonstrate a higher commitment to their vision, mission, values and goals. Lastly, physical sciences teachers should find opportunities to gain a deeper understanding and meaning related to their content area and the overall curriculum in the school.

2.9 THE ROLE OF A TEACHER AS PART OF PLC

The knowledge, abilities, and values that South African schools should place an emphasis on are outlined in the National Curriculum Statement, Grades R–12. The curriculum of the school seeks to provide learners with knowledge and skills that they can use in their everyday lives. In this way, the curriculum promotes knowledge in regional contexts while taking various global imperatives into consideration.

One of the broad goals of the South African curriculum, "Inclusivity," describes the role teachers should play in ensuring learners' success. According to CAPS, every school's planning, administration, and instruction should prioritize inclusion. This is only possible if all teachers possess a thorough understanding of how to identify and remove learning obstacles as well as how to plan for diversity.

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The best way to manage inclusivity, in accordance with CAPS, is to make sure that all relevant support groups within the school community, including teachers, Direct-Based Support Teams, Institutional-Level-Support Teams, parents, and Special Schools as Resource Centres, are aware of any barriers and take the necessary steps to remove them. Teachers should implement a variety of curriculum differentiation techniques, such as the Professional Learning Community, as outlined in the Department of Basic Education's Guidelines for Inclusive Teaching and Learning 2010 to handle learners' barriers in the classroom (NCS, 2012).

The researcher believes that the classroom approach to teaching physical sciences practical work should be based on learner-centeredness to integrate active participation through hands-on involvement, especially in diverse school spaces. Teachers should start working in teams like in PLC to demonstrate and do practical work together to solve real-life context problems to assist learners. It is for this reason that the researcher asserts that for physical sciences teachers to be able to master teamwork during the teaching of practical sciences, they need to be taught how to work in teams by employing a professional learning community during the delivery of physical sciences practical work.

Teachers must take on new responsibilities, according to the Revised National Curriculum Statement (RNCS). The new administration views teachers as major forces behind South Africa's educational change. The Curriculum Assessment Policy Statement views teachers as learning mediators, interpreters, designers of learning programs and materials, leaders, administrators, and managers, academics, lifelong learners, community members, citizens, and pastors, as well as assessors and learning area or phase specialists (DoE, 2012).Based on the above statement it is of utmost importance to highlight the important aspect of physical sciences teachers' role in the PLC concerning curriculum knowledge and skills (on practical work) that an empowered teacher should display to cope with the role of the teacher in the PLC.

A physical sciences teacher is expected to demonstrate four types of knowledge categories for the execution of physical sciences practical work in the Free State. These are, firstly, subject matter knowledge, which is about conceptual, procedural, content that needs to be taught to learners, and the understanding of physical sciences practical work. Second, having general pedagogical knowledge entails understanding various teaching and learning techniques, the context, and how to read South African curriculum documents. Finally, pedagogical subject knowledge is a vast and interactive field in which a teacher should be aware of learners' perspectives, misconceptions, and misunderstandings of physical sciences. The researcher thinks that professional development is necessary for teachers to demonstrate

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all of these knowledge categories, and a professional learning community is one place where teachers in various school settings can share knowledge with one another.

It's crucial to first define professional development (PD), which refers to the knowledge, abilities, and dispositions that a teacher should have in order to effectively and positively contribute to learning inside the PLC. PD is demonstrated by a "empowered teacher" and is critical to understand. A teacher's professional competence is enhanced through the development of skills, knowledge, and disposition, according to Bizzell (2011), who defines professional development as any action. In Zepeda's (2008) perspective, professional development (PD) is a component of a system of supports for educators, School Management Teams (SMTs), and students who want to enhance their learning environment and school.

Similar to this, Maistry (2017) asserts that PD is a continuous process intended to further train teachers, particularly FET teachers of physical sciences, to improve quality performance. Samuel (2008) and Maistry (2008) claim that PD is a successful method for teachers to learn new information, hone new abilities, and provide an example of self-improvement. Fullan (2015) concurs with this definition and argues that professional development (PD) refers to activities that enhance one's abilities as a teacher, including knowledge, experience, and other traits. The researcher firmly feels that PLC is the ideal platform for teachers to develop and learn from others, especially in the diverse high school settings in South Africa, given the aforementioned criteria of professional development.

The Department of Basic Education (DBE) in South Africa has set out teacher training or developmental workshops over the years to develop and train new and old teachers in the system to address critical challenges faced by teachers in various subjects (DBE, 2011). However, the researcher contends that, in physical sciences, particularly in the TMED of the Free State province of South Africa, such workshops have occurred, although only the emphasis was more on the theoretical part of the subject and practical work was left out. According to the researcher, it is important to pay close attention to how to teach practical work to learners and how to improve practical work performance. This, according to the researcher, can be accomplished by including contextual and situational factors that support teachers in gaining skills that enable them to deal with change and development, particularly in a diverse high school setting. Cooperative learning is a useful method for accomplishing this objective. By exposing teachers to constructivist learning environments and real-world examples of cooperative learning during their developmental training, it may be possible to achieve the goal of improving practical job performance.

Constructivism should be incorporated into teacher development, according to Nel et al. (2012), who believed that it would be the best plan for all South African schools. Accelerating

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cooperative learning environments is necessary, and teachers must be held accountable for using teaching strategies that empower teachers to take control of their own education and foster civic and social responsibility. Physical sciences teachers in the FET phase must be exposed to such teaching and learning environments during their educational development in order to become proficient in them and acquire the required expertise before presenting the material to the learners.

Professional development (PD), according to Browell (2010), is focused on the quality of ongoing professional knowledge and skill updating throughout the teacher's career, necessitating self-direction, self-management, and sensitivity to growth opportunities given at work. It places a focus on the knowledge, skills, and attitudes that all teachers, leaders, and other staff members need to have in order to assist all learners in reaching their maximum potential as learners. Khumalo (2016) concurs that PD entails the growth of knowledge, skills, values, and characteristics that enable those who receive them to succeed at their highest levels at work. It seeks to give professionals—including physical science teachers—the tools they need to advance their fields and, in doing so, aid in the more efficient learning of learners.

All of these characteristics are crucial for this study because they will help teachers succeed in their field and, as a result, improve learner performance in physical sciences practical work in diverse high school settings. Constructivism especially embodies pedagogical and situational learning, though they are generally qualities. In addition to empowering teachers, a constructivist approach to teaching and learning will provide them with real-world experience in how to design instruction to meet the needs of all learners and produce the types of learners envisioned by the Department of Basic Education in the National Curriculum Statement (Grade R-12).

According to Moletsane (2004), professional development should be understood as more than just gaining knowledge and skills; rather, it should also include personal growth that allows teachers to grow as individuals and be equipped to handle the various problems that are presented to them. PD is therefore a continuous, career-long process rather than an occurrence, as claimed by Mathibe (2007). Professional development is continuous, as noted by Wallace and Gravells (2007), but Bubb and Earley (2007) track it from initial training through induction, career advancement, and ultimately retirement. Physical science teachers in the PLC may be able to keep up with local, national, and international advancements on practical work promotion and enhance their practice due to the ongoing nature of professional development.

One of the main objectives of professional development, according to Van Driel (2010), is to urge teachers to employ more efficient teaching strategies, which in turn improve learner

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outcomes. The need for opportunities for ongoing professional development for teachers to guarantee performance improvement and learner achievement is widely recognized in the pertinent literature (Mestry, Hendricks & Bischoff, 2009). Steyn and Van Niekerk (2002) note that leadership practices that impact learner success can be developed through PD activities. According to Goldring, Pretson, and Huff (2010), who also highlight the importance of professional development for teachers, the professional learning community is one of the facilitators in helping teachers teach learners to reach new levels of performance and learning.

In his explanation of collaborative PD, Moteetee (2019) describes one of the traits of PD. It might make it possible for teachers in the physical sciences to take part effectively and constructively in professional learning communities. The collaboration seeks to establish a setting where the teachers cooperate to resolve issues with the curriculum, in this case, practical work, through the use of group problem-solving. Gaining more information and applying specific skills and abilities is one advantage of the collaborative model of professional development (Joyce & Calhoun, 2010).

Teachers of physical sciences might be able to collaborate in order to advance learning through a shared purpose. Planning, instruction, peer observation (Mundry, 2005), the implementation of health programs, PLC collaborations, and the monitoring and evaluation of PLC programs are all areas in which teachers can learn from one another. The literature's widespread belief that shared leadership is a crucial component of school effectiveness, which Kwan (2009) calls a general notion, strengthens the case for collaboration between teachers and other PLC members. This partnership is an essential part of teachers' professional development.

Another characteristic listed by Moteetee is "ongoing PD" (2019). According to her, professional development for teachers should be a continuous procedure rather than a one-time event that is forgotten the next day. The continual nature of PD is summarized similarly by Bubb and Earley (2004) who claim that continuing education is one of the qualities that set pros apart. The primary thrust of the justification given is that teachers ought to strive for personal development in order to become better practitioners. Due to ongoing curriculum revisions, teachers must remain informed about regional and societal issues that are relevant to their roles within the school and the Department of Education as a whole (Wallace & Gravells, 2007). The process of professional development (PD) for teachers ought to be one that advances both their scholastic and personal development. Knowing how PD should proceed is crucial, particularly given the various high school settings in South Africa.

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2.10 ROLE OF SCHOOL MANAGEMENT TEAM (SMT) REGARDING PLC

The SMT's function in carrying out practical work in the physical sciences is discussed in this part. It first defines what the SMT is and its roles in general, challenges faced by the SMT in executing the curriculum of which practical work is a part, the implications of non-involvement of the SMT in ensuring that physical sciences practical work as part of the curriculum is well taught and lastly it looks into the actions that the SMT (particularly the physical sciences departmental head and the principal) should take in implementing the successful teaching of physical sciences practical work.

In order to guarantee effective teaching and learning in schools, school leadership takes a variety of steps, which are referred to as education management. The term "school management team" (SMT) is used to refer to all members of the school administration who are responsible for overseeing the management of the school's physical assets, financial resources, and human resources (including students, teachers, and the school community) in order to meet the needs of its learners and meet its strategic goals and objectives (Van Deventer & Kruger, 2000). Heystek (2004) claims that the SMT is a team in charge of the school's professional administration, which includes all the programs that support teaching and learning. The SMT is composed of the principal, deputy principal, department heads, and top teachers.

The definition of the SMT is sufficient for this research because it already prepares the SMT for the leadership and management of practical work teaching as a component of the physical sciences curriculum during the FET phase of the diverse high school settings in South Africa. The SMT must commit to PLCs, according to the expert. Commitment to the PLC is largely dependent on the ability of the individual to create a particular behavioural pattern that can most significantly contribute to effective teaching and learning. People who adhere to the PLC's discipline, according to Senge et al. (2012), are constantly developing their capacity to learn and create. By being dedicated to what is vital to both the individual and the school, they help their schools learn.

According to Khumalo (2014), SMT participation in assuring successful practical work teaching, particularly in diverse high school setting, also entails empowering teachers to teach for increased learner accomplishment. According to Ndou (2008), a skilled leader who sets the pace, provides guidance, and unites teachers by inspiring and motivating them to continue even in the face of challenges and obstacles is necessary for the teaching of practical work as a component of the physical sciences curriculum. Therefore, the management's primary responsibility is to inspire and motivate teachers to teach practical skills. Without motivation

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and exposure to fresh approaches to practical work, physical sciences teachers cannot successfully undertake the teaching of practical work on their own.

The principal is in charge of carrying out the curriculum, which also involves practical work. The Department of Basic Education (2016) states that the principal's main responsibility is to provide leadership and management in all aspects of the school to allow the creation and maintenance of environments that support the highest standards of learner achievement. The Department of Basic Education subsequently places a strong emphasis on curriculum delivery under the guidance of the principal. This is correct, according to the Department of Basic Education (2016), and overseeing the program is one of the principal's main duties. The principal is responsible for giving leadership and making sure that learner achievement is increased, according to the SASA (SA, 1996).

Physical science teachers could learn how to communicate better and more effectively with other members of the professional learning community and develop goals based on common and mutual agreement as a result of the SMT's role in this study. Teachers who are exposed to management support develop strong interpersonal skills over time. These relationship and communication skills are essential for both personal and professional success. Criticos et al. (2014) claim that teachers who receive sufficient support from the school management team also develop extremely strong and successful teamwork skills.

As they attempt to solve issues and complete a learning task—improving practical work performance in this study—teachers who are exposed to SMT's support learn to collaborate and accept various mentalities. Thus, the SMT not only promotes effective and productive interaction among teachers but it promotes social cohesion since groups of teachers in the physical sciences PLC constitute different members from different backgrounds who engage in a common task with a shared vision. The SMT helps with laying a foundation for creating a more tolerant and socially coherent learning community.

Some of the challenges faced by the SMT in improving the academic performance of which physical sciences practical work is a part are discussed in the following paragraphs. This includes the unequal distribution of facilities and resources at school and the lack of training and support. This study needs to look at some of these challenges to understand the impact these shortcomings may have on the improvement of practical work performance.

The unequal distribution of facilities and resources, according to Angula (2015), poses the biggest obstacle to increasing efficiency in practical work. The physical architecture of thousands of schools is still subpar, there aren't enough science labs, and many are unsafe for habitation, according to Ralenala (2018). In the setting of the researcher's school, there is

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frequently neither water nor electricity on the premises, and these circumstances not only impede the school's teaching and learning activities but also have an adverse effect on the health of both teachers and students. The greatest challenge for the SMT is the high absenteeism rate that follows, which causes poor performance.

The schools selected for the current study are in rural areas, as opposed to those in urban areas, which lack a sufficient infrastructure, so the situation has not changed significantly in South Africa as of yet. Regardless of whether facilities and resources are present or not, there are ideas to boost learner performance. According to Graeme Bloch, an education policy researcher for the Development Bank of South Africa, who was cited by Kgosana (2006), inventive teachers conduct experiments by improvising. For example, they might cut bottles into glass beakers or come up with their own measurements. According to him, every school has a right to a fully functional classroom, and sometimes, even the best facilities can't compensate for uncommitted teachers. The researcher argues that priority must be given to learner support materials that are crucial for them to perform better.

Another difficulty the management faces in achieving increased performance is a lack of assistance and training. In most cases, the curriculum itself is sound, according to Lumadi (2014), but hurried implementation leaves teachers in the dark about their duties. According to Bantwini (2011), two-day orientation trainings were the only ones offered when CAPS was first introduced. The first day of these trainings focused on curriculum generalities, and the second day covered content knowledge, primarily the theoretical portion of it without any practical application. One-time training sessions like this are insufficient (Lumadi, 2014).

A report from October 2009 found that not all principals, including SMTs, had the necessary training to fulfill their duties of supervising and directing teachers' work. School management teams without managerial expertise encounter progress-impairing management problems, according to Masitsa (2005), Bush, Joubert, Kiggundu, and Van Rooyen (2009). They also emphasized the requirement for principals to receive training in order for them to effectively implement the curriculum. Ono and Ferreira (2010) go on to say that, particularly in diverse and contextually challenging school environments, teachers' professional development needs to be prioritized in order for them to deliver high-quality outcomes and resume their previous responsibilities in enhancing academic performance.

All parties involved should support efforts to improve academic performance. Since schools are the places where good teaching and learning should take place, it is important to encourage and support them in their efforts to succeed. Numerous commenters have conducted research that demonstrates how frequently this support is lacking. It was discovered that district staff did not assist teachers in mastering RNCS in a different research

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study by Bantwini (2010). The concept that subject education specialists should visit and assist them where they were struggling was also stated by teachers and departmental leaders.

If all of the SMT's aforementioned natural tendencies are fostered or satisfied, the researcher is of the view that PLC meetings for the physical sciences may be beneficial. As teachers talk and debate information in their groups and between groups during PLC meetings, their competence may improve. As they debate their divergent points of view and adhere to the deadlines, teachers help one another become more proficient in the material they are teaching through practical work and problem-solving. The SMT's responsibility is to ensure that deadlines are made and to support teachers as they go through development when difficulties arise.

Furthermore, autonomy support (which is a well-internalised form of intrinsic motivation) from the SMT may provide a worthwhile contribution toward improving teachers' intrinsic and self-determined extrinsic motivation, even more so in diverse high school settings (Gillet, Vallerand & Lafreiniere, 2012). The researcher believes that since teachers have taken the step of collaborating for the sake of improving learners' performance, they need the management's words of encouragement and support.

2.11 CONCLUSION

To improve the poor performance of physical sciences practical work in the diverse high school settings in the Free State, the professional learning community's involvement in teaching physical sciences practical work is crucial. This part discussed the theoretical underpinnings of the practical application of physical sciences as well as the professional learning community. Practical work, physical sciences, CAPS, hands-on learning, and PLC are just a few of the ideas that were used in the study and were clearly defined and explained. Similar to this, teachers' perceptions of PLC and practical work are important for understanding the possible contribution they made to learners' poor performance in physical sciences practical work.

However, it has been suggested that using positive teaching methods and resources will have the biggest impact on improving learner performance on practical work. There is also a full examination of PLC as a cooperative method, outlining how, if done correctly, PLC may help learners perform better academically on practical work. Any classroom instruction strategy must adhere to the requirements of the relevant regulatory framework. One approach where teachers work together toward a common objective is PLC, which is strongly backed by research.

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According to the above preliminary literature review, learner-centred methods are consistently found to be more successful. This chapter emphasized the hands-on approach as a tactic in the pursuit of efficacy in teaching practical work because learner-centred methods can result in high-quality learning. Learners should go through the entire lesson with a practical understanding of the purpose, procedure and findings of the experiment and hence they need to be hands-on. The awareness of PLC, its benefits and the characteristics discussed in this chapter will enable teachers to encourage learners to achieve well in physical sciences practical work. It will also assist teachers to become more aware of those learners who need to be taught in a certain way.

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CHAPTER 3

RESEARCH PARADIGM, DESIGN AND METHODOLOGY

3.1 INTRODUCTION

The preceding chapter on the literature review discussed the professional learning community, its characteristics, and the significance of practical work in physical sciences. The research methods and design that were employed in this study are the main topics of this chapter. The researcher engaged research participants via the professional learning community, whom the researcher believes are knowledgeable and experienced in physical sciences for Further Education and Training (Grades 10–12) and its practical work, using participatory research that was framed in a case study, an interpretivist research design, and an underlying mixed research methodology.

This chapter's primary goal is to describe methodology, research paradigms, sample techniques, and strategies for gathering and analyzing data (Punch, 2006). A number of methods and initiatives employed in this investigation are offered in order to guarantee that the findings are trustworthy and credible, and can, thus, be confirmed and sent to other researchers in comparable circumstances.

3.2 RESEARCH PARADIGM

A paradigm is a collection of presumptions or concepts relating to fundamental truths that give birth to a particular worldview. It discusses fundamental beliefs about faith, including opinions about the nature of reality, the connection between the knower and the known, methodology presumptions, and other ideas about fundamental beliefs about faith (Maree, 2010). In the pursuit of new knowledge, study is a tool for knowledge acquisition and for improving our comprehension of the world we inhabit; our worldview shapes how we perceive the world (Maree & Westhuizen, 2012). Research paradigms are based on this worldview or set of assumptions, beliefs (Nieuwenhuis, 2012), perceptions, and ideas to justify how the world works, and the behaviours that result from these assumptions, perceptions, and ideas (Denzin & Lincoln, 2008; Huitt, 2011).

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However, a paradigm is described as "a loose collection of logically related assumptions, notions or propositions that orient thought" or as the philosophical underpinnings or driving force behind a study (Bogdan & Bicklen, 1998; Cohen & Marathon, 1994 as cited in Mackenzie & Knipe, 2006). Furthermore, a paradigm is "a belief system that ties the user to a specific worldview," according to Denzin and Lincoln (2008). Furthermore, Guba & Lincoln (2008) also describe a paradigm as a “basic belief system or worldview that guides the investigator, not only in choices of methods but in ontological and epistemological ways”.

Hammersley (2012) concurs and describes a paradigm as “a set of philosophical assumptions about the phenomena to be studied, about how these phenomena are to be studied, understood and even about the proper purpose and product of research”. Chalmers, 1982 as cited by Wills (2007) agrees by modifying the definition of a paradigm as “made up of the general theoretical assumptions, laws and techniques for their application that the members of a particular scientific community adopt”.

From the aforementioned definitions, it can be inferred that a paradigm is a set of guiding principles, values, and norms that a researcher should prioritize in order to achieve the intended goal of their study or inquiry. In this study, these beliefs as a researcher are in line with the interpretive (constructivism) paradigm and will therefore be elaborated to help clarify the origin of the paradigm that underpinned this study, as the researcher needs to take a stand in terms of the paradigm that would direct the intentions in carrying out the research processes. A researcher lacks the foundation to use a specific research methodology, methods, and designs without a paradigm (Denzin & Lincoln, 2010; Mackenzie & Knipe, 2006).

This study aimed to give an evaluation of the impact of the professional learning community on raising learner performance in the practical work performance in the physical sciences throughout the FET phase. The primary research question in this study is also: How may PLCs be utilized to enhance learners' success in practical work in the physical sciences? A pragmatic paradigm was used to address the research question in order to satisfy the study's objectives. Pragmatists concentrate on the "what and how" of the study (Johnson et al., 2007).

The researcher gave a more comprehensive picture of the research problem regarding the impact of the PLC on raising learner performance by combining both qualitative and quantitative methodologies. This was done to ensure that the qualitative and quantitative viewpoints were complementary to one another due to their strengths in overcoming the limitations of each (Nieuwenhuis, 2016).

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3.3 INTERPRETIVE RESEARCH DESIGN

This study, which is founded on the interpretive paradigm, aims to clarify the function of the professional learning community in the teaching of practical work in the physical sciences in order to improve learner performance. In this section, the researcher explains and justifies his choice of an interpretive research paradigm, which is suited to a qualitative research design (Nieuwenhuis, 2012). The researcher draws on constructivism and critical theory to answer his research questions and justifies the participant selection criteria used, the procedure that was followed in choosing those participants, the methods of inquiry to be used to capture, code, and categorise data, and the methods to be used to analyse data. The researcher also covered the reliability of the data that would be produced and provided an explanation of the social issues that were pertinent to this study.

The paradigm that the researcher chooses to use affects how they frame their research issue and how they look for data to support their research questions. The study strategy is also determined by the paradigm, which also affects the methods and methodology of choice (Scotland, 2012). The research's selected paradigm will also affect the researchers' method of conduct and the research's source materials (De Vos, 2005).

An interpretivist study strategy emphasizes people's individual experiences, their interpersonal relationships, and how they use meaning exchange to "create" social reality (Maree, 2010). Research methods that will help to comprehend how people interpret and engage within their social context are utilized when examining the phenomenon (subject). According to interpretivism, reality is socially produced rather than being defined objectively (Mackenzie & Knipe, 2006). The fundamental premise is that by situating individuals in their social environments, it is possible to better comprehend how they view their actions (Maree, 2010). The goal of interpretivist research is to provide a perspective on the issue under investigation and to analyse it in order to shed light on how a particular set of people interpret their surroundings or the phenomenon they come across.

The depth and complexity of the explorations and descriptions that the qualitative approach produces is one of its biggest advantages (Maree, 2010). Through inductive methods of data collection and analysis to comprehend phenomena, constructivism tries to generate or build theory (McGregor & Murnane, 2011; Mackenzie & Knipe, 2006; Steenhuis & De Bruijn, 2005). Second, constructivist scholars seek to comprehend, articulate, and communicate information regarding social contexts, such as the function of the professional learning community in imparting practical knowledge throughout the Further Education and Training phase (Mack, 2010; Mertens, 2010).

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Qualitative approaches to research have foundations in philosophical traditions, but with different epistemological and ontological assumptions and methodological considerations (Creswell, 2013; Maree & van der Westhuizen, 2012). The main underlying paradigms of qualitative approaches are constructivism and critical theory (Nieuwenhuis, 2012). The constructivist paradigm is rooted in interpretivism (Nieuwenhuis, 2012).

This qualitative study is guided by a constructivist paradigm, where the participating teachers have to try to understand, construct, and present their knowledge about practical work in the PLC (Nieuwenhuis, 2012), individually and collaboratively (Denzin & Lincoln, 2005). The interpretive approach assumes that we can access reality only when individuals socially construct meaning from their subjective experiences (Huitt, 2011; Nieuwenhuis, 2012). The following gathering tools (that is, direct observations, group discussions, interviews, video/recording tapes, and questionnaires) will be used in this study to generate and interpret data concerning teachers' perspectives on the PLC's role in teaching practical work.

Philosophical elements related to constructivism.

In the following section, the researcher discusses philosophical elements (that is, ontology and epistemology in constructivism).

According to Creswell (2013) and Denzin and Lincoln (2005), ontology is the study of the social world's reality and how people fit within it (Ritchie & Lewis, 2011). As the foundation of reality or being, ontology acknowledges that reality has many sides (Scotland, 2012). (Creswell, 2013). Ontology is the study of reality, being, and the nature of existence, according to Ormston et al. (2013) and Hammersley (2015). Depending on the circumstances, a researcher might consider, for instance, whether social reality exists independently of human conceptions and interpretations, whether there is a shared reality, or whether it might have multiple faces.

Ontology comprises the assumptions about what there is in the world that we may try to know or understand (Ritchie & Lewis, 2011) – in short, ontology asks the "what is?" question. According to relativism, reality is subjective (Scotland, 2012), and can only be known through socially constructed meaning (Ritchie & Lewis, 2011). Reality is interpreted differently by different individuals (Ritchie & Lewis, 2011; Scotland, 2012), and is constructed by the individual through the interaction between them and the social world (Scotland, 2012).

The ontological question furthermore must explore if there are similar or shared social realities among individuals, which gives meaning to how the reality of the individual is constructed through the meanings and understandings developed socially and experientially, or if there

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are numerous context-bound realities, and whether these realities are inflexible and generalised (Ritchie & Lewis, 2011). If the realities are flexible, it will result in multiple constructed realities rather than a single reality (Denzin & Lincoln, 2005; Ritchie & Lewis, 2011).

The epistemology or ontological explanation of the worldview that underpins this study asserts that humans construct knowledge based on how they interpret how they interact with their environment and other people (Arthur et al. 2012). Therefore, it is impractical to separate factual knowledge from the principles that underlie people in a particular phenomenon, such as values, attitudes, beliefs, intents, and assumptions (Nieuwehuis, 2010; Trede & Higgs, 2009; Kraus, 2005). Constructivism is a worldview that contends that reality is socially formed via experiences and that there are various realities because each phenomenon is distinct.

For this reason, this inquiry aims at understanding the phenomenon in its natural context (Koro-Ljunberg et al. 2009; Richards, 2009; Baxter & Jack, 2008; Mangan, Lalwani & Gardner, 2004). Moreover, constructivism emphasises that reality exists within social interaction and societal interaction with the environment (Allen-Collinson, 2012; Bisman, 2012; Mills, Bonner & Francis, 2006) and PLC stands specifically for interaction.

Furthermore, Heidegger as cited in Conroy (2003) classifies existence in the world as authentic (real), inauthentic (counterfeit) or undifferentiated (orthodox). The first mode of existence is resembled by original and consistent thought patterns showing interaction with the environment as drawing knowledge and learning from that context. The second mode of existence is indicated by counterfeit or synthetic actions that are not directly correlated to the person, therefore distancing knowledge acquisition from the social context. The third mode of undifferentiated existence is seen as orthodoxy by just conforming to the prominent social habits and beliefs without making sense of these habits.

According to Allen-Colison (2012), Mills, Borner, and Francis (2006), Guba and Lincoln (1994) there are various truths and no such thing as a single, unchanging, and absolute objective truth about reality. Their justification is that individuals in various societal contexts have skewed facts that are based on their unique interactions with the outside world. Heidegger (as cited in Wright & Losekoot, 2010) further argues that if we cannot make an effort to understand ourselves, our being, as deeply entrenched in our social context it would therefore be impossible to understand ourselves without knowing the phenomena of social context. Likewise, it would also be difficult to understand the world if our being is excluded.

The constructivist viewpoint on techniques of data collection and analysis is supported by phenomenography, which is the knowledge acquisition in multiple directions in which people

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observe, comprehend, and interpret unique phenomena in diverse elements of the world (Van Wyk, 2013; Arthur et al. 2012, Niewenhuis, 2010; Creswell, 2009). Epistemology seeks to identify ways of gaining knowledge regarding the ontological stance or the constructivist paradigm.

The ontological position in this study is that the individual and the social world exist independently, but that the individual subjectively forms an understanding of the research problem through an interpretation of the data to be gathered from the teachers of physical sciences participating in the research. The diverse understanding of reality by the research participants in the social world will assist me as the researcher to capture the various conceptions of how the participants see their reality (Creswell, 2013; Ritchie & Lewis, 2011).

Epistemology is concerned with what contributes to and constitutes knowledge (Creswell, 2013; Denzin & Lincoln, 2008), how knowledge is obtained, the nature of knowledge, and different forms of knowledge. Carter & Little, (2007) define “epistemology” as the manner of thinking and knowledge acquisition and interpretations that helps to determine research methodology. Epistemology asks the question “what is the nature of the relationship between the individual who inquires and what can supposedly be known?” (Scotland, 2012, p.9). Epistemological assumptions explain the way knowledge is created, acquired, and communicated (Guba & Lincoln, 1994; Scotland, 2012), and how we justify knowledge (Creswell, 2013). An epistemology will lead the researcher to also ask “What does it mean to know?” (Guba & Lincoln, 1994; Scotland, 2012).

Additionally, epistemology is concerned with methods that help researchers create knowledge about what is already known and what is perceived as knowledge (Ormston et al. 2013; Hammersley, 2012).

According to the interpretivist's epistemological position, the participants and the researcher cannot be completely separated from one another, and as a result, the researcher is interactively involved in the investigation's processes. By connecting with individuals, the researcher would effectively interpret the phenomenon from within. The phenomenological paradigm also argues that in order to analyse and comprehend what is happening in the social environment, the observer is working along with the phenomenon being witnessed (Arthur et al. 2012; Nieuwenhuis, 2010; Gray, 2009; Kraus, 2007). The constructivist researcher aims to comprehend the context as the natural setting of the research participants since people are born into the world with meaning ingrained in their cultural surroundings.

Subjective epistemology is concerned with what constitutes social knowledge (Ritchie & Lewis, 2011), and how it is obtained (Denzin & Lincoln, 2005) and justified (Creswell, 2013).

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It assumes that individuals cannot separate themselves from what they know, and how they understand the connection between whom they are and how they understand themselves and others in society. Understandings are therefore co-created (Denzin & Lincoln, 2005). The interpretivist paradigm that I adopt in this study underwrites subjectivist epistemology (Denzin & Lincoln, 2008). Individuals have their assumptions and beliefs about the world they live in (Nieuwenhuis, 2012). I can access these assumptions and beliefs through my analysis of the visual data provided by the participants in the study.

Approaches to constructivist research are mentioned to highlight the symbolic interaction and hermeneutics (Mead, as cited in Wright & Losekoot, 2010). Moreover, Mead (as cited in Wright & Losekoot, 2010) defines symbolic interaction as a way of communicating with one another using gestures. Meaning could only be derived if the sender and the recipient understand each other. Therefore, a constructivist investigator should engage in understanding the interaction between the objects and their environment, moreover, perceive both the participants and context as dynamic to accept the interpretation of the involved objects about their experiences in their social context.

Hermeneutics on the other hand originally was the study of interpreting ancient historical texts seeking to understand the social context at the time from the authors' point of view (Wright & Losekoot, 2010). Therefore, an inquiry is natural to enable a researcher to explore the features of social context that could not be analysed by scientific methods. The reasoning thereof revolves around the contrasts and the similarities of the different ways knowledge has been constructed by various stakeholders in the phenomena (Bisman, 2012).

According to Mills, Bonner, and Francis' (2006) theory, researchers must take a position with the paradigm that best matches their assumptions about reality in their respective fields of study. As a result, the paradigm of choice serves as the foundation for the investigation, methodology, and technique of choice for data gathering. Additionally, constructivism allows the researcher to explain and interpret the setting in light of the involved people. The researcher may also incorporate more intricate characteristics that are exclusive to that particular phenomenon (Bisman, 2012).

In this study, the researcher chose interpretivism as a research paradigm, because the study seeks to understand the role of the professional learning community in teaching practical work.

3.4 PARTICIPATORY APPROACH

The coordination and execution of the research process with people whose lives and important acts are being studied receives special emphasis in the participatory research method

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(Bergold & Thomas, 2012). This describes how two perspectives—practical work and the PLC—were used to generate the study's objectives and research questions. Participatory research demands that participants disclose their opinions on the matter as well as their own views and experiences (Cook, 2012). Dentith, Measor, and O'Malley (2012) contend that this strategy permits diverse viewpoints because knowledge creation necessitates them. These viewpoints promise to offer a novel and distinctive take on PLC and practical work, facilitating the identification of new facets.

In the current study, the participatory strategy included both action and inquiry. Principals and teacher participants talked about problems they were facing, potential solutions, and necessary next steps. The participatory strategy used in this study aims to promote professional learning community where there is collaboration and explore the potential effects it may have on learner performance in physical sciences practical work.

Special focus is placed on coordinating and conducting the research process with the people whose lives and significant acts are being researched by the participatory research approach (Bergold & Thomas, 2012). This suggests that the study's goal and its research questions emerged from the blending of two perspectives, namely the professional learning community and practical work.

Cook (2012) asserts that for participatory research to be successful, participants must be open to sharing their own thoughts and experiences, as well as their perceptions and viewpoints on the situation. Dentith, Measor, and O'Malley (2012) contend that this method makes room for competing views because they are essential to the generation of new knowledge. These perspectives guarantee a fresh and distinctive perspective on the subject at hand, enabling the identification of new elements.

In the current study, the participatory methodology combines both action and inquiry. Teachers are talking about their difficulties and considering steps that need to be made as well as potential answers. The participative strategy used in this study aims to influence learners' performance positively on practical work and decision-making processes.

3.5 CASE STUDY DESIGN

The case study research approach, according to Yin (2009), is an empirical investigation that looks at a current occurrence in the context of real-world experience. It enables the researcher to investigate people or groups, straightforward and intricate actions, connections, communities, or programs. When the professional learning community is used as a teaching

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and learning strategy in the teaching of practical work, Christie et al. (2000) identified the case study as a qualitative research design that observes to understand the underlying factors at play. An exploration or in-depth research of a "bounded system" through time is what Leedy & Omrod (2002), De Vos et al. (2005), and Creswell (2002) define as a case study. Additionally, a case study is described by McMillan and Schumacher (2010) as a thorough justification of a "bounded system" in terms of participant characteristics and the surrounding circumstances.

A case study is regarded as a qualitative research strategy since it enables the researcher to induce different complexities in the social setting while utilizing a variety of data collection tools. In addition, the case study highlights how different viewpoints are combined and contrasted to create a rich and elaborate understanding of the social context in the professional learning community (Gray, 2009).

Yin (2003) is in favour of dismantling many occurrences and then rebuilding them. An intervention within an interpretivist paradigm, a case study methodology, and a small sample are necessary because the study's goal is to investigate the function of PLCs in the teaching of practical work.

Case study methodology is the main emphasis of this work. When examining a small sample of individuals, a case study approach is employed as a type of qualitative descriptive research. This indicates that the final result of a case study is a detailed, in-depth, or "thick" description of the topic being studied. A "thick" description is a thorough, literal account of an incident or other subject under investigation within a context that is time- and place-bound. A case study is an investigative technique in which the researcher investigates in-depth a particular program, event, activity, process, or one or more people (Creswell, 2009).

When the lines separating a modern occurrence from its context are blurred and numerous sources of information are utilised, a case study is thought of as an empirical investigation (Maree, 2010). A case study aims to gain a thorough (holistic) understanding of how participants relate to and interact with one another in a particular setting as well as how they interpret the phenomenon being studied. A case study approach's use of many sources and procedures for data collection is one of its primary advantages.

3.5.1 Benefits of a case study

Using case studies has a number of benefits. Three benefits are listed by the researcher as being helpful to the current investigation.

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3.5.1.1 Studies the immediate context

The case study in the present study extracted and evaluated the data in the immediate and relevant setting (grades 10–12, FET schools), that is, in the context of the execution of physical sciences practical work. The researcher studied the topic in his surroundings in order to investigate the methods for developing the professional learning community.

3.5.1.2 Allows for Qualitative and Quantitative data analysis

Both the quantitative and qualitative analysis of the data is possible due to variations in intrinsic, instrumental, and collective case study methodologies (Zainal, 2007). Participants in this study were needed to provide this in order to collect the qualitative data from the descriptive accounts of the behaviours and environments in order to better understand how the professional learning community might improve learners' effectiveness in practical work. The current study, however, looked for support from both the participants' categorical and numerical responses.

3.5.1.3 Explanation of real-life situations

The in-depth qualitative narratives frequently produced in case studies help to investigate or describe the data in a real-life environment as well as to illustrate the nuances of real-life circumstances that may not be represented by experimental or survey research. For example, a case study of a participant's "physical sciences practical work performance" might provide access to not just the numerical data on the teaching tactics utilized, but also the justifications behind them and how they interact with other teaching methods.

3.5.2 Negative aspects of the case study

Utilizing case studies has some drawbacks. The study's two drawbacks, which the researcher looks into, were a hindrance.

3.5.2.1 Little base for generalisation

Despite the benefits that the case study design revealed in this study, there were drawbacks as well. Case studies involve a limited number of subjects; some are conducted with just one (McMillan & Schumacher, 2010); four schools were chosen for this study, and as a result, they

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offer very little basis for scientific generalization. It was challenging for the researcher to generalize the study's results (i.e. TMED to other districts).

3.5.2.2 The length of case study design

The case study took too long to complete, was challenging to carry out, and generated an enormous quantity of paperwork. Longitudinal or ethnographic case studies have the potential to collect a lot of information. When data is not organized and managed systematically, risk results. The case study technique is sometimes criticized for its reliance on a single case study, which makes it challenging to draw general conclusions (Steinberg, 2015).

3.5.3 Types of case study designs

Case studies can be divided into two categories: individual and many (collective) case studies, according to Stol and Fitzgerald (2014). They may be used holistically, which denotes a thorough examination of a unit of analysis, or embeddedly, which denotes the usage of a number of different units of analysis. Individuals, a class, an organization, a body of papers, a group of people, or a location where data is gathered are all examples of units of analysis. According to the aforementioned definition, the researcher categorizes this study as a single unit of analysis case study because a group or community of teachers from different schools is chosen to create a professional learning community (McMillan & Schumacher, 2010).

In addition, Stake (2008) as cited in McMillan and Schumacher (2010) differentiates case study types as intrinsic and instrumental case studies. The former mainly focuses on rare cases and the latter is theme or trend-based (Zucker, 2009; Breton, Kitchenman, Budgen & Li, 2008). Furthermore, Guba and Lincoln (1981), as cited in Zucker (2009), suggested another three types of case study designs, namely, factual, interpretative and evaluative. Firstly, it could be a case or inquiry where a researcher produces a profile of facts, secondly interpreting and constructing insight or assessing the phenomenon to build a theory.

Baxter and Jack (2008) also added exploratory, descriptive and explanatory types of case study designs concerning their application. The first category is used to investigate occurrences that lack a particular, established custom or outcome. The second is used to explain a phenomena and its actual occurrence. For more complicated scenarios that surveys or tests could not verify or supplement, the latter form is preferred (Stol & Fitzgerald, 2014).

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3.5.4 Characteristics of a case study

Characteristics of a case study are found in definitions including “systematic inquiry into an event or a set of related events which aims to describe and explain the phenomenon of interest” (Bromley, 1986 as cited in Zucker, 2009). Brown (2008) referred to a case study as a multifunctional qualitative strategy that is accommodative and adaptable to all other designs of qualitative inquiry, and allows the exploration and understanding of complex issues. Moreover, Van Wynsberghe and Khan, (2007) characterised a case study as trans-paradigmatic, depicting that it could be applied despite the paradigm inclination of the study. They further stressed that the case study is trans-disciplinary, meaning it is employable across the pool of studies in different faculties of a body of knowledge.

Johansson (2003) stated that a case study's primary goal is triangulation to validate the inquiry due to its accommodating nature that permits the use of a variety of approaches, strategies, methods, and ideas. Further evidence that case study research aims to provide "how" and "why" explanations came from Andrade (2009) and Stol and Fitzgerald (2014). The study also seeks to address one of the sub-questions, “how can the professional learning community improve learners’ performance in practical work?”. Therefore, a case study is a suitable research design for this study.

Various definitions of a case study include the following terms: sequential, systematic, procedural, and process-based and others use protocol. These terms suggest that a case study has chronological stages and guidelines that govern its use. The researcher who uses a qualitative research approach in exploiting a case study should be acquainted with these rules and adhere to them. Miambo and Pervan (2004) explained that a “case study protocol” instils “uniformity in data collection and analysis” to enable the transferability of the inquiry to other similar settings.

Moreover, Breton et al. (2008) emphasise triangulation and a trail check as valuable benefits of a case study. They allow the researcher to compare and consolidate data from various sources and to trace back the relationship between data and research questions.

Zucker (2009, 2001) and Brown (2008) iterate five components of a case study as formulated by Yin (2003), they are:

- Formulation of research questions
- Submission which emulates a theoretical case
- Unit of analysis
- Reasonable relationship between data and the propositions

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- Criteria for interpreting the findings

Zucker (2009) stipulates a list of case study protocol stages that researchers should consider in their inquiries, they are:

- Preparation
- Prior to beginning
- Strategies for collecting data
- Methods of analysis
- Stages of analysis below
- Describing experience – stage 1
- Describing meaning – stage 2
- Focus of the analysis – stage 3
- Examining rigour – stage 4
- Writing up the case – stage 5

A qualitative case study research approach, specifically “intra-seminar” case study design was chosen with the intention of using focus groups and individual interviews to collect detailed information from the participants regarding the function of the professional learning community in teaching practical work. Intra-seminar case study design entails an in-depth study of a social unit over a long period of time, it requires immense patience and meticulousness on the part of the researcher (Arya, P, 2020). The researcher should be well-trained to ‘bracket out’ his value preferences and preconceptions before going into the field. As fieldwork often throws surprises, the researcher must be both perceptive and adaptive enough to tweak her techniques of data collection and make them most suitable for a particular occasion. According to Royer and Zarlowski (2007), a single case study is appropriate for theorizing (confirming, challenging, or extending) about a specific event or occurrence and is recognized as a reliable source for making generalizations about organizations as a whole. To improve the current practice, this research's objective is to report on the opinions and experiences of PLC participants rather than generalizing to a larger community.

3.6 RESEARCH DESIGN

A research design is a strategy that a researcher uses or adheres to when carrying out a study (Nieuwenhuis, 2012). According to Creswell (2013), the research design will specify the procedures for gathering and interpreting data as well as how the data is related to the research questions. This is done in an effort to understand or investigate a phenomenon or

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problem. This makes it possible for the researcher to make judgments about the study's goal (Fouche' & Delport, 2005). Therefore, it is crucial to carefully organize the study strategy so that the data obtained as proof and the interpretation of the data will address the research questions (Leddy & Ormrod, 2013).

As the specific design genre or strategy of inquiry, the exploratory sequential mixed methods case study design was employed in this study. According to Creswell and Piano Clark (2011), this design has the advantage of enabling the results of the first qualitative method to inform the development of the second quantitative method. Research on using the professional learning community to improve learner achievement at FET schools served as a guide for the study's methodology. A quantitative and qualitative technique were both used in this study.

The sequential exploratory design begins with the collection and analysis of qualitative data in the first phase and prioritizes doing so, according to Connolly and Lang (2013). The researcher did a second quantitative phase with the same participants to confirm what was said in the qualitative phase, which suggests that the researcher first obtained and reviewed qualitative data for this study before expanding on its conclusions. According to Mcguigan (2011), one of the benefits of using both a qualitative and quantitative research design is the possibility that one will prove to be more beneficial than the other at certain points in the study.

3.6.1 Qualitative Research Method.

In general, qualitative research seeks to understand issues through participants' perspectives (Ritchie, Lewis, Nicholls & Ormston, 2013). Stuckey (2013) claims that it is an approach that emphasizes phenomena that occur in natural settings and necessitates comprehending such phenomena in all of their complexity. Maree (2010) claims that the goal of qualitative research is to obtain comprehensive descriptive data on a particular event or circumstance in order to make sense of and better understand what is being observed or researched.

These definitions of qualitative research make it clear that it often involves interacting with, observing, and interpreting the participants in their natural environment in order to study individuals or systems. A qualitative research method is distinguished by the environment in which it is conducted; in this study, the setting will be the PLCs established, the science resource centres, and the laboratories, all of which are essential supports for the school's instructional program throughout the FET phase. This will be most appropriate when the researcher tries to comprehend participant behaviour in relation to the PLC as it takes place without external limitations and control.

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Qualitative research uses a “wide and deep-angle lens” (Johnson & Christensen, 2012) to investigate individuals’ choices and behaviours in their contexts. When the researcher studies the complexities of a phenomenon or situation that exists in the contexts of individuals, they must find the reasons or explanations for the phenomenon or situation explored.

Although qualitative research allows for different approaches and philosophical assumptions, there are common features of qualitative research designs. The common features include characteristics related to who and what is being studied, methodological characteristics, and characteristics related to the goal of the inquiry (De Gialdino, 2009). In the following section, I motivate my choice of qualitative inquiry, by discussing the common characteristics of qualitative research designs.

Qualitative research as a scientific method is exploratory, and it aims to generate or construct new knowledge from the data that is collected during fieldwork (Johnson & Christensen, 2012), to develop new grounded theories or modify and expand on the theories that underpin the study (De Gialdino, 2009). As a result, new perspectives can be added to what is already known (Gobo, 2005; Morse, 2003). This is attempted in this study, where the aim is to understand each participant’s view and thinking regarding reasons for the high failure rate in practical work, the physical sciences practical work itself in the participant’s context, and changes that may be brought by the professional learning community as theoretical underpinnings of the study (Donald et al., 2012; Maxwell, 2004).

The qualitative research design is an interactive process (Cresswell, 2013), which strives to understand and explore how individuals understand the world, and how this understanding is portrayed in individual’s lives, in their behaviour, and in the way they interact with each other in the world (De Gialdino, 2009). As in this study, a qualitative research approach allows participants to attach meaning to and give account for their personal viewpoints on practical work (Atkinson, 2005; De Gialdino, 2009) and to share these experiences during PLC meetings (Johnson & Christensen, 2012).

Using interactive modes of inquiry and various data collection techniques, qualitative research enables the researcher to acquire data from participants in their natural settings or contexts (Creswell, 2013). The situational and contextual nature of the data collected makes it unpredictable (Johnson & Christensen, 2012). Teachers taking part in this study are doing so in their natural environment because the fieldwork is being done in a science lab.

Qualitative research is interpretive (Creswell, 2013; Denzin & Lincoln, 2008). The qualitative researcher aims to understand the many facets of reality and phenomena under investigation, to learn more about them, without being biased (Johnson and Christensen, 2012). When a

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phenomenon is explored, multiple truths are uncovered (Nieuwenhuis, 2012); for this reason, the role of the researcher should be made clear (Denzin & Lincoln, 2008). In this study, my role will be to gather and interpret data on whether the professional learning community can assist teachers to use different methods in teaching practical work and to establish if it can positively affect learners' performance.

Both inductive and deductive thinking can be used in research (Creswell, 2013), but qualitative researchers favour inductive approaches to data analysis because they are more compatible with a positivist paradigm (Nieuwenhuis, 2012). The ability to examine the details of the data through inductive analysis and creative synthesis enables the researcher to find patterns, themes, and relationships between the units of analysis. This aids the researcher in developing a comprehensive grasp of the phenomenon being studied (Johnson & Christensen, 2012). Inductive data analysis will be used in this research. Additionally, the flexibility of inductive reasoning makes it possible to be sensitive to the participants and the context in which the data will be gathered (De Gialdino, 2009).

Data that is detailed is qualitative (Johnson & Christensen, 2012). The goal of qualitative research is to understand the complexity of a phenomenon or a situation that people are in, rather than to discover a single, universal truth (Leedy & Ormrod, 2013). The participants' viewpoints and opinions are taken into account (Creswell, 2013), and the results of the thought process are given meaning and importance (Ellis, 2004).

The interpretations participants assign to their experiences can be used by the researcher to make deductions about the experience's or problem's overall nature (Creswell, 2013; De Gialdino, 2009). In order to draw conclusions from how participants interpreted their experiences and to report those conclusions in the form of a descriptive narrative, the purpose of this study was to analyse and interpret data for the characteristics of the professional learning community and the role of practical work.

Finally, qualitative research enables the researcher to collect, understand, and present data through research in a world that is always changing (Creswell, 2013), taking into account the various processes and changes that are felt by the person (De Gialdino, 2009; Mason, 2006). The study's qualitative methodology enabled the participants to reflect on their experiences in this setting.

According to Gay, Mills, and Airasian (2009), qualitative research is conducted in the setting where the phenomenon under study manifests itself. This phenomenon, according to Maree (2007), is an attempt to examine behaviour and events in ordinary circumstances in order to fully understand the message that the participants are trying to express. Denzin and Lincoln

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(2011) encourage the dedication of qualitative practitioners to the naturalistic perspective and the interpretive interpretation of human experience. They go on to say that qualitative researchers place a strong emphasis on the social construction of reality, the tight relationship between the study subject and the researcher, and the constraints placed on the investigation by the setting.

Verbal descriptions can be provided using a variety of qualitative techniques, but each one aims to convey the complexity and diversity of behaviour that takes place in natural settings from the viewpoint of the participants. Data is gathered, then inductively analysed to provide insights. This study aimed to develop a small, distinct group such as participants (teachers) in schools in order to evaluate the potential impact the PLC may play in improving the outcomes of practical work in high schools. The many sites where the research was conducted in the context of this study included four participating schools (with two teachers from each).

A qualitative researcher, according to Creswell (2012), starts with assumptions, a worldview with the potential use of a theoretical lens, and the study of research issues inquiring into the meanings that people or groups ascribe to a social or human problem. Merriam (2014) asserts that because qualitative research seeks to comprehend and interpret events from an interpretive perspective, the researcher is the primary instrument for data gathering and analysis in this type of research (Creswell, 2012; Hatch, 2002).

The main purpose of exploratory qualitative research is to understand the underlying causes, beliefs, and motives. It offers understanding of the issue or aids in formulating concepts or theories for possible qualitative studies. Further investigation of the issue and the discovery of thought and opinion trends are also accomplished through qualitative research. The strategies used to acquire qualitative data can be semi-structured or unstructured. Individual interviews, focus groups (group talks), and participation/observations are a few typical ways. Typically, just a tiny sample size is used, and participants are chosen to meet a predetermined quota.

The qualitative approach is deliberately chosen because the researcher will be playing an active role throughout the study (Glesne, 2011).

According to Creswell (2011), a qualitative technique employed in this study is based on the qualities listed below:

• Qualitative research is conducted in environments that naturally arise human behaviour and events.

• In contrast to quantitative designs, qualitative research is predicated on quite different assumptions.

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• The data that come out of the qualitative study are descriptive; the researcher is the main tool for data collecting. In other words, rather than reporting data as numbers, the participants' words or images are used most often.

• The emphasis is on the perceptions, experiences, and ways in which individuals make sense of their life.

• Qualitative research concentrates on both the process taking place and the result. Understanding how things happen is of significant interest to researchers.

3.6.1.1 Advantages of qualitative research approach

According to Creswell (2007), Maxwell (2012) and Rahman (2016), qualitative research applies a detailed description of participants' opinions, feelings, and experiences. Second, it is said that qualitative research encompasses a larger variety of human opinions and hence provides a more comprehensive understanding of human experiences. Finally, qualitative research helps the researcher understand the participant's inner feelings and how their culture shapes meaning.

The researcher found that the teacher participants made a concentrated attempt to express their thoughts and feelings about professional learning community.

The researcher also discovered that the teachers were not aware of the effect that the PLC had on learners' improvement in physical sciences practical work.

3.6.1.2 Disadvantages of the qualitative research approach

According to Creswell (2009) and Hancock (2015), qualitative research has the following disadvantages:

- Firstly, qualitative research is much more time-consuming to collect data compared to quantitative research.
- In the broader sense of gaining knowledge with the time-consuming factor looming in qualitative research, it means that only a few teachers and learners are accommodated by this technique.
- Secondly, the researcher's personal biases and eccentricities may easily influence the outcomes of the results.

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- There is a possibility that the researcher may include their feelings, which is incorrect in research on participants' feelings and experiences.
- If a qualitative researcher observes only one teacher of a particular school regarding practical work or interviews, one principal based on leadership, and its significance to the PLC, the findings could be skewed.

The researcher attended the PLC meetings and all scheduled meetings with other teacher participants without fail. This assisted the researcher to have debriefing sessions and interviews with other participants and allowed him to distribute and ensure that questionnaires were completed. However, some teacher participants were hard to find and interact with since they did not attend and having to connect with them virtually was also a challenge since they complained about data.

3.6.2 QUANTITATIVE RESEARCH APPROACH

To better understand the phenomena that observations reflect, observations are numerically represented and manipulated in quantitative research (Rubin & Babbie, 2016). In quantitative research, there is a greater emphasis on objective measures and statistical, mathematical, or numerical data analysis (Williams, 2007). These data may be collected using a variety of procedures, including surveys, questionnaires, and polls, or by changing statistical data that has previously been collected using computer technologies (Gopisetty, 2016). The researcher decided to utilize a quantitative strategy to gather anonymous and comparative data because both the teacher and principal participants were included in the study. According to Mcguigan (2011), as indicated in the research design, quantitative research is entirely objective in the data collection and analysis processes.

The main component of a quantitative research design is totally focused on the statistics and data, which provide a still image of a certain moment in time. This type of research methodology, according to Leedy and Ormrod (2005), is particularly applicable to this study because it focuses on teachers' professional development within the learning community in order to improve learner performance. It is concerned with the reliability, validity, and generalization of observed behaviours.

Because it is a classic method for clarity and understanding, questionnaires are frequently used in quantitative research or predominate within. This approach was used throughout the entire investigation, mostly due to the variety of the research situation. During PLC meetings,

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questionnaires were handed to the teacher participants. Additionally, there was no restriction on what context the completed questions may be submitted in.

A key element of the quantitative research approach is the use of appropriate and simple language in surveys, which makes them easier to access and assures data accuracy throughout interpretation, conclusions, and recommendations. In order to exclude any possibility that an outside force could influence the outcomes of the quantitative technique, the researcher must set apart time for himself away from the task. One way to ensure the correctness of the outcomes is to put oneself into the background while the answers are given.

3.6.2.1 Advantages of quantitative research approach

Reliability and validity will be presented in general terms to further illustrate the benefits of the quantitative research approach, as they might be viewed as two of the most significant benefits (De Vos, Strydom, Fouche, & Delport, 2007). First, the researcher aims for the reliability of their quantitative research instruments to show consistent, accurate, and precise, which are the common denominators (Mislevy, 2007). Another scientific instrument, called validity, is equally crucial in the paradigm of the quantitative research approach. Validity ensures that the instruments measure appropriately, and in this case the idea was to determine how the professional learning community may help learners do better in physical sciences practical work.

3.6.2.2 Disadvantages of the quantitative research approach

According to Shuttleworth (2008), this research methodology can also be demanding, time-consuming, and difficult. In addition, there are frequently some ambiguities and uncertainties that call for testing and improvement. Francis (2012) asserts that it is crucial for researchers to seek out the truth in social contexts because, if science fails to make dependability clear to the lay audience as a tool that transcends gender, location, economy, and beliefs, it will become more evasive. According to Babbie and Mouton (2007), establishing construct validity may be one of the trickiest research procedures because it entails figuring out how well an instrument captures an observed theoretical construct. The sole weakness of the quantitative method approach in terms of reliability is the orientation level of the target audience toward the idea of dependability, which prompted the researcher to take the initiative to encourage participants to participate in the current study.

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3.7 MIXED METHOD APPROACH

Researchers that employ mixed methods may collect, examine, and integrate both quantitative and qualitative data over the course of a single study or over a prolonged period of time in order to address their research objectives (Creswell, 2013). The mixed methods research approach is basically pragmatic and concentrates on both the quantitative and qualitative components of research (Morgan, 2007). The researcher was curious to know how the professional learning community may be used to improve learner performance on physical sciences practical work throughout the FET phase in diverse high school settings. Because of this, the study used a mixed-methods research design, which entails integrating qualitative and quantitative research approaches (Tashakkori & Teddlie, 2010).

The fundamental advantage of mixed-method research is that study problems can be understood more thoroughly than if the two research methodologies were employed separately. A mixed approach is a superior strategy since it helps the researchers to reply to research problems that are difficult to address using other methods, claim Tashakkori & Teddlie (2010). Mixed method research, as opposed to qualitative or quantitative research, has more advantages and less disadvantages, (Creswell & Plano Clark, 2007). According to Bulsara (2007), using hybrid procedures may aid the researcher in creating new knowledge that may entail the contemporaneous sequential application of the two methods. As a result, qualitative and quantitative researchers are encouraged to collaborate across disciplines.

3.8 POPULATION AND SAMPLING

A population can be described as a single group of individuals, institutions or objects with general characteristics that are of interest to researchers. The general characteristics of groups distinguish them from other people, institutions and objects (Rafeedali, 2020:1). The study was conducted at four public secondary schools in Thabo Mofutsanyna District in the Free State, where the failure rate of physical sciences practical work has been identified. The participants of this study consisted of eight educators (two per school), and two principals who in two different secondary schools.

3.8.1 Sampling

Sampling is the practice of selecting a small portion of the population to serve as a representative sample for the study's overall population (Johnson & Christensen, 2008; Vogt, 2007). According to Etkina, Musa, and Alkassim (2016), sampling only represents a small

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portion of the population, cases, or other things that are the subject of the inquiry. According to Robson (2007), a sample is a collection of people chosen to represent the entire population in order to make objective generalizations. The procedure by which a researcher selects a sample from the population being investigated, is known as sampling Kumar (2014).

In order to provide results with the required level of accuracy and to be able to identify any significant differences or connections that may exist in the study population, a sample must be the appropriate size, according to Omair (2014). A population, in the words of Cohen, Manion, and Morrison (2013), is a larger group of "subjects" from which the sample for a study is taken. Participants are those who take part in the study and contribute data (McMillan & Schumacher, 2010).

The target population is the entire population that possesses the characteristics that the researcher is interested in (McMillan & Schumacher 2010; Johnson & Christensen 2008). This study focuses on two schools with labs that are fully equipped and two other schools with no labs at all. Given the number of high schools and the size of the classes in Thabo Mofutsanyana District in the Free State, it would be redundant and impracticable to measure every member of the target population (McMillan & Schumacher, 2010). Eight teachers (two from each school) were chosen as participants, and a sample of four schools was chosen as well.

According to De Vos et al. (2002), sampling—the act of taking a chunk from a population and using it as a proxy for the entire population—is one of the most crucial research principles. Purposive sampling, according to McMillan and Schumacher (2010), chooses information-rich situations for a thorough investigation. The study's goal was to address difficulties experienced by teachers in the lab by examining the part that PLCs can play in assisting and enhancing the outcomes of practical work. The researcher anticipated that the four selected schools would provide sufficient data to meet this goal.

3.8.2 Purposive convenient sampling

The use of "purposive sampling" allowed the researcher to deliberately look for the most valuable data source (Yin, 2011). While Neuman (2006) argues that purposive sampling enables the researcher to choose individuals who are information-rich, Maree (2007) states that purposive sampling is employed in exceptional instances where the sampling is done with a special case in mind. Personal judgment must be utilized in purposive sampling to select cases that contribute to the resolution of research problems or the accomplishment of research goals. Creswell and Piano-Clark (2007) stated that researchers could choose individuals who have first-hand knowledge of the core phenomenon and viewpoints under investigation.

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Homogeneous sampling, which focuses on the subgroup in which all the sample members are similar, such as a specific occupation or position in an organization's hierarchy, is one form of purposive sampling example that applies to this study (Saunders, Lewis & Thornhill, 2012).

The purposive sampling technique was used since the selected group had to possess specific characteristics typical of the research group (Cohen, Manion & Morrison, 2013). By using purposeful sampling and creating precise criteria for participant selection, it also assisted in preventing prejudice and preconceptions (Creswell, 2014). Participants had to be well-versed in how the professional learning community may improve learner performance in practical work in the physical sciences from the standpoint of a purposive sample (Nieuwenhuis, 2016). This required finding and selecting a group of individuals who were aware and competent about an intriguing phenomenon (Creswell, Plano Clark, 2011).

For the purpose of hiring FET teachers with expertise in physical sciences, the researcher requested recommendations from department heads of the schools. Therefore, purposive sampling began to concentrate on individuals who had characteristics that would benefit the pertinent inquiry more (Etikan et al., 2016). By doing this, it was ensured that the study's participants were suitable and that those with the most relevant data took part.

Additionally, this study used convenience sampling, a non-probability sampling technique. Convenient sampling refers to the process when the researcher chooses the sample components based on their easy accessibility and closeness (Gravetter & Forzano, 2012). Teachers from Nketoana Municipality's Free State schools in the Thabo Mofutsanyana District served as the accessible participants because the quantitative phase required validation of the qualitative phase's findings. Since the schools are close to the researcher's place of work, simple access to them increased the study's viability.

This indicates that participants make a practical choice when choosing an accessible geographic location. Due to the study's lack of a generalization goal, a small sample number was used. All teachers in four schools were asked to engage in the study in order to gather as many survey responses as feasible. Participants returned all the questionnaires they received, filled them out, and a sample of them was used for quantitative analysis.

The researcher located 8 teachers and 2 principals in the four chosen schools in the TMED, FS as the sample for this research project. The representation of teachers and principals who freely chose to participate in the chosen schools is shown in the tables below (along with their identified codes). The Free State Department of Education (see Annexure H) and the principals of the two separate schools in circuit 6 were asked for their approval before the study could be carried out.

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TABLE 3.1: DISTRIBUTION OF QUESTIONNAIRES TO TEACHER PARTICIPANTS IN THE FOUR SELECTED SCHOOLS OF THABO MOFUTSANYANA DISTRICT

Schools in TMED	Number of teachers	Distributed questionnaires	Completed questionnaires returned	Return rate per school
School A	2	2	2	100%
School B	2	2	2	100%
School C	2	2	2	100%
School D	2	2	2	100%
Total	8	8	8	100%

TABLE 3.2: PARTICIPANT'S CODE

GENDER (Participants)	FOCUS GROUP (A or B)	CODE
Female	A	FGAP1
Female	A	FGAP2
Male	A	FGAP3
Female	B	FGBP4
Male	B	FGBP5
Female	B	FGBP6
Female	B	FGBP7
Female	B	FGBP8
MALE	1	Principal 1
MALE	2	Principal 2

Creswell and Plano Clark (2007) pointed out that researchers could recruit participants on purpose who have first-hand experience with the primary phenomenon and perspectives under study. The researcher carefully selected the sample of eight teacher participants

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because they had the most relevant information about practical work in the physical sciences. The researcher was unable to include all the teachers who make up the study's population because of the TMED's significant number of schools.

Two groups of participants in this study on the function of the professional learning community in improving learner performance were drawn from the design and methodology. FET physical sciences teachers made up the first research population. The same circuit's schools, and more specifically the TMED in the FS, were used to determine the target population. The selection of schools for the sampling was deliberate (schools where FET physical sciences is taught). Principals from schools in the TMED made up the second research population.

3.9 DATA COLLECTION TECHNIQUES

A qualitative research design can benefit from a variety of data gathering techniques, including interviews, focus group discussions, observations, field notes, and other interactive techniques like visual and artistic methods (Greenwood, 2012; Denzin & Lincoln, 2008; Johnson & Christensen, 2012). According to Creswell (2012), data collection is the method used by the researcher to recruit participants and gather the data required to address the study questions. According to Leedy and Ormrod (2013), there are four key points that need to be addressed when dealing with data: what data is required, where the data is located, how the data will be obtained, and how the data will be evaluated.

In this study, the researcher used participatory methods, and the participants were actively involved in generating the artefacts that served as data. The researcher opted to use visual methods, namely focus group interviews, observations, information-sharing sessions, workshops, demonstration lessons, debriefing, and discussion sessions (Wang, 1999; Greenwood, 2012). Visual methods were chosen because they make data more explicit and contribute to a more in-depth understanding of the research problem (Butler-Kisber & Poldma, 2010). Visual methods are predicated on assumptions of constructivism since the participant is actively involved in knowledge construction (Novak & Canas, 2008), and knowledge is constructed through multiple realities and co-constructed views, through individuals interacting about perceived realities (Butler-Kisber & Poldma, 2010; Novak & Canas, 2008). Since the researcher was working with teachers, methods were purposefully chosen to keep participants interested in the activity. Visual methods are participatory (Mannay, 2013; Richards, 2011), and they can be created without the influence of the researcher (Mannay, 2013).

Visual methods are fun for teachers to use and data from visual methods represent both what the participant wants to reveal, and how they want to reveal it. This gives them control over

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the research process, which, in turn, motivates participation (Richards, 2011). Visual methods are especially popular to use with children and the youth (Skovdal, 2011), since they promote collaboration (Allen, 2013), and are a non-threatening way to reveal or talk about sensitive issues (De Lange, 2012). Furthermore, they provide concrete artefacts which can be discussed at a later stage (Enright, 2013; Petheram, High, Campbell, & Stacey, 2011).

Using data collecting methods, researchers can systematically compile information about the research subjects and the environments in which they occur (Creswell, Klassen, Clark & Smith, 2011). Two phases of the investigation were separated. The researcher explained semi-structured questions and open-ended questions on structured questionnaires to teachers and principal participants during interviews, which served as the initial stage of data collection for the study. Focus group interviews and teacher observation were part of the research study's second phase. These data collection techniques and processes were used to help reach some of the goals and respond to the study questions.

In this study, the researcher used the following methods for gathering qualitative data:

3.9.1 Focus Group Interviews (FGI)

A focus group discussion is a group interview that, ideally, is conducted in a group of five to twelve participants. Through a focus group discussion, new views and ideas can be aired concerning the phenomenon under investigation (Johnson & Christensen, 2012). Brewerton & Millward (2004) and Litosseliti (2003) define a focus group as a carefully planned and organised discussion that intends to acquire knowledge about an insight into a certain area of interest in an inquisitive manner, through a selected group of participants sharing knowledge, ideas, experiences and perceptions.

Interviews that were semi-structured provided the data for this investigation. Focus group interviews (FGI) were utilized to hone in on a topic, specifically an assessment of the professional learning community's contribution to improving learner performance. The deliberate choice of teacher participants was a key factor in the focus group interviews' effectiveness (Maree, 2016). Based on the PLC's expertise of how to enhance learner performance, participants were selected. Focus groups comprised of teachers from TMED secondary schools took part in the study. To respect Babbie and Mouton's (2010) caution regarding participants' proximity to the researcher, all secondary schools selected for this study were in the same circuit and district.

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Participants respond to one another's comments during the focus group discussion, which is an interactive manner for them to express their opinions (Nieuwenhuis, 2012). Since participant replies spark debate of the topic, which in turn produces extensive, in-depth data, it is a beneficial tactic that complements other data collection techniques (Johnson & Christensen, 2012; Nieuwenhuis, 2012). Focus group discussions, according to DiCicco and Crabtree (2006), enable the researcher to gain a larger range of knowledge. The research chosen a focus group of eight teachers to gather information regarding the integration of the professional learning community to solve issues faced by teachers in teaching practical work in further education and training of physical sciences.

There are, however, limitations to focus group discussions. Although some participants may find the focus group discussions threatening, they may, on the other hand, be encouraged by the dynamics of the group to share their views as a result of the responsiveness of other participants which is one of the primaries aims of the professional learning community (Nieuwenhuis, 2012).

Focus group help the researcher comprehend how teachers react to phenomena, ensuring the accuracy of the data collected and that it is relevant to the study (Nieuwenhuis & Maree, 2007). Since this study uses a qualitative case study method, it is important to gain understanding of the teachers' experiences during the PLC discussions of practical work. The purpose of the focus group discussion is to gather various perspectives and experiences from the group's participants (Creswell, 2013). Eight physical sciences teachers from various schools in the same district made up the focus group for this study, which typically consists of eight teacher participants.

Focus group allow for a variety of specific viewpoints because open-ended questions are used. Teachers participating in the focus group interview are encouraged to express their own thoughts and emotions throughout the process, and this allows for the generation of rich data. The benefit of a focus group enables the researcher to retain control over the interview's line of questioning and answers and make sure that the teachers do not stray from the subject at hand (Creswell, 2013). The interviews will be taped, transcribed, and analysed afterward.

In this research, participants participate in group discussions to share and discuss their strategies for teaching FET science through demonstrations done in the classroom, setting up the apparatus, and conducting experiments. The debate, in my opinion, enables teachers to elaborate on their ideas and absorb those of others to help them develop critical thinking skills when faced with decisions in their classrooms.

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Focus group discussions were chosen for this study's focus in order to collect rich data from a specific subset of the study population, specifically the professionals who were chosen to participate in the qualitative case study's professional learning community. Focus groups are particularly considered as an effective study technique for exploring reality and complex behaviour as well as for facilitating the sharing of experiences and feelings with others that participants see as being similar to them in some way (De Vos et al., 2005). Furthermore, the objective of the focus group talks in this study was to gather information about the study's objectives by encouraging participants to be open and honest about what they know, believe, and feel (Krueger & Casey, 2010).

Eight FET physical science instructors and two principals participated in two focus groups that were conducted in the TMED. To utilize their data for this study, participants had to sign a consent and authorization form. The researcher visited schools to set up a suitable time and get approval from the departmental heads (DHs) and principals to perform this study. The second task was to conduct the focus group interviews.

The listening and talking in focus groups are equalized, and members take turns speaking while raising their hands to be identified to speak, pointing out relevant data. These are just a few benefits of focus group semi-structured interviews that were applicable to this study. Second, more individuals are employed at a lesser cost (Oltmann, 2016), and focus groups allow participants to come together and create meaning collectively rather than individually (Edwards & Holland, 2013). Finally, a focus group can assist identify distinctive viewpoints and problems with a subject, which can lead to rationalization and additional conversation, revealing more information and revealing the subject's many features.

Focus group semi-structured interviews may have the drawback of being overly subjective and unrepresentative. Participants could experience dominance or distortion from others and lose the desire or willingness to express their true feelings (Creswell, 2009). According to Rule and John (2011), the lack of secrecy in the group setting suggests that focus group discussions may not be the best method for learning about participants' private experiences. Finally, participants assert that focus group interviews might also yield few and subpar data, lowering the calibre of the overall understanding (Oltmann, 2016).

To allow participants to express their opinions and experiences with others who shared them, the focus group for this study was made up of people with reasonably uniform socio-demographic characteristics. Additionally, during the sessions, quick notes were taken. The researcher drew up the transcript on the spot, taking notes as he observed things throughout the focus group interview session for each group member in order to evaluate the study's trustworthiness.

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3.9.2 Teacher's workshops (Information sharing sessions)

The teachers' workshops served as a forum for the teacher professionals to exchange knowledge and skills with other official colleagues, potentially enhancing learner performance on physical sciences practical work. Invitations to attend the workshops were extended to the subject education specialist (SES). The invited SES gave their engaging presentations, and teachers were free to discuss any issues that came up. The researcher took notes about physics practical work on the spot, which she later typed into a Microsoft document. The analysis would then be conducted using the document.

3.9.3 Direct Observations (DO)

It is frequently believed that the researcher will be best served by using observation as a method of acquiring data to gain a deeper understanding of the thing being observed (Maree, 2016). The researcher in this study used a direct observation sheet (APPENDIX H) to analyse how the professional learning community influences learner performance in physical sciences practical work. The researcher's goal was to gain additional knowledge about the PLCs that teachers utilize for collaborative group work. Due to the way observational data was presented, the researcher was able to compile background knowledge and acquire a first-hand account of the activities occurring in the natural field setting (Zohrabi, 2013). Through this, the researcher could observe what was occurring in the PLC.

Direct observation of a situation does not require any technical tools except pencil and paper. Gay and Airasian (2000) explain that the advantages of participant observation include the ability to gain insights and develop a relationship with the participants that cannot be obtained in other ways. Normally, participant observers are professional researchers that become part of social situations to investigate them. When teachers observe lessons systematically, they are taking on a second task that sometimes fits in with their teaching but may sometimes conflict with it (Altrichter et al., 2003).

The researcher's role during direct observation is 'observer as participant' (Creswell, 2013). This allows for the information to be gathered or recorded as it occurs. The researcher is actively involved in the process, while also observing teacher participation. The purpose of observation during research is to gather information from physical sciences teachers without communicating with them (Nieuwenhuis & Maree, 2007).

The researcher uses senses and intuition while remaining objective (Cronje, 2015). For the researcher, it is important to see how teachers interact with each other as well as the activities

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that need to be completed. Field notes are taken during direct observation as part of recording observations. The data gathered will be used as part of the triangulation analysis.

According to Mertler (2009), the technique of paying close attention to and methodically documenting what the researcher sees and hears in a particular circumstance in order to collect qualitative data is known as observation. Observation, in the words of Nieuwenhuis (2012), provides the researcher with a "inside perspective" on the dynamics and behaviour within a particular location. The term "participant observation" is preferred by Strydom (2012) because observational research necessitates the presence of research participants in the environment being observed. Consequently, participant observation is "a qualitative research method that explores the natural and everyday set-up in a particular group or setting" (Strydom, 2012). There are four different categories of observations, including the following, according to Nieuwenhuis (2012):

- Complete observer, in which the researcher stands outside of the action and keeps a distance.
- Observer as participant, where the researcher immerses themselves in the experience while avoiding active participation by concentrating solely on observation.
- Participant as an observer, in which the researcher takes part in the situation while also keeping an eye on it.
- Complete participant, in which the researcher fully participates in the situation while secretly observing.

Being an "observer as a participant" during one of the physical sciences teachers' demonstrations allows all teacher participants to observe how each of the eight teachers selected implements the method of teaching practical work in their classes. Focus group interviews and first-hand observations were done at the same time. In the standard laboratory of the secondary schools, the researcher watched all the PLC's participating teachers.

The researcher selected the PLC participants who performed the exercise for him to observe. The objective was to show how PLC traits can be applied to real-world tasks to improve learner performance. Direct observations were made of the lab's accessibility and apparatus availability levels. In a classroom where no learners were present, direct monitoring was conducted. On the observation record sheet, a detailed account of what occurred and the researcher's opinions regarding the nature of the practical work demonstration were recorded. (Maree, 2016). During direct observation, the researcher took thorough notes on self-made observation record sheets. To prevent the loss of data, those notes were combined with what was seen.

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Blank spaces on the observation report form were provided for teachers to identify their practical equipment knowledge and expertise, how well they utilized their time during the demonstration, and how well the equipment/apparatus they were using worked as intended. The researcher actively participated in the sessions while simultaneously acting as a spectator during the demonstration turns of other participants, providing him the opportunity to observe the interactions freely and without interfering with them. Each of the eight participating teachers had a different observation period that lasted anywhere between 30 and 45 minutes.

3.9.4 Structured Questionnaires (SQ)

The questionnaire, in the opinion of Oladeji (2012), can be viewed as a collection of detailed inquiries on a certain subject that a participant is expected to address. A questionnaire, according to Babbie (2011), is a collection of inquiries created with the goal of gathering data pertaining to a specific study issue. In this study, open-ended questions from a self-made questionnaire (APPENXIX E & F) were employed. The goal of the questions was to gain understanding of the influence or potential function of the professional learning community in improving learners' performance in real-world settings.

Amongst other methods, structured or closed-ended questionnaires (APPENDIX E) were employed as method of data collection in this study. Closed-ended questions were used to gather quantitative information, and open-ended questions were utilized to gather qualitative information from the Babbie & Mouton participants (2007). The questionnaire's first section (Section A) included questions about participants' biographical information in order to learn more about their experiences with FET physical sciences practical work in the setting of TMED high schools.

The second part of section B concentrated on ways that the professional learning community may enhance learners' success in practical work. The open-ended questions in the questionnaire's structure were made to allow participants to express their thoughts on the practical work done by FET learners in the physical sciences. During PLC sessions, participants received the questionnaire regarding FET physical sciences to complete.

The questionnaire is used as a tool for investigation and is most widely used as the primary data-gathering tool because of the following advantages (Schnelter et al., 2003; Bird, 2009):

- It is economical for both the sender and the respondent in terms of time, effort and cost.
- Anonymity of participants can be guaranteed; it makes it easier to access study subjects who couldn't otherwise be reached.

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- It is comparatively simple to administer, plan, and build.
- With correct application, it has a lot of promise.
- After expertly constructing it, the investigator is free to ask anyone to administer it on his behalf.
- Perfect for a methodical investigation of the connections between variables.
- It helps focus the respondent's attention on all the important details by relieving pressure for a rapid response and allowing the subject to respond at their own pace.

Apart from the advantages mentioned above, a questionnaire has the following disadvantages (Schnelter et al., 2003; Bird, 2009):

- SQ could result in a loss of rapport and frustrations when respondents feel that their options were included.
- Studies using questionnaires frequently don't delve far enough to get at the heart of people's thoughts and emotions.
- A high proportion of non-response is possible, and timely delivery of the questionnaires can be challenging.
- Some responders might not feel comfortable expressing their opinions on contentious topics in black and white. Interviews are the only way to elicit these opinions.
- In-depth questionnaires with complex questions will likewise have a low response rate.
- Sometimes, respondents fill out the survey lazily, which affects the accuracy and dependability of their answers.
- There isn't much that can be done to correct a subject's incorrect interpretation of a query.
- Some questionnaire parts may have unclear or incorrect questions and instructions.

3.10 THE PILOT STUDY

A pilot study, according to Cadete (2017), is a small-scale, preliminary investigation that determines whether the most crucial elements of a main study are feasible. Before conducting a more extensive investigation, a pilot study or feasibility study is a tiny experiment created to test the logistics and collect data. A pilot study is carried out on a small scale, according to the Collins English Dictionary (2014), to determine whether something is successful enough to be applied on a bigger scale. A feasibility study, also known as a little version or trial run conducted in advance of the big study, is what Cohen, Manion, and Morrison (2011) refer to as a pilot study.

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In order to check that the questions were understandable and straightforward and to take proactive measures to avoid any problems when conducting the interviews, the researcher piloted the focus group and individual interview questions with two principals who were not part of the study's sample (Strydom & Delport, 2012). The initially planned interview questions were used, and the pilot study went off without a hitch. Having less participants not fill out the questionnaires was the main objective of the pilot study in this study. The researcher decided to use the teacher participants to test a questionnaire as a result. The researcher took note of the following factors regarding this when testing the draft questionnaire:

- Advice provided to responses.
- Word choice and writing style.
- The questionnaire's formality or informality in terms of presentation and tone.
- The questionnaire's length.
- The questionnaire's order.
- The interviewees' level of competency, as measured by their ability to comprehend the inquiries and provide the anticipated responses.
- Format queries and scales were employed.

It was occasionally required to modify the way that some questions were phrased, both for the interviews with principal participants and the questionnaires for teacher participants. The questionnaire aimed to find out how teachers felt about the professional learning community and how they would go about improving learner performance in physical sciences practical classes. Finalized questionnaires were given to the four chosen schools in circuit 6 of TMED.

3.11 TRIANGULATION

The utilization of two or more methods of data collection is described by Cohen, Manion, and Morrison (2011). They contend that this method contributes to the research study's precision, richness, and depth of comprehension while also maximizing the validity of the qualitative findings. By using various paradigm positions from various angles to a measured position on the phenomena under study, Nick (2007) establishes triangulation data analysis.

Triangulation is a research technique that tries to ensure the reliability and authenticity of the study's findings. It comprises "the painstaking assessment of data gathered through multiple methodologies" in order to provide a more accurate and trustworthy estimate of the qualitative results for a given concept (Oliver-Hoyo & Allen, 2006). In order to determine how the research findings may alter the participants' practice, Krefting (2001) contends that member-checking and triangulation methods between the researcher and the participants are essential. In order

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to ensure that all the data in this investigation was trustworthy and consistent, triangulation was performed.

According to Farmer et al. (2006), triangulation is more effective at capturing a comprehensive picture of the phenomenon under study because each research technique used provides a unique contribution to the puzzle. Every tactic adopted presents a different, distinctive view of the phenomenon. When triangulation is used for completeness, divergent results can improve the explanations for the phenomenon rather than leaving the researcher baffled over what to do with results that do not converge (Redfern & Norman, 2004).

In the current study, focus group interviews and questionnaires were both employed. The triangulation of data suggests that data interpretation is derived from many places in order to create a comprehensive picture of the narrative. In this study, triangulation was utilized to compare the results from the focus group discussions and the questionnaires. The participant responses to the questionnaires and the focus group interviews were analyzed by the researcher to find recurring and recurrent themes that were being expressed by the participants.

Triangulation is the use of two or more approaches to collect data for the study (Cohen, Manion & Morrison, 2011). This study used a variety of data collection methods. These included debriefing meetings, information-sharing sessions with the PLC group, focus group interviews (FGI), direct observations (DO) and structured questionnaires (SQ). To make sure the findings were compatible with data from other sources, the researcher included triangulation in this investigation. Additionally, the researcher employed triangulation, which entailed combining more than one research method, including the qualitative approach, the quantitative approach, and group interviews in the study, to increase the validity and dependability of the data.

The study's conclusions are additionally strengthened and attempted to be improved via triangulation, making them more acceptable to supporters of both qualitative and quantitative approaches (Zohrabi, 2013). The researcher triangulated data by acquiring it using a variety of techniques in order to improve the accuracy of the data and their interpretation (Hesse-Biber, 2010). The researcher may use triangulation to combine the information she has collected from the FGI, DO, SQ, debriefing, and information-sharing sessions.

To determine whether the focus group interview questions were adequate for gathering rich data that answered the proposed study questions, the researcher performed pre-focus group interviews (Elo et al. 2014). Direct observations, one of the tools used for data collection, were employed as a sort of data triangulation to confirm the findings in order to ensure the validity

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of the findings throughout the study (Zohrabi, 2013). The researcher further improved the study's credibility by having the participants attest to its findings (Cope, 2014).

3.12 DATA ANALYSIS

The method of organizing, structuring, and giving meaning to data is known as data analysis (Merriam, 2009). The analysis and presentation of data are the main topics of interest in this area of the study, according to Muzah (2011). According to Gultig et al. (2006), data analysis is the methodical organization and synthesis of data that incorporates the use of one or more statistical techniques. By looking for patterns that the generated data represents, qualitative data analysis enables the researcher to apply inductive reasoning to support the claims they have made (Leedy & Ormrod, 2013). Because many realities emerge from the data, inductive data analysis is well suited to the interpretive paradigm (Nieuwenhuis, 2012).

The researcher employed an inductive method of data analysis for qualitative data, focusing on the professional learning community and practical work as the key themes of the various data sets. The goal was to accurately represent the opinions and understandings of the participants while remaining as objective and unbiased as possible during data collection, analysis, and reporting of the results (Creswell, 2013; Ritchie & Lewis, 2012). The interpretivist paradigm, which was employed in this work, involves using quantitative procedures and tools to analyze quantitative data (de Vos et al., 2011). It made use of methods like descriptive analysis of quantitative data and theme analysis of qualitative data. Techniques for combining or connecting qualitative and quantitative data analysis are used in research projects (de Vos et al., 2011).

3.12.1 Qualitative data analysis: Thematic analysis for the qualitative data section

The act of translating data into meaningful information and facilitating conclusions is known as thematic analysis (Hammersley, 2015). Data was analyzed using an interpretative philosophy with the goal of evaluating the symbolic and meaningful elements in qualitative data (Maree, 2016). The tapes of the interviews' transcripts were closely examined and analyzed.

Thematic analysis is a qualitative analytical method beneficial for "discovering, interpreting, and reporting patterns (themes) within data" (Braun & Clarke, 2006). Due of the freedom it gives the researcher in choosing a theoretical framework, it is commonly used in qualitative research. The advantage of theme analysis is that it may be used to whichever theory or

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concepts the researcher chooses for the study. Thematic analysis' inherent flexibility allows for a rich, in-depth representation of complex data.

Additionally, it permits the researcher to contrast participants' views on various issues (Maree, 2007). In this study, categorizing specific phenomena of the professional learning community is made possible by thematic analysis of interview data. Additionally, this study supports Braun and Clarke's (2007) assertion that it is appropriate to select an analytical strategy that is guided by both the research topic and more general theoretical presumptions. Based on the participants' responses, data will be analysed. To interpret a specific set of data, the researcher will look at all the methods used to collect it, including PLC conversations, direct observations, group interviews, and surveys (Johnson & Christensen 2004).

A thematic approach to data analysis was employed, combining codes that are organized into code families (Nieuwenhuis, 2016). Themes from the focus group interviews included the PLC challenges, the PLC professional development on enhancing learner performance, the PLC challenges, and the motivation for the PLC to improve learner success in physical science practical work. This was done by following the steps Braun & Clarke (2006) indicated for analyzing qualitative data:

• Organizing, which includes classifying papers into folders, creating an electronic database, and chopping large items into manageable pieces.

• Perusal - Getting a general understanding of the information and taking note of preliminary interpretations.

• Classification: Grouping data into groups or themes and determining the meanings associated with each.

• Synthesis is the formulation of hypotheses or statements, the construction of tables, graphs, and hierarchies.

The participants' data were read, and similar responses were qualitatively color-coded to help understand the data and spot trends from the information gathered (Creswell, 2012). McMillan and Schumacher (2010) imply by this study that the material gathered is divided into digestible chunks and classified in accordance with the possible interpretations they conclude. Coding, according to Cohen et al. (2011), involves looking at data to identify any patterns, themes, or groupings that might be present. Hammersley (2015) issues a warning that incomplete summaries of the facts pertaining to the phenomenon may result from such data coding and may not be adequately contested. This technique was utilized to examine the participant responses that were primarily obtained from focus groups, and it was found to be quite effective.

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3.12.2 Descriptive data analysis for the quantitative section

Using descriptive and inferential statistics, the quantitative data was gathered and examined. The goal of descriptive statistics is to organize and summarize the available data using univariate and bivariate analysis such that it is easier to understand (Creswell, 2012).

The basic objective of descriptive statistics is to summarize, explain, and give meaning to a particular data set. According to Nick (2007), the arithmetic mean, the median, the standard deviation, and the interquartile range are the most often used descriptive statistics methods. The most common measures of numerical data are those that represent a set of data distributions by the central tendency.

Eight organized questionnaires were given out, and the researcher collected all of the responses from various schools. After the raw data were gathered and recorded, frequency distributions and descriptive statistics were used to analyse how the professional learning community affected learners' performance in physical science practical work. The information was summarized using frequency distribution. The various response types are shown in this distribution along with the frequency (number of participants).

Additionally, a percentage of the sample size was used to describe the frequency in each of the several categories (Maree, 2016). The term "descriptive statistics" refers to a variety of statistical techniques used to meaningfully organize and summarize data (Maree, 2016). According to Simpson (2015), descriptive statistics have been utilized to summarize the data on the contribution of PLCs to improving learner performance in practical work in the physical sciences, such as averages, standard deviations, and the most prevalent category.

For each participant's biographical data, frequencies and percentages were presented according to the teacher's gender, age, teaching experience, position, and teaching qualification. Statistics were used to generalize the numerical representations of the data, and numbers were used to depict the data visually (Simpson, 2015).

3.13 QUALITY CRITERIA

Since it prevents the researcher from influencing the study's findings, this phase of the study is crucial. The primary standard for sound qualitative research, according to Babbie and Mouton (2008), is reliability. The criteria covered in this section should, in the end, persuade the reader that the researcher was neutral and objective during the process of gathering and

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analyzing data. A study's credibility and authenticity (i.e., reliability and validity) are ensured by its trustworthiness (Anney, 2014).

Credibility, dependability, transferability, and conformance are the four divisions of the concept of trustworthiness (Gunawan, 2015). Being credible implies being able to persuade readers that the study's findings are important and that the research is of a high calibre (Maree, 2007). Essentially, a study's credibility can be measured by how closely its findings correspond to actual, first-hand knowledge of the topic being investigated.

3.13.1 Credibility

According to Farmer et al. (2006), the researcher can employ a number of tactics to ensure the credibility of his or her research in accordance with the criteria of truth value, application, consistency, and neutrality. These strategies can be used to assure the credibility of the results. Credibility and reliability go hand in hand. Credibility is the degree to which one may be certain that a researcher's findings are supported by the data and ought to be presented and discussed exactly as they were gathered from the participants (Myan & Maree, 2010). Additionally, they define credibility as the truthful portrayal of a certain situation or occurrence as stated by the researcher (Myan & Maree, 2010). Additionally, they define credibility as the truthful description of a certain situation or occurrence as the researcher has portrayed it (Myan & Maree, 2010). According to Kumar (2014), credibility describes a condition in which the research study's participants accept the findings produced using qualitative methods.

3.13.2 Transferability (Applicability)

Transferability is the degree to which findings can be applied to different contexts and target audiences (De Vos et al., 2011; Stommel & Celia, 2004). If the findings are applicable to scenarios outside the study environment and there is some degree of similarity or consistency between the two contexts, the research meets this requirement. The findings of this study are not extrapolated to other circumstances.

3.13.3 Reliability (Consistency)

Reliability is one of the criteria used to determine trustworthiness by subjecting the results of the study to scrutiny (2006). Thus, reliability refers to the stability (dependability) of the data over time, conditions, and occasions (Polit & Beck, 2008).

3.13.4 Confirmability (neutrality)

Confirmability is the potential for agreement between two or more independent parties regarding the accuracy, relevance, and interpretation of the data (De Vos et al., 2011; Polit & Beck, 2008; Stommel & Will, 2009). Confirmability is often referred to as objectivity (2004).

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The researcher ensures neutrality by exercising caution and purposefully not exposing or displaying prejudice toward any feature that is included in the empirical portion of this study (De Vos et al., 2005). The researcher handles the aforementioned factors relating to the reliability of the research in a way that ensures confidentiality (De Vos et al., 2005; McMillan & Scumacher, 2012).

3.14 ETHICAL CONSIDERATIONS

According to McMillan and Schumacher (2010), "credible research design requires not just the careful selection of informants and efficient research techniques, but also commitment to research ethics." According to Strydom (2005), research ethics are "a collection of moral principles that establish norms and behavioral expectations for acting as appropriately as feasible toward subjects and responses." The majority of research ethics concerns, according to Leedy and Ormrod (2005), fall into four categories: protection from harm, informed consent, right to privacy, and honesty with professional colleagues.

Regarding each of the aforementioned ethical criteria, the researcher took the following into account in this study.

- Protection from harm is not regarded as a severe issue because of the research's nature. But when conducting interviews or conducting observations, the researcher takes care to avoid causing "extraordinary stress, shame, or loss of self-esteem" (Leedy & Ormrod, 2005).
- Prior to their participation, the sample participants received an informed consent letter to reassure them that the study adhered to ethical standards (Halse & Honey, 2010). The letter outlines the goals of the study, the parameters of the participants' participation, and makes clear that the participants' participation in the study is entirely voluntary and open to termination at any moment.
- Participants are assured that, in order to respect their right to privacy, their involvement and responses will be kept anonymous and confidential. However, in order to guarantee the accuracy of the data transcription, participants were requested for their consent to record the conversations.
- By following quality standards and meticulously documenting sources, the researcher has also been honest and forthright in conducting the study and with professional colleagues in the field of educational research.
- The researcher also gave the assurance that the identities of the participating schools won't be revealed. The district in which the study is conducted, the proper principals

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and participating teachers, as well as any other officials with a stake in the evaluation, will also have access to or be made aware of the study's findings.

Additionally, the Bloemfontein Campus, CUT, FS Faculty Research and Innovation Committee (FRIC) gave its approval for this research to be carried out. The researcher also requested permission to conduct research in schools from the Free State Department of Basic Education and was granted permission to access schools.

3.15 CONCLUSION

This part was primarily concerned with providing a thorough explanation of the study's research strategy and design. It was explained that the study's mixed methods approach was used to gather information from the participants who were chosen for the research. Additionally, the study's philosophical framework is addressed. It's significant to observe that this study is grounded in an interpretivist paradigm in this regard. The researcher looked into how PLCs could help students who were performing poorly in physical sciences practical work using an interpretivist strategy.

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CHAPTER 4

DATA ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

In the previous chapter, the study plan and research methodologies were discussed. The methods and resources the researcher used to gather data from the participants who were mentioned in the first chapter were therefore covered in depth in chapter 3. As a consequence, the emphasis of this chapter is on outlining the findings, reviewing the participant data, and delivering and interpreting the participant data in light of the methods and strategies discussed in the previous chapter.

According to the chronological sequence of data collection, the data analysis and interpretation are organized. This chapter aims to present the findings from the questionnaires given to the participants, classroom observations, semi-structured interviews with principals, and focus groups with all physical science teachers (8) in the chosen schools for this study.

To address the goals and respond to the queries posed in chapter one, the data is presented and analysed. The main research question was: **How can PLCs be used to improve the learners' performance in the practical work of physical science?** The following sub-questions grew out of the primary research question:

What notions do FET physical sciences teachers attach to PLCs, specifically in the South African context?

- What are the issues and challenges faced by physical sciences teachers when attempting practical work in Further Education and Training (FET) science?
- Which strategies for the process may be used to implement PLCs for practical work in FET science?

The themes and categories of this study were developed and organized based on these sub-questions. The researcher chose to use a mixed-method strategy (i.e., quantitative and qualitative research approaches) to collect data for the participants in this study using individual questionnaires, classroom observations, and interviews, as mentioned in chapter 3. FGAP1, FGAP2, FGAP3, FGBP4, FGBP5, FGBP6, FGBP7, and FGBP8 were used as letter codes to identify teacher participants from the four sampled schools, while Principal 1 & Principal 2 were used to identify principals. Italicized text indicates participant answers that

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were typed verbatim. Finally, what was deduced from the data was treated as study findings and will be discussed in chapter 5.

4.2 ANALYSIS, INTERPRETATION AND DISCUSSION OF FINDINGS FROM THE QUANTITATIVE SECTION OF THE STUDY

4.2.1 Introduction

The findings of the quantitative data analysis are presented, discussed, and given an in-depth interpretation in this section. The results from the quantitative data were analysed, presented, and discussed in order to provide clarification for what will be said in the qualitative phase and to address the questions raised by the research objectives. The researcher analysed the quantitative answers using descriptive statistics, such as frequencies and percentages. The data obtained were summarized using frequency distributions and percentages. These distributions display the frequency (number) and percentage of respondents together with the various response categories. The information gathered, including averages about the PLC's influence on raising learners' performance on practical tasks, was described using descriptive statistics.

4.2.2 Frequency and percentage distribution of biographical information of teacher participants

The presentation of participant biographical information, which is presented as frequencies and percentages based on the teachers' gender, age group, years of physical sciences teaching experience, positions as teachers, grade levels, and the number of learners in a classroom, comes before the analysis, presentation, and discussion of quantitative data. The study also considered the school's geographic location (urban, semi-urban, and rural), the facilities that were accessible (access to lab, equipment, or apparatus), the frequency of practical exercises, and the method of teaching used in the classroom.

Teachers from the public secondary schools in circuit six of the TMED, Free State, participated in the study. The study sample was given a total of 8 questionnaires to complete, and a 100% response rate was obtained. Eight participating teachers' biographical data are shown in tables and figures as frequency and percentages. First, the individuals' gender was looked at.

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4.2.2.1 Teacher participants according to gender

Table 4.1 Gender of teachers (n=8)

Gender	Frequency (f)	Percentage (%)
Male	3	37.5
Female	5	62.5
Total	8	100

Table 4.1 shows that there were 62.5% female participants and 37.5% male participants among the instructors who took part in this study, indicating that female teachers made up the majority of the participants in circuit six of the TMED, Free State.

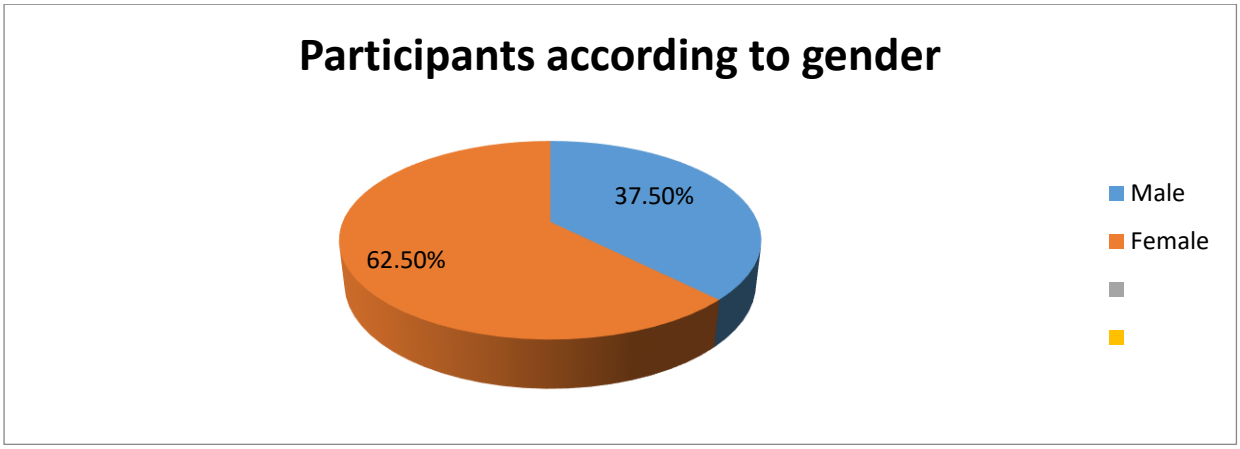


Figure 4.1: Participants according to gender

Figure 4.1 shows a total percentage of 37.5% males and 62.5% females who participated in the study.

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4.2.2.2 Teacher participants according to age

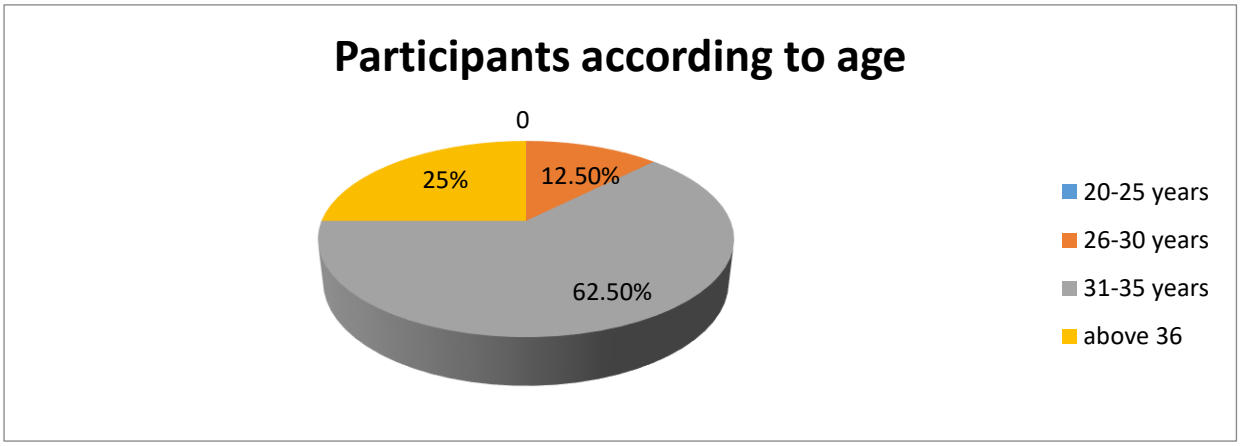


Figure 4.2: Participants according to age

Figure 4.2 indicates the age of teacher participants. Their ages ranged between 26 and above 36 years, while the majority (62.5%) were aged between 31 to 35 years as presented in the graph.

4.2.2.3 Teaching experience in Physical Sciences

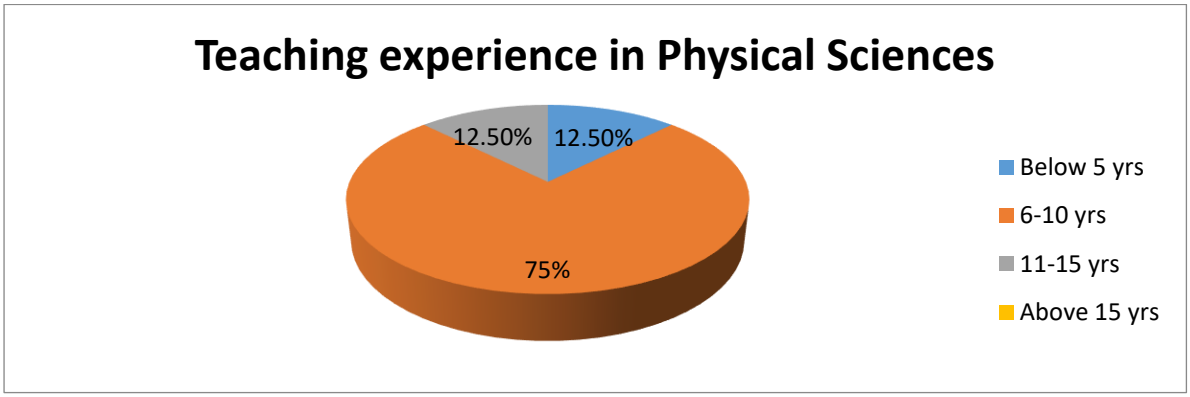


Figure 4.3: Teaching experience in Physical Sciences

Figure 4.3 displays the teachers' experiences in teaching the physical sciences who participated in the research project. The participants' backgrounds varied in terms of years of expertise teaching physical sciences. The majority of participants (75%) had taught physical sciences for six to ten years and had an average of 37 years of experience; the participant with the least amount of experience (less than five years) had just entered the field after graduating from a higher education institution and had the same percentage (12.5%) as the participants with an average of eleven to fifteen years of teaching experience.

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4.2.2.4 Class size taught

Table 4.2. Class size (n=8)

	Category	Frequency (f)	Percentage (%)
Maximum number of learners taught in a classroom	Below 20	2	25
	21-30	1	12.5
	31-40	4	50
	Above 40	1	12.5

Table 4.2 shows participants' responses on the maximum number of learners they taught in their physical sciences classrooms. It shows that the majority of the teachers (50%) had between 31 and 40 learners in a class.

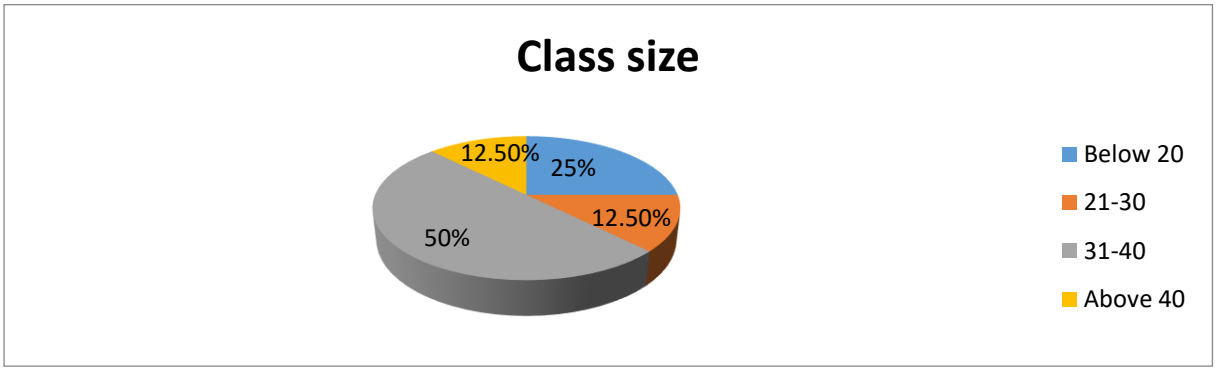


Figure 4.4: Class size

Most of the participants (50%) indicated that they had between 31-40 learners in the classroom. It was important to look into the class size in this study to get an indication of the implications that it might have in doing physical sciences practical work.

4.2.2.5 Highest level of teaching qualification

Table 4.3 Highest level of teaching qualification (n=8)

	Category	Frequency (f)	Percentage (%)
Highest teaching qualification	B.Ed	3	37.5
	ACE/PGCE	1	12.5
	Honours degree	4	50
	Master degree	0	0

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The teachers who responded to the questionnaire had the greatest level of teaching qualification, as shown in Table 4.3. In order to determine the suitability of the individuals chosen, it was crucial for this study to emphasize the highest academic degree attained. The participants exhibit teaching proficiency in the physical sciences and constitute a targeted sample with formal higher learning qualifications, which are necessary to work in the teaching profession. None of the participants who were teachers and filled out the questionnaire had a master's degree in education (0%). The most common degree for teachers was an honours degree in education (50%), followed by a B.Ed (37.5%).

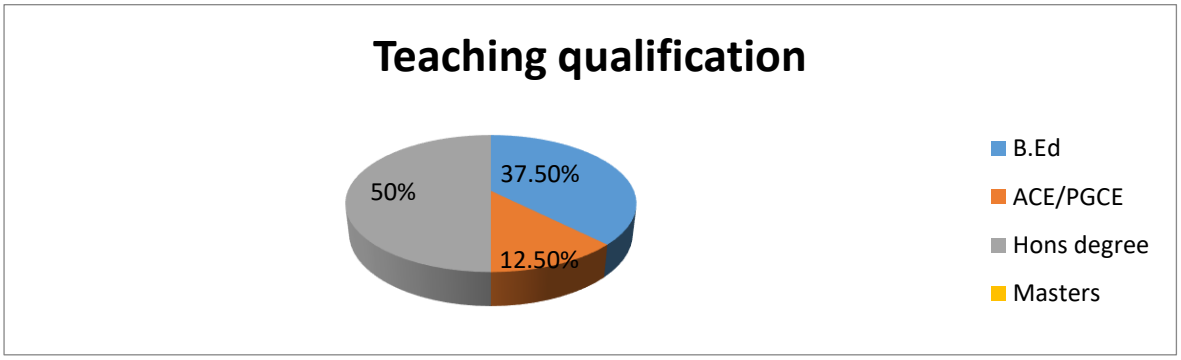


Figure 4.5: Teaching qualification

A lower number of teachers (12.5%) obtained ACE/PGCE in education as depicted in figure 4.5.

4.2.3 Quantitative analysis of biographical information

All of the participating teachers in this study are from the rural communities that are home to the chosen schools. In the Free State province of South Africa's circuit 6 of TMED, a cohort of teachers who teach physical sciences in the rural area served as the study's subject population. Despite being located in rural regions, all of the chosen schools had access to electricity and running water.

Only one teacher participant in the four secondary schools selected for the research had less than six years of classroom experience; the other six had between six and ten years; and the final participant had between eleven and fifteen years. According to reports, teachers' effectiveness and experience are related (Alexander & Fuller, 2005).

This could be explained by the fact that as teachers advance in their careers, they are more likely to gain knowledge of the topic and the learning challenges that exist within it. Teachers would then be better equipped to help learners overcome their learning obstacles as a result

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of this information. As a result, there is a greater likelihood that the teacher will become more effective over time.

The participants mostly teach grades 10-12 learners, four of them were very experienced post-level 1 teachers who could give guidance to less experienced teachers and four were heads of departments. Five participants taught physical sciences from grades 10-12 and one participant taught grade 10 only. On the availability of a laboratory in schools, one participant indicated that they had a laboratory in their school and that it was well equipped.

Five admitted to having a laboratory but had only a few pieces of equipment/apparatus to do practical work and one also agreed to have a laboratory in their school but it was moderately equipped. On whether practical work is performed at schools, including those prescribed by CAPS, participants responded differently. One participant responded that practical work was done every time, whilst two participants said they were done often, and five participants said practical work was rarely done due to lack of time and equipment.

All of the participants acknowledged that they use hands-on activities in their classes to help learners better comprehend the ideas and abilities needed for the study of the physical sciences. Even though the majority of them admitted to doing practical work, their capacity to do so depended on the tools being available. One school had more resources than the others in terms of the availability of the materials that allowed for practical work to be done.

This section of the study looked at the operative research as well as the biographies of the participating teachers. It included a discussion of the similarities and differences between the participants' responses, as well as an analysis, interpretation, and debate of the participants' responses.

The opinions of participants in the physical sciences about their unique experiences, the conditions at their different schools, the Professional Learning Community (PLC), and practical work are the subject of the study's following section. Participants in the study who taught physical sciences were asked to provide a written response to eight open-ended questions. The quantitative answers were examined using descriptive statistics.

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4.3 FREQUENCIES AND DESCRIPTIVE STATISTICS FOR STRUCTURED QUESTIONNAIRE QUESTIONS (Section B of the questionnaire)

4.3.1 **QUESTION 1:** ***Do you teach practical work in your school? Enumerate the problems that you encounter when teaching physical sciences practical work (c.f. 2.5).***

Teachers had varied opinions on the question of teaching practical work in their schools and problems encountered when having to perform the practical work. The explanations and descriptions attached to practical work in physical sciences largely determine how teachers approach this issue. All the participants (100%) agreed to teach practical work, however their way of doing this differed. More participants (87.5%) alluded to taking their learners to the laboratory to do practical work while other participants (12.5%) said it all ended in the theoretical classroom where demonstrations were made because there was no laboratory in the school. The majority of participants (87.5%) noted that while their schools had labs, there was not enough apparatus or equipment available to conduct every required experiment outlined in the CAPS document.

The issue of time was brought up by one participant whose school had a well-equipped laboratory as one of the major challenges she faced when conducting practical work with her learners. This is consistent with Ramnarain and Hlatswayo's (2018) findings from their research on the value of practical work in high schools. Physical sciences is only allotted an hour a day, according to the participant described above to cover both theoretical and practical work. It was extremely difficult for her to follow the procedure, describe the scientific concepts, and complete the practical work because she was pressed for time to finish the Annual Teaching Plan (ATP) for the purpose of other learners' formal assessments.

Hodson (2002) goes on to state that practical work need not always interfere with activities done at the laboratory bench, which helps to resolve this issue. The use of worksheet activities in conjunction with teacher demonstration or video/film presentation, conducting interviews, debating, and role-playing, completing writing assignments, creating models, posters, and scrapbooks, using different types of library work, and creating videos are all acceptable alternatives.

On the other hand, Yager (2007) contends that practical work could be rephrased to denote a location where learners can test their theories and/or explanations for things they have seen while pursuing their interests in the universe in which they find themselves. As a result, Yager (2007) emphasizes the significance of addressing the issues teachers face when teaching

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practical work. According to Tamir (2008), the laboratory should be used as a setting where science learners can participate in practical activities like observations and experiments, that is, not just to verify but also to discover.

The teachers' opinions agreed with the literature reviewed in chapter 2 of this study, despite the fact that they varied from teacher to teacher due to their various institutional settings. First off, Bekalo and Welford (2006) state that learners should always participate in practical work. According to Hodson (2002), any teaching strategy that necessitates active rather than passive participation is consistent with the idea that practical work itself is a direct experience that facilitates learning. Bradley and Maake (2008) contend that the definition of practical work can be broadened to encompass tasks like project work, library study, fieldwork, site visits, environmental monitoring, and technology exploration.

4.3.2 **QUESTION 2:** ***What is your opinion regarding a suggestion of incorporating/using the professional learning community to improve learners' performance in practical work?***

When asking important questions about learning and pedagogy, as well as issues pertaining to scientific practical work, teachers need supportive, collegial communities (Loucks-Horsley, et al., 2008). Activities for professional learning communities might include setting aside regular time each day for planning and debate among teaching colleagues from the same school or from other schools.

Some of the members' answers to the aforementioned query are as follows:

"*I enjoy attending the professional learning community to learn about new ideas in science teaching"* (FGAP1).

Another participant commented:

"I enjoy working with colleagues about science curriculum and teaching, even if it means after-school meetings" (FGAP2).

Teacher 3 (FGAP3) was also of the idea that:

"I have adequate opportunities during the school day to collaborate with my fellow science colleagues about science teaching and learning."

The majority of the participants appeared to find the idea of using the PLC to improve learner performance by preparing lessons jointly appealing. When planning a lesson on their own, teachers expressed a lot of worries, including the challenges of accessing, confirming, and

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integrating different learning resources. They were particularly troubled by the challenges of dispelling the ideas and biases that learners of various ages and backgrounds bring to the study of scientific practical work (Appleton, 2006). Nearly all of the teachers agreed that these factors in some way influence how well learners learn from classroom practical work, including the learners' abilities, learning strategies, age and developmental level, attitude and motivation, and previous knowledge.

4.3.3 QUESTION 3: *In your opinion, what form of support should the department of basic education extend to senior secondary schools to promote the teaching and learning of physical sciences practical work? (cf. 2.10).*

The purpose of this question was to gather teachers' opinions regarding the assistance that the department of basic education may provide in order for them to perform better on practical work in the physical sciences. Teachers could give more than one viewpoint. All the participants were of the view that developmental workshops should be organised by the department to train all the physical sciences teachers on how to handle apparatus and teach practical work in their respective schools. Participants strongly felt that all schools must have laboratories and assistants responsible in the laboratory and be frequently monitored to check if chemicals and equipment are in good condition.

Regarding the developmental workshops, mainly organised for practical work, the viewpoints of teachers are classified based on the following:

- Practical work session-related viewpoints.
- Educator’s viewpoints based on the traditional approach to practical work teaching; and
- Other viewpoints.

The table below indicates the viewpoints of teachers. This table aimed to illustrate teachers’ viewpoints on their understanding of practical work in physical sciences. The following table speaks to what extent participants agree with the statements regarding the developmental workshop (for teachers) on physical sciences practical work towards improving learners’ performance.

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Table 4.4: Teachers' viewpoints regarding developmental workshops on practical work

No.	Statement	Strongly agree 1	Agree 2	Neutral 3	Disagree 4	Strongly disagree 5
1	The subject advisers (as subject experts) facilitate the process of learning and provide guidance and help where necessary. The subject advisers do only 25% of the work.	37.5	37.5	25		
2	Sessions with clearly defined outcomes.	100				
3	a session where teachers work autonomously and are accountable for their own learning.	25	25	12.5	37.5	
4	A session meant to enable teachers to reach and explore their maximum learning potential.	100				
5	An activity-based session, doing science practically, discovering about science.	100				
6	A session where teachers participate actively and think critically.	50	50			
7	a session where teachers can show that they comprehend fundamental physics ideas and notions.	100				
8	A session where teachers are expected to investigate, solve problems, do experimental work, class work, and practical demonstrations.	12.5	25	50	12.5	
9	A session that emphasizes the development and application of scientific process skills in a variety of	100				

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	contexts, the growth of scientific knowledge and understanding, and a grasp of the connections and responsibilities between science, society, and the environment					
10	An investigative session.	50	50			
11	A session where there is an integration of knowledge.	100				
12	A session that defines essential competencies, attitudes and values which teachers should acquire and develop.	12.5	37.5	50		
13	An interactive session.	100				
14	A session that enables teachers to apply scientific methods, skills and knowledge to problems in innovative ways.	100				
15	A developmental workshop which consists of phase organisers, programme organisers, specific outcomes, various practical experiments/activities, methods and time frames.	100				
16	A session based on the philosophy that all teachers can learn.	100				
17	a session that covers both what teachers learn and what they are capable of doing once the learning process is complete.	100				
18	A session that promotes scientific literacy.	100				
19	A session based on scientific inquiry.	100				

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20	A session that aims to develop teachers' basic skills, focusing and planning, investigation, gathering, manipulating and analysing data, and communicating findings.	100				
21	A session that prepares teachers for scientific research.	100				
22	A session driven by society's needs.	50	50			
23	A session that includes all types of teaching methods	100				
24	A session that describes concretely and in detail teaching, learning and assessment activities that are to be implemented.	100				
25	A session where outcomes are achieved through practical work and asking questions.	100				
26	A session that enables teachers to formulate and utilise ideas and knowledge.	100				
27	A session that takes teachers' differences into account.	100				
28	A session where teachers learn things practically with the help of the subject advisers.	100				
29	A session with different assessment methods.	100				
30	A session that encourages teachers to be more creative.	100				
31	A session that develops self-confidence because of being able to discover the outcomes of the activity.	100				

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Teachers expressed a variety of different views. The major challenge regarding the developmental workshops for physical sciences practical work in the FET phase is how to plan and execute a practical work lesson in physics and provide more practical knowledge (Hodson, 2012). Compared to other viewpoints, some 75% of the teachers seemed to think that a practical work session must be a learner-centred activity with certain expectations from learners. Investigating, resolving issues, carrying out actual work, and performing practical demonstrations are all part of these expectations. On the other hand, during the teacher development workshop, all participants (100%) were of the opinion that the session should emphasize the development of teachers' fundamental skills, including concentrating and planning, researching, gathering and manipulating data, and communicating results (Bekalo & Welford, 2010).

4.3.4 QUESTION 4: From your experience, in your opinion, what advantages if any, are there when teaching physical sciences practical work?

This question intended to test teachers' comprehension of the benefits of hands-on learning in the physical sciences. What exactly are the results of practical work in the physical sciences, in other words, in the eyes of the teachers? In Table 4.5, the following categories are used to group the teachers' points of view:

- Acquisition of knowledge.
- Skills-related advantages.
- Development of problem-solving skills.
- Development of cooperative learning skills; development of attitude; and
- Other viewpoints.

Table 4.5: Teacher’s viewpoints on the advantages of teaching physical sciences practical work.

When asked to remark on the benefits of doing comprehensive practical work in senior secondary schools, all of the participants (100%) agreed that practical work aids greatly in the acquisition of knowledge. All participating teachers agreed that practical work showed a grasp of the concepts, principles, and knowledge learned in the physical sciences (Curtis et al., 2016). All of the participants concurred that doing practical work improved comprehension of the material in the physical sciences. Additionally, they believed that knowledge is best understood through practice, which helps learners acquire facts, concepts, theories, and laws as well as how variables and quantities relate to one another (Omiko, 2015).

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Teacher participants were also asked to air their views concerning skills-related advantages. 100% of the participants agreed that practical work helps to develop the skills such as observing, predicting, comparing, measuring, estimating, recording information, researching, sorting and interpreting, hypothesising and classifying, handling and using apparatus, as well as drawing conclusions (Colen, 2013).

On the development of problem-solving skills, all teacher participants were also in agreement that practical work helps with the development of scientific reasoning, broadens the mind of the learner and aids the learner to identify and solve problems and make informed decisions (Sharma & Bansal, 2017). Teachers' participants agreed that practical work helps learners to act confidently on their curiosity about natural phenomena, to investigate relationships and solve problems in science.

Participants also unanimously agreed that practical work helps learners organize themselves and their tasks in a responsible and efficient manner when it comes to the development of cooperative learning skills (Ndihokubwayo et al., 2018). They also concurred that practical work enables learners to collaborate successfully within a team, group, organization, and society. Practical work also promotes collaborative learning. Other arguments made by teachers about the value of practical work included that it helps learners comprehend the work they are doing, shows how physics functions in real-world situations, and verifies laws and hypotheses (Ifenkwe, 2013). The teachers who took part in the discussion agreed that doing practical work supports prior knowledge and shows a grasp of the world in a related way.

The format of presentation and level of detail in the list of benefits of practical work differs greatly (Kempa, 2008). Teachers' opinions on the aforementioned paragraphs typically accord with the literature study on the benefits or outcomes of practical work (Van der Linde et al., 2004; Allsop, 2001; Bradley et al., 2008; & Treagust & Thair, 2009). According to the literature reviewed for this research, practical work should:

- Support theoretical learning by reinforcing the comprehension of science concepts and principles by simplifying abstract ideas.
- Learn useful techniques and abilities.
- Stimulate learners' interest and inspire them to realize that science is enjoyable by teaching scientific processes, participation in problem-solving, and thinking strategies.

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These benefits of practical work are consistent with the outcomes of the natural sciences as stated in the Curriculum and Assessment Policy Statement (CAPS) and with the guiding principles of constructivism. Implementing these benefits in the physical science practical work classroom is a difficult task for teachers. The benefits listed by the teachers in the previous chart (table 4.5) are an expansion of the results of practical work. Concentrating on these benefits in practical work is justified by the adoption of what is basically a discipline-centred methodology for determining the goals of science education (Kempa, 2008).

From the responses gathered, the researcher came to the following conclusions regarding the establishment of developmental workshops to improve performance:

- Teachers should receive training on how to present tasks that encourage the growth of analytical and deductive reasoning, manipulative skills, and problem-solving abilities.
- Attention should be paid to the teacher's capacity to establish an appropriate context for learners in the desired, reachable classroom.
- Attention should be paid to the mismatches between learners' intended and actual desired goals and activities.
- The teacher's approach to practical work should direct learners towards the accomplishment of the desired goals of practical work and CAPS.
- Inquiry teaching should receive major emphasis on physical sciences practical work.
- Constructivist teaching should be used in an integrated setting as a channel to engage learners in critical thinking and problem-solving.
- The emphasis of the hands-on approach should be on the development of practical skills,
- The teacher's position should change from that of an instructor to one of a facilitator of the learning process.
- Problem-solving as a teaching strategy should be incorporated into practical work. The latter embodies most of the techniques and learning skills that physical sciences teachers should consider important when teaching physical sciences using investigative methods. The teacher's role in problem-solving should involve thinking about presenting everyday situations and experiences that relate to each concept of fundamental law discussed.
- Cooperative learning should be encouraged.

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4.3.5 QUESTION 5: Share your opinions on how a professional learning community can be implemented in senior secondary schools to address challenges faced by educators in teaching physical sciences practical work and how, if possible will it improve learners' performance? (cf. 2.8)

In some instances, teacher participants believed that one way of implementing PLCs in the FET phase of high schools to address challenges faced by teachers to see learners' improvement in practical work was by doing preparations together, doing presentations and discussions/feedback based on each other's presentations. The following table categorises teachers' responses based on the idea of improving learners' performance through the professional learning community

Table 4.5 Participants' views on how PLC can be implemented in the FET phase

Categories of participants' opinions on how PLCs can be implemented	Responses on how to improve learner performance
Preparations	• Have all materials needed at hand for preparations • Have clear learning outcomes of the lesson • Ensure all teachers who are members of PLC have their lesson preparations • Allow enough time for preparation • Boost each other's confidence by ensuring all is free from the beginning of the presentation to the end • Since CAPS is not so old, ensure our preparations are modern and learner-centred
Presentations	• Assist in giving relevant examples • Assist one another in making sure that learners understand their roles and what is anticipated of them during teaching and learning. • Help with focusing on relevant aspects • Ensure the presentation involves the learners by being hands-on • Assist in giving techniques freely and confidently during the presentation • Ensure integration of concepts where needed • Allow learners sufficient time to ask questions • In the absence of apparatus, assist each other by improvising, like making/doing own apparatus

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	• Assist each other on how to use certain apparatus and how to handle them • Learn how to communicate effectively with the learners • Learn how to facilitate and monitor what learners are doing. • Avoid being too much formal with the aim of not scaring learners to be free to do the practical work • Learn how to expose learners to the lab environment to make them feel comfortable
Discussion/Feedback	• Allow constructive criticism from peer colleagues on one's presentation to realise your mistakes

The opinions of the participants make it obvious that approaching practical work presents difficulties. It is necessary to engage in the professional learning community for professional development because the teachers who took part in this study do not fully comprehend their role in the practical activity. After watching other teachers' presentations on actual work, teachers realized many errors they make through the PLC. The findings of this survey are consistent with research from other developing nations, such as South Africa (Bekalo & Welford, 2000:203; Treagust & Thair, 2009:358).

4.3.6 QUESTION 6: What are the benefits of being a PLC member? (cf. 2.7.2.1 – 2.7.2.8)

Responses from participants on the benefits of being a PLC member were that when you are part of the professional learning community, you can:

- Learn from your own mistakes and other people's mistakes and correct them.
- Realise your weaknesses and strong points.
- Realise your role as a teacher.
- Learn from other teachers' presentations.
- Understand better when you see others presenting/performing practical work lessons.
- Assess yourself.
- Realise your shortcomings and revisit other members' ways of approaching practical work.
- Learn new techniques.
- Improve your confidence in presenting your lessons.
- Compare your approach to others' lessons and improve your own.
- Determine what to improve and how to.
- See different teaching approaches.
- Helps you to shift from an old approach to the new approach.

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- Improve attitudes towards CAPS.
- Learn how to use different strategies.
- Serve as a demonstration model lesson.

According to the researcher, teachers prefer to centre their learning on collaborative inquiry and their conversations about their reflections, which is supported by the above explanation of collective learning (Kruise, 2014). One advantage of professional learning communities is collective learning, which encourages teachers to consider how they can enhance their lesson plans by putting a strong emphasis on student learning. Teachers may need to focus their attention on learning new approaches, curricula, and assessment procedures, it has been proposed (Hord, 2012).

4.3.7 QUESTION 7: How can PLCs be used to improve learners' performance in physical sciences practical work?

Participants offered the following ideas for how PLCs can work together to raise learners' performance in practical physical science work:

- *Increase teachers' knowledge about teaching practical work.*

Teachers' subject matter knowledge affects both the content and the processes of their teaching instruction, thus influencing both what and how they teach (Wahyudi & Treagust, 2004). On whether teachers feel confident about their subject matter knowledge, the majority (75%) indicated that they feel confident though a considerable number of teachers (25%) did not feel confident about practical work.

However, there are areas in physical sciences which include explaining subject matter properly. These include exposing learners to practical work where the teacher needs to give real-life examples, apply principles of science to real-life examples; provide current ideas about science concepts and differentiate teaching for different topics and allow learners to be hands-on.

Teachers must have the ability to critique and apply subject matter knowledge to practical work in any new situation (Parker, Wallace, & Fraser, 2003; Ware, 2002b). Twenty-five per cent (25%) of the teachers felt they were always able to provide examples from the world around them. However, a significant number of teachers (75%) have faced difficulty in providing real-life examples during their teaching in the classroom.

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- *Update teachers' knowledge of practical work.*

Since the classroom environment is currently gaining greater attention, teachers felt that since the emphasis on school effectiveness had decreased in the past, they needed development workshops to refresh or expand their knowledge of practical work (Creemers & Reezigt, 2006). Effective teaching is supported as a critical objective to be achieved in the Ministerial Task Team Report (DBE, 2013). Additionally, DBE works to enhance and grow staff members' capacity to deliver effective teaching, which would likely enhance learning and produce improved learner outcomes. Through teacher development programs and recurrent practical work sessions with new techniques, effective teaching can be achieved. A wide range of learning opportunities are included in teacher development.

- *Exchange methods in teaching practical work.*

According to the teacher participants, informal teacher-to-teacher collaborations can still be advantageous for the learners. Genuine cooperation is best accomplished through a planned process for exchanging perspectives and content (Henderson & Mapp, 2012). When lesson planning with colleagues, teachers should learn how to collaborate. A teacher should support other teachers and let them help him or her in educating learners. A teacher should further motivate learners to collaborate in groups (cf. 2.8.2). Team teaching and result analysis are crucial because integrating learner performance would not only benefit such a teacher but also aid enhance results for the entire school (Wagner, 2002). As they gain experience and time, teachers' knowledge evolves (Gess-Newsome, 2009).

4.3.8 QUESTION 8: What challenges do you experience when conducting practical activities? Please list them.

The following is a list of responses from participants regarding the challenges they experience when conducting practical work:

Management related:

- Insufficient/inadequate/little/shortage/limited apparatus to do practical work, especially in rural schools.
- Lack of funds to purchase apparatus.
- Principals not being prepared to purchase apparatus.
- Resources available for demonstration by the teacher.
- Lack of textbooks.
- Practical work takes longer, and teachers are expected to rush and finish the Annual Teaching Plan (ATP).

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- Emphasis is placed on the completion of ATP.
- ATP is too long.
- Poor teacher-to-pupil ratio.
- No laboratories.

Leaner related:

- Lack of commitment from learners.
- Those who have apparatus do not know how to use them because of lack of exposure.
- Time is limited for practical work.
- Large number of learners in our classrooms and little space for practical work.
- Learners who take a longer time to understand.
- Learners get excited by some of the apparatus and do not pay attention in the practical.
- Mishandling of apparatus by some learners.
- Learners have certain misconceptions about practical work.

Teacher related:

- Teachers lack knowledge of the subject.
- Workload is too heavy.
- Learners regard physical sciences as a complicated subject.
- Lack of knowledge of some aspects related to CAPS.
- Lack of interest by some teachers.

Despite the Curriculum Assessment and Policy Statement for Physical Sciences' insistence that actual work must be done in classrooms, the majority of the participants in the professional learning community are worried about their insufficient backgrounds in the physical sciences (Gudyanga & Jita, 2019). Lack of preparation causes teachers to struggle when trying to carry out practical work activities. The majority of the sampled teachers admitted that they required help learning new teaching methods and discovering instructional resources.

The absence of resources is one of the difficulties participants identified with carrying out practical work. One participant mentioned that although their school offered physical sciences, there was no laboratory at all. Another participant agreed with him when he said that sometimes there are chemicals present, but they have expired. He added that some chemicals may be contaminated or old and not produce the desired results.

Lack of time was a problem that surfaced more frequently. Participants brought out the fact that practical work takes a lot of time and that there is no time designated for it in the policy

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statement. Participants appeared to agree that not having enough time is a significant factor in the difficulties they have when carrying out practical work. The participants expressed their belief that they needed more time to concentrate on practical work and that they were unable to balance the demands of teaching both theoretical and practical work in the physical sciences. According to research by Gittelsohn et al. (2003), there are obstacles at both the organizational and individual levels, including time constraints, difficulty prioritizing tasks, a perceived lack of resources, inadequate equipment, and the most prevalent difficulty implementing practical work.

Participants in the study mentioned class size as one of the major stumbling blocks to doing practical work in schools. One participant wrote (FGAP1):

"larger classes present challenges for teachers to do different practical work activities".

At the simplest level, it is difficult for many learners to physically see the demonstrations, as a result, class size also influences how teachers approach their teaching in practical work in terms of what they might consider feasible and reasonable to attempt to manage (Gudyanga et al., 2019).

4.4 ANALYSIS, INTERPRETATION AND DISCUSSION OF FINDINGS FROM THE QUALITATIVE DATA SECTION.

Beginning with a presentation of participant biographical details along with their opinions or characteristics regarding the professional learning community and practical work, this section covers the qualitative data analysis and results interpretation. This part of the study investigates the thematic approach to qualitative analysis, which is followed by the presentation and interpretation of the focus group interviews (FGI). A table-format display and explanation of the direct observation are provided after the qualitative data is presented in accordance with the themes.

4.4.1 Thematic approach for qualitative data analysis

Thematic analysis is a process for finding patterns within qualitative data (Braun & Clarke, 2013). As a result, this part of the study uses a theme qualitative analysis methodology. Thematic analysis also seeks to identify themes, which are then used to analyse the study or make a point about an issue (Maguire & Delahunt, 2017). The collected data was consequently accurately and consistently classified and examined by the researcher. The

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qualitative thematic data approach developed by Anaheim was thus used in this research and is as follows:

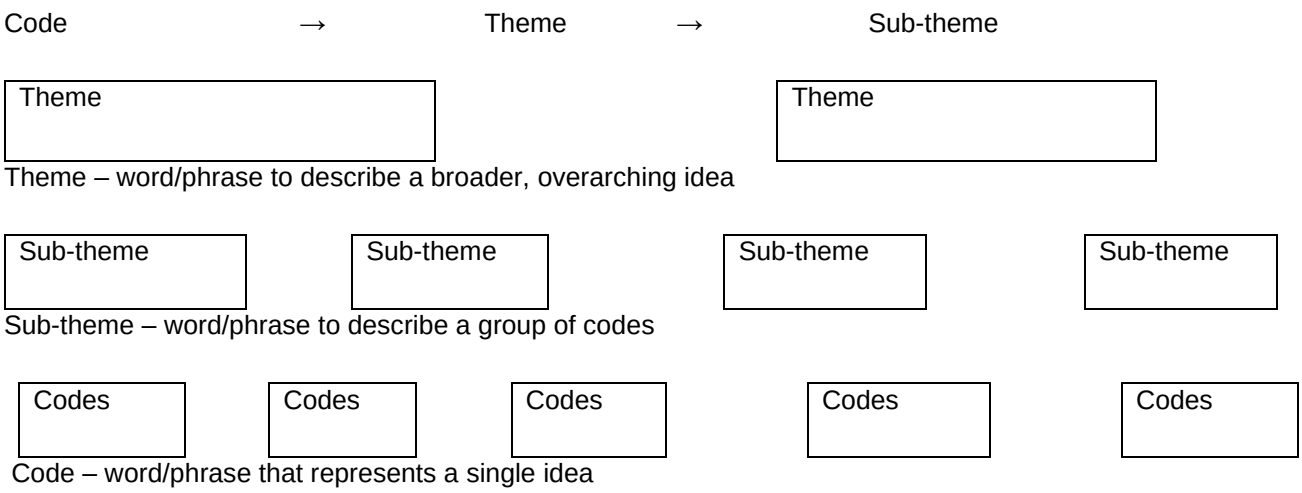


Figure 4.6: Thematic data qualitative approach (model derived from Qualitative Analysis of a National Survey of Paediatric Residents Academic Medicine)

4.4.2 Data from the Focus Group Interviews (FGI) discussion

Regarding the location, it was difficult to have members of the professional learning community (PLC) all together in one place/venue due to the outbreak of the national Covid-19 pandemic. There were strict regulations that needed to be followed, like social distancing, wearing masks, washing hands and sanitizing to prevent or curb the spread of the virus. As a result, the researcher organised a virtual meeting (zoom) with the participants to have further discussions.

Table 4.6: Schedule of Focus Group Interviews (FGI)

Location	Date	Time	Composition	Participants	Rank
Virtual (Zoom)	18/9/2020	09h00-09h45	Members of PLC	3	P. Sciences teachers
Virtual (Zoom)	21/9/2020	11h00-11h45	PLC Members	5	P. Sciences teachers

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The teachers of physical sciences in the designated schools were randomly picked to be the participants. Three physical sciences teachers, one from a high-performing school and two from low-performing schools, participated in the first focus group interview. Five physical sciences teachers participated in the second round of group interviews, with two coming from high-performing schools and three from low-performing ones.

Both sessions were held in English and ran roughly 45 minutes out of the allotted 60 minutes. As shown in Table 4.6 above, the focus group discussions were conducted in September 2020, just before the end-of-year exams. To identify the precise focus group, use the location and the times in the table.

In order to elicit perceptions into attitudes, views, and opinions on the role of the professional learning community in teaching physical sciences practical work, a series of pre-approved questions was used. The information was gathered by the researcher using a specific query at specific times. The categories that emerged during the analysis and outcome interpretation were used to group this data. The participants' exact remarks are reproduced verbatim and are italicized. Only previously identified features from the qualitative data were addressed, and new topics were covered, with the primary goal of the data collection being to corroborate the qualitative phase.

To determine whether the FGI questions were suitable for producing rich data that addressed the proposed research topics from the viewpoint of credibility in this study, the researcher conducted pre-focus group interviews (Elo et al., 2014). The data analysis findings from the two focus group interviews (FGI) were used to create codes, categories, and themes. The qualitative findings of this study were presented in accordance with topics that emerged from the FGI responses based on the research questions. During data analysis, focus group members from focus groups A and B (FGPA/B), represented by a total of 10 codes from the two focus group interviews, were used:

Table 4.7: Participant's code

GENDER	FOCUS GROUP (A or B)	CODE
Female	A	FGAP1
Female	A	FGAP2
Male	A	FGAP3
Female	B	FGBP4

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Male	B	FGBP5
Female	B	FGBP6
Female	B	FGBP7
Female	B	FGBP8
Male	School 1	Principal 1
Male	School 2	Principal 2

- Questions 1, 4 and 5 focused more on physical sciences practical work, whether teachers/participants received sufficient training to attempt practical work in their classrooms, and lastly discovering challenges participants experienced while supervising practical work in their classroom set-up.
- Questions 2 and 3 investigated the participants' understanding of the professional learning community and its effective implementation towards practical work at the further education and training band in high schools.
- The physical sciences teachers' desire to use the professional learning community to further their development while ensuring that it helped to improve students' success in practical work in the physical sciences was assessed by questions 6 and 7.

The feedback from the participants will be presented in the following sentences, which will also explore how the participants' ideas and views are similar and different. There were three major themes and two sub-themes that provided a deeper understanding of the participant responses.

4.4.3 THEME 1: Self-perception on practical work (confidence in using equipment and materials).

This theme emerged from the question the researcher asked to discover if there were any aspects of practical work covered during the participants' teacher training and if they added any value to teachers' classrooms. This question was incorporated into question number four which inquired about the challenges teachers experienced when supervising practical activities in their science classrooms and how can they overcome them.

An overview of practical work was provided in Chapter 2, which was the study's literature review. It is described as the laboratory work, experiments carried out by the teacher, demonstrations, or hands-on experimentation by learners in a laboratory or classroom

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(Bradley & Maake, 2008). All specified practical work for all grades in the FET phase (i.e., grades 10–12) must be completed and officially evaluated at the end of each term, according to the Curriculum Assessment Policy Statement (CAPS) for the FET physical sciences curriculum.

The FET physical sciences teachers who participated in the study were asked three questions in order to learn more about their own attitudes toward practical work as well as those of their learners. They were also asked to identify any factors that may have helped them effectively teach practical work in their classrooms.

Generally, all FET teacher participants (8 in total) indicated that they attended the physical sciences content workshop and although enough time was spent on the theoretical part of physical sciences, some topics needed to be covered including how learners will be assessed. Notably, all participants pointed out that practical work, as part of physical sciences, was expected, although 7 participants (FGAP1, FGAP2, FGAP3, FGBP 4, FGBP5 & FGB6, FGBP7) declared that they had no laboratories in their schools. Furthermore, four other participants (FGAP1, FGAP3, FGBP4 & FGBP5) indicated that even if they tried to do practical work in their classrooms, they had limited equipment/apparatus to complete experiments. Additionally, one participant (FGBP8) mentioned that although there was no development on practical work from the training, there was a well-equipped laboratory in their school and an expert colleague who was a veteran in physical sciences teaching and who assisted her with practical work.

A typical response from two physical sciences teachers in focus group 1 (FGAP1 and 2, FGBP6), when asked to respond on the challenges experienced when supervising practical work in their classroom, was that:

"…practical work can be a bit frustrating…in that some of the anxiety is experienced, especially when you know you can try and perform a certain experiment, but you just don't know how to set up and do it due to lack of knowledge and…" (FGAP1).

Teachers feel anxious for a variety of causes, including concern over not getting the desired results from their practical work. They fear that they won't be able to adequately describe how to test a hypothesis or how to analyse and interpret data using graphs and calculations. Limited time to complete the practical work is another issue. In addition, prior experiences in their own physical science classes as learners, the influence of their old teachers, and perhaps remembering that practical work was hardly ever done at their schools could all contribute to practical work anxiety (Mizzi, 2013).

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Another perception the researcher picked up from teachers' perceptions based on the challenges experienced in doing practical work, was a negative attitude towards practical work and lack of confidence which results in poor performance in practical work. Many teachers tend to avoid practical work and focus more on the theoretical part. This is evidenced by learners' good performance on theory control tests and examinations on physical sciences but poor performance on practical work.

Teachers also admitted to 'lack of preparation' as one of the challenging factors. One participant during the interview said:

"I think what contributes to poor performance in practical work is lack of effective teaching in practical work. Teachers must be prepared to go to classes well prepared and also teachers must try as much as they can to involve learners in the activities…" (FGBP7).

The vast majority of those who participated in the interviews agreed that in order to teach practical work effectively, a teacher must be well-prepared, which includes performing practical work independently before showing it to or doing it with learners.

This supports Botha's (2010) contention that schools are successful if teachers engage learners effectively in the classroom. According to another teacher, "*Effective teaching is constituted by ensuring that all learners become part of your learning entity (allow them to be hands-on by touching and feeling), you must not exclude learners, you must always ensure that they are creative, they demonstrate their critical thinking by participating in the lesson, for example, if you just teach without and not ask them questions, they get bored and show no interest and as a result, the teach becomes ineffective*." (FGAP2).

This supports Doolittle's (2014) theory that learners actively participate in the learning process and eventually manage their own learning, which will improve their critical thinking skills and make them more dynamic in the creation of information. Another teacher, who also serves as the departmental head at his school, believed that since there is little time available for practical work during school hours, teachers must be willing to go above and beyond when it comes to teaching it. In his opinion, teachers must defend the future of the learners through excellent teaching that improves learner performance in physical sciences practical work.

4.4.4 THEME 2: The motivation for using Professional Learning Community (PLC) to improve learners' performance.

Two interview questions that probed teachers' perceptions of and knowledge of the professional learning community—specifically, whether it has any effect on their classrooms—led to the development of this theme. The further education and training (FET) band in

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secondary schools asked teachers to describe how they understood the professional learning community and how it was effectively applied to teaching practical work.

The degree to which teachers participate in professional dialogue about particular educational problems is referred to as PLC, and it includes collaboration, shared practices, and reflective dialogues among other things (Amerian & Mehri, 2018). Regarding the derivatization of practice or feedback on teaching, which entails teachers observing one another's classes to provide and receive feedback (Opfer, Pedder, & Lavicza, 2011).

According to Li (2016), implementing PLC to improve learner performance can also promote deeper learning and has a positive impact on creating a learner-centered learning atmosphere. Kukulska-Hulme and Viberg established five PLC implementation educational goals to promote collaborative learning and prepare learners for the knowledge society (2018). (Knowledge creation abilities and cooperation skills). The following problem was raised by one of the participants at the FGI:

"Teachers lack the knowledge of practical work."

"Workload is too heavy"

"Most of the learners see physical sciences as a complicated subject"

"Another thing we are experiencing is lack of knowledge of some aspects related to CAPS"

"Lack of interest by some teachers" (FGAP3)

The results of the FGI revealed that participants firmly support the idea of a professional learning community as a method for improving learner perfomance in practical work in the physical sciences. The consensus among the participants was that since these plans can be completed collectively, PLC relieves teachers of the need to make individual preparations. People shared how sharing best practices among themselves helps them become better teachers.

The following factors motivated participants' various perspectives on how to comprehend PLC during the FGI:

"Learn new techniques" (FGAP2)

"Improve your confidence in presenting your lessons" (FGBP5)

"Determine what to improve and how to" (FGBP6)

"Realise your shortcomings and revisit other members' way of approaching practical work" (FGAP1)

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"Understand better when you see others presenting/performing practical work lessons" (FGAP3)

"Assess yourself" (FGBP7)

"Realise your weakness and strong points" (FGBP8)

Based on the aforementioned motivation, participants shared their varied perspectives on how PLC can improve learner performance on practical work. The majority of teachers who participated said that when people work together to complete a job, the results are likely to be more favourable (Bjomberg, 2014). When teachers who are teaching the same learning area work together, the results should be better (McEwan, Ruissen, Eys, Zumbo & Beauchamp, 2017). Some participants expressed the opinion that the following sub-themes best explained how PLC improved learners' performance on practical work:

4.4.4.1 Subtheme 2.1: The use of applications (APPs) or programs to improve learner performance.

The FGI determined that secondary schools have the most educational program resources available. Evidence suggests that schools employ YouTube (a free video-sharing website), Edukits (a hands-on scientific application), and PhET (an interactive simulation for science and mathematics) to let learners see real-world science projects. As Traxler (2010) suggested, a variety of websites and programs are used in schools, particularly connected devices that let learners access and view various knowledge banks from wherever they are. Since most learners have access to mobile devices, these apps are simple to use and have a significant impact on education. They are appropriate for anytime, anywhere learning, in-class presentations, and small-group instruction (Calabrich, 2016).

According to Oncu and Cakir (2011), incorporating science programs into the classroom can also help to foster deeper learning and has a positive impact on creating a learner-cantered teaching atmosphere. Programs must be used in the classroom to improve learner performance. According to Tedla (2012), programs are effective tools that help learners improve their knowledge and skills for collaboration, communication, and problem-solving. They also support cutting-edge teaching and learning strategies. Throughout lessons, digital programs assist learners in developing new abilities and their understanding of technology. It was discovered during the FGI that learners did well when given help from digital programs.

Additionally, it was discovered during the FGI that APPs can be conceptualized as learning tools (Polly et al., 2018). By providing them with helpful programs or APPs in an online environment or being explicit about technology use in a physical classroom, learners may be better able to focus on the actual problem-solving activity rather than navigating through a

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number of platforms. When learners engage in digital literacy activities, they view these tools as intriguing and unique, and their thought processes become more creative (Saine, 2012).

The FGI also revealed that APPs and programs enhance learners' ability to collaborate. Today's learners use technology extensively in their daily lives. They look for material on the internet to aid their learning. Through social networking sites and chat programs, they also get to practice different forms of collaboration with their classmates and teachers (Li, 2016). Participants also noted how easy it is for them to collaborate, especially in groups. The goal of learning through teamwork is to unite teachers as they work together in small groups to develop technological solutions for genuine pedagogical problems (Mishra, Koehler & Zhao, 2007).

However, it is also anticipated that teachers will approach technology as a tool for achieving the instructional objective and will work together to solve problems they face in the real world while instructing a particular topic, like this example of physics practical work (Agyei & Voogt, 2011). Participants also mentioned that teamwork is promoted while using application devices for collaboration and that social interaction occurs in the classroom.

4.4.4.2 Subtheme 2.2: Obstruction to the implementation of APPs/programs and their influence on improving learners' performance on practical work.

The use of applications (APPs) for school curricula presents obstacles for schools, as was determined during the FGI. According to the statement;

"Schools are having issues that make it difficult for teachers to use APPs in the classroom" (FGAP3)

According to Tedla (2012), the PLC may encounter two distinct kinds of difficulties when attempting to improve learner achievement in the classroom: The difficulties teachers face first (i.e., lack of confidence, lack of teacher competence, resistance to change and a negative attitude). Obstacles to schooling are a second (i.e., lack of laboratories, lack of time, and lack of effective training). Some of the challenges had been labelled as PLC issues by participants, it was found during the FGI.

There are two kinds of teachers when it comes to using technology, positive and negative teachers, it became clear during the FGI. During the FGI, it was found that some of the individuals had no issues with the technology.

"We feel good about technology" (FGAP4)

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"We are excited about using YouTube videos for learners to watch practical experiments since we don't have a problem in using technology today" (FGBP8)

"it is a learning curve and I rely on the learners if I experience a problem during contact time and using the APPs to enhance learning" (FGAP1)

It was found during the FGI that the majority of the young teacher participants feel appreciated and secure. They are content with the use of technology and have not yet been persuaded to drop out of school.

4.4.5 THEME 3: Professional development strategies necessary for the implementation of PLC and improving learners' performance.

The third theme examined PLC professional development to improve learner success in practical work in the physical sciences. The PLC aims to increase teachers' pedagogical expertise in integrating practical work and their knowledge of learning opportunities (ISPFTED, 2017). When it comes to teachers and those who lead the session, one teacher facilitates in the PLC structure while others strive to deal with their difficulties and a scaffolding process starts. In the framework of a sociocultural approach and in relation to concepts like help, assistance, and direction, Amerian and Mehri (2014) go on to further clarify scaffolding.

A teacher is in charge of facilitating learning and taking part in the social mediation process within the PLC. As a result, they must decide on a cunning strategy to help other participants and provide assistance by providing them with the required tools and equipment to perform practical work. The facilitator provides support by guiding and elaborating when one person completes an experiment or practical work. As a result, the facilitator gives advice to the other participants (Van de Pol et al., 2012).

According to Amerian et al. (2014), the teacher should be knowledgeable about the process even though the presence of a facilitator is not the only element in successful scaffolding. According to Moseley et al. (2009), the teacher needs to have a firm grasp of the operational tools and theoretical underpinnings of how they operate in order to meet specific curricular goals and enhance learner success. When teaching and learning about practical work in the physical sciences, some teachers, according to the FGI, need to improve their practical abilities in order to improve learner performance. When discussing various requirements, some participants brought up the following demands.

"I think one needs a developmental workshop on physical sciences practical work, a session where teachers are doing science practically, perform experiments and do practical demonstrations." FGAP1

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"As a teacher, I need the ability to work collaboratively with other teachers where there is active participation and think critically." FGAP3

"I will be happy if I get practical training on physical sciences practical work, for this will encourage teachers to be more hands-on and creative." FGBP5

The FGI revealed the necessity for teachers to have the authority to help learners comprehend practical skills and how to use equipment and apparatus as learning aids that will support them in doing better. Teachers are therefore inclined to ask questions and are open to investigating how useful tools and resources might aid in their personal development and increase their awareness of the significance of these resources for learners and for learning (DBE, 2012).

It was explored that participants need ongoing practical professional development in physical sciences and they need to continually belong in PLCs for their professional development. Furthermore, some of the participants (FGAP1, FGAP3 and FGBP5) mentioned that they need to be trained for most of the prescribed practical work in the Free State Assessment Guideline (FSAG) until all teachers are on board and can teach and do practical work for learners. During the FGI, it was discovered that teachers in some schools support and empower one another. It was found that there are outstanding teachers with a grasp of practical work, and these teachers help and mentor one another. In light of this, one participant said:

"Practical work teaching is our language, learners visit the laboratory once a week to explore, feel and touch apparatus while performing experiments. No threats for us and we understand the importance of physical sciences practical work" (FGBP5)

According to Jaffer et al. (2007), teachers should employ a teaching strategy that aligns with their personal teaching and learning paradigm. Additionally, the use of science tools and apparatus gives teachers the chance to explore a wide range of options that may be suited for their needs as teachers (Fentie, 2019). As a result, teachers continue to place a high priority on utilizing real-world tools and resources effectively and to their full capacity in order to promote learning and help learners achieve curriculum goals (DBE, 2012). It is considered that practical skills can only enhance learner performance if teachers are skilled in using them (Abbitt, 2011).

The researcher suggested that physical sciences teachers pursue practical work experience as part of their professional development. Teachers must continue to put their entire learning potential and curriculum objectives first, as well as maximizing real-world tools and resources in the right way (Gudmundsdottir & Hatlevik, 2018).

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4.5 DATA FROM SEMI-STRUCTURED INTERVIEWS WITH THE PRINCIPAL PARTICIPANTS

The section that follows provides a presentation of the data that was gathered from the key conversations. This section analyses, interprets, and discusses the facts. The following questions were posed: briefly describe your knowledge of leadership and what it involves in schools; What does ongoing scholastic growth look like in schools? How can school leaders direct the extracurricular events so that learners perform better academically? Which leadership style have you employed in your capacity as the school's principal to change projects there? How does the school's principal, who serves as a representative, ensure that procedures are followed?

These inquiries served as the foundation for organizing and conducting this interview's themes and categories. Italics were used to type the participants' verbatim comments in addition to the participant-assigned codes (principal 1 & principal 2) to conceal their identity. Finally, the conclusions of the investigation were taken to be what could be drawn from the data.

4.5.1 Leading in schools

Following an interview with the principals at their respective institutions, the following details were given. Analysis, interpretations, and discussions were conducted after the presentation of the individual data.

According to participant 1:

"Leading is one of the core duties and responsibilities of the principal which include administration and management. It also means to take people from one point to another through influencing them." (Principal 1)

He continued by saying that organizing, planning, creating plans, and overseeing are all aspects of leadership (cf. 2.10). The participant came to the conclusion that being a leader means setting the example for others to follow and imitate. The principals provided the following responses when asked to briefly describe their understanding of leadership and what it involves in a school setting (Bracken & Associates, 2016):

"Leading involves supervising, controlling, monitoring, influencing and implementing programmes." (Principal 1)

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According to participant 2, management and leadership go hand in hand, and using management tools to inspire and grow others is part of being a leader.

"It is important to know that you cannot separate leadership and management" (Participant 2).

For this specific participant, being a leader entails setting an example, implementing control measures, and utilizing the four management tools, such as supervision and control, to achieve the goals. He continued by saying that being a leader entails establishing an example for others to follow.

"Leading for me is setting the example, showing colleagues how to do things and do them as expected." (Principal 2)

Similarities and differences

Management or management tools were cited as a component of both principals' leadership responsibilities (Iles & Preece, 2006). The two participants were adamant that leadership involves inspiring or influencing others. The differences between their answers included accountability, where principal 1 thought that leading referred to teachers' goals and aspirations, monitoring and supervising, and being a team member (Manaseh, 2016).

4.5.2 Leadership approach

The participants' responses on the leadership style they used to lead change initiatives at their schools are discussed in this section. Moving from point A to point B was made simpler by the first participant's adoption of the consultative approach, which included open communication and employee involvement. However, in the long run, opposition develops to autocracy even when it produces results. By keeping lines of communication open, the first participant encouraged workers to use their creativity. However difficult it may be to assess, participant 1 believed that this strategy was now effective. Although there were few complaints, there was mostly pleasant comments.

"My way of doing things is fully engaging others by communicating inputs from staff and are welcomed so that they can take ownership of ideas which makes the task from moving from one point to another easier" (Principal 1).

He also said that his style varies depending on the situation; he has an open-door policy but takes an autocratic strategy when important decisions need to be made. According to the first participant, the open-door policy was successful because teachers brought ideas to the office. Even in their homes, this strategy is used (Valdez, Broin & Carrol, 2015) .

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"It depends on the environment you find yourself in. At our school, I have an open-door policy with regard to our colleagues and staff." (Principal 1)

The second participant said that their strategy involved organizing, planning, and developing strategies to evaluate teaching and learning. By assigning responsibilities to ensure that teachers advance professionally (Gichohi, 2015), this participant's strategy combined democracy with authoritarianism. The democratic technique was utilized when asking teachers for their ideas, and the autocratic approach was applied when a task needed to be finished by a specific deadline. The second participant believed that this strategy was successful because teachers provided their thoughts, perceptions, and opinions on specific decisions by highlighting the flaws.

"The leadership approach that I'm following is a flexible one; it contains both democracy and autocracy because we need to be critical in some areas." (Principal 2)

Additionally, he noted that he followed a democratic style and kept the instructors updated on all events. This was done in order to evaluate the goals they had established and jointly develop intervention plans. Through regular conversation, this method encourages teachers to take responsibility for what is done and to prevent rebellion. People can better appreciate the importance of making specific decisions with the aid of this strategy.

"I am using the democratic model. I inform teachers of everything that we plan to do." (Principal 2)

Similarities and differences

The fact that both participants said that consultation was a part of their approach explains the parallels in the responses. Both of them hinted that the methods they employ value teachers' input in decision-making. Both participants agreed that including teachers fosters their professional development, increases their openness and sense of responsibility for the duties given to them, and promotes teamwork (Leiva, Montecinos, Ahumada, Campos & Guerra, 2017).

The variations in responses include that adopting an authoritarian paradigm results in resistance while employing a democratic model makes going from one point to another simpler (Principal 1). The responses from Principal 2 range from monitoring, imitating, taking a flexible tack, delegating, and creating goals.

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4.5.3 Improvement and sustainable academic improvement

The discussion that takes place in the section that follows centres on how participants conceptualized improvement, sustained academic improvement, and how they went about achieving sustained academic improvement of learner outcomes at their various schools.

The first participant described sustained academic success as an improvement that doesn't fluctuate too much and is attained through consistency, the formulation of objectives, and the development of teaching and learning-friendly environments. Not a one-off occurrence, but a consistent pattern of achieving positive outcomes.

"Set specific standards, learners are evaluated and improvement in academic achievement should not fluctuate too much." (Principal 1)

He saw sustainable improvement as no quick fix and that would not happen overnight.

"When it comes to sustainable academic improvement, there is no quick fix to it." (Principal 1)

The second participant asserted that every school strives for long-term academic achievement. It can be done by putting strategies into practice, offering remedial teaching, planning afternoon classes, participating in Continuous Professional Development (CPD), peer teaching, and paying careful attention to the teaching and learning process.

"Every school is looking for that, to improve academic performance." (Principal 2)

The second participant said that sustained progress means making improvements to what one already possesses. By altering the intervention tactics, this can be accomplished.

"Sustainable academic improvement entails what you have improved on, and it has to do with performance that is good and not fluctuating." (Principal 2)

4.5.4 How to lead to positively affect academic improvement

This segment discusses the participants' perspectives on how principals might enhance learners' learning outcomes through school leadership. The question posed to the principals in this regard was: How can principals, as leaders, direct the curriculum activities in their schools to favourably affect learners' scholastic growth?

According to participant 1, a leader can affect the academic performance of learners by setting an example, acting honourably, and fostering confidence so that teachers are confident in the leader's commitment to their well-being (Akert & Martin, 2012). The leader must work to create

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an atmosphere that allows both the teaching staff and the learners to reach their maximum potential and thrive (Valdez et al. 2015).. The following language is part of Principal 1's response:

'" As a leader, you must set an example. Exemplary leadership is important." (Principal 1)

The first participant said that being knowledgeable about the subject matter of your profession, prepared for lessons, in charge of, and able to supervise teachers are all critical leadership skills. A leader should engage in both academics and athletics to help the learners develop holistically, he added. One can prevent learners from suffering from disadvantages by taking this action. Also underlined was the necessity of maintaining open lines of communication in order to improve academic success. Principal 1 responded with the following in part:

"In as much as I should set an example, it's important that I must be prepared when I go into a class to teach." (Principal 1)

Principal 2 claims that monitoring teachers' performance and assisting them in overcoming discipline-related challenges will have a positive indirect impact on learners' academic achievement. The necessity of principals serving as leaders to ensure that teachers have the tools they need was also mentioned. According to Principal 2, departmental heads being present in person will also boost learner performance. To be at the vanguard of change, leaders must also be reliable, accountable, and "long life learners." What follows shows how he responded:

"Trust is good, but monitoring is the best. It's important that teachers are monitored although you trust them in order to keep track of their performance." (Principal 2)

Additionally, he asserted that leadership ought to be associated with academic advancement and that the role of the leader is crucial in motivating others through possessing positive traits, developing trusting relationships with teachers, setting an example of behaviour that followers can imitate, being emotionally intelligent, and being a good listener (Shaheen, Perveen & Malikz, 2013)

"Firstly, emotional intelligence is very important because you should know how to work with people." (Principal 2)

4.6 FINDINGS FROM DIRECT OBSERVATIONS

In order to better understand how the professional learning community can help students perform better on actual work in the physical sciences, direct observation was used. Because of this, mediatory learning (Hall, 2007), which can be viewed as a tool used to improve

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learners' performance, is suggested by sociocultural theories (i.e., the part that social interaction plays in psychological development). As a result, the PLC is tasked with making sure that participants interact and work together on practical tasks to exchange best practices and raise learner performance. DBE (2015) asserts that teachers need to have accelerated access to and educational use of practical/experimental tools. Therefore, in this research study, observational data provides a first-hand account of the activity carried out in the natural field setting and allows the researcher to gather contextual factors from the eight participants who were specifically chosen from four different schools in TMED.

Because the teachers were working in their usual setting, which is a crucial aspect of a case study, observations were taken in the classroom (Yin, 2009). Each teacher participant was observed during two lessons that both required, suggested, or both included a practical exercise. Throughout a variety of professional learning community sessions, each teacher was the focus of two observations.

The researcher can be methodical and record the societal context of people's work with the help of a schedule (Yin, 2009). The activity period lasted for about an hour, and the lessons were spread out over two PLC meetings. The researcher participated fully in every lesson he attended, with the exception of a few moments when he sat in the back of the room to take field notes. To record as much information about the session's actual activities as feasible, field notes were created. The semi-structured lesson observations were impacted by a deliberate attempt to explain how teachers use science equipment in their classrooms to support teaching and learning (Suleiman, 2013).

Yang and Heh (2010) claim that the following issues got additional attention:

- Teacher’s knowledge and skills, including methods (i.e. apparatus/equipment are used in class, technology is incorporated into instruction, a variety of instructional strategies are used, and critical thinking skills are encouraged in the PLC).
- Teachers’ effective use of time during demonstrations
- Reliable functionality of the apparatus/practical equipment

The researcher was able to monitor the activities taking place during teaching and learning periods in the classroom using an observation schedule. The researcher's ability to concentrate on the instructors' instructional strategies was made possible by the planned observation. An observation schedule helps the researcher be systematic and record the complete social setting in which people work, as Maxwell (2005) noted.

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Additionally, teacher participants worked together and communicated while utilizing tools or apparatus that the leading teacher may make to improve practical work as a way to take part in knowledge production (Haelermans, 2017). Through interaction and resource management in the PLC collaborative setting, participants were able to develop and share ideas. Participants decided on actual experiments that are described in the CAPS document so that the researcher could watch in a classroom without learners. Participation in a hands-on learning environment was also required (Calvani et al., 2012).

The objective was to record the nature of the practical activity and how it improved learner performance. The researcher watched the participants select their practical lessons for 30 to 45 minutes. Teachers demonstrated using a variety of tools as they observed various practical sessions. The effectiveness of real equipment use and integration in raising learner performance was evaluated by the researcher. Since learners were not present during the data collection, participants ran the observed sessions; however, they reported how the sessions impacted learner performance. All of the practical experiment sessions were recorded on the observation sheet used for this research.

Table 4.8 presents practical experiments and sessions observed and demonstrated by the participants per school and per grade in the Further Education and Training (FET) band in the absence of learners:

Table 4.8: Summary of practical experiments together with sessions observed and demonstrated per participant and grade

Teacher Code	Grade	Practical experiment	Activity
FGAP1	12	Conservation of linear momentum	Prove that momentum is conserved (remains constant) in an isolated system.
FGAP2	10	Heating and cooling curve of water	Show how the temperature changes as a substance is heated or cooled down.
FGAP3	11	Newton's second law of motion	Discover the changes that a force can produce in the motion of a body.

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FGBP8	10	Flame tests of metals	To identify the metal ion in the sample. Variation in the flame colour due to the presence of metal ions.
FGBP7	10	Magnetic field around a bar magnet	Determine that a bar magnet gets stronger as we move towards the poles and gets weaker in the middle of the magnet.
FGBP6	12	Titration	To determine the concentration of sodium hydroxide using a standard solution.
FGBP5	12	Internal resistance of a battery	To find out the internal resistance and EMF of a given power supply.
FGBP4	12	Preparation of esters	To produce different esters by using a range of carboxylic acids and alcohol.

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4.7 PRESENTATION AND INTERPRETATION OF DIRECT OBSERVATIONS

Table 4.9: Practical session performed and demonstrated by the first participant (FGAP1) for the researcher to observe:

Code for the participant	Practical work/experiment selected for demonstration & Grade	Observed practical session	PLC perspective on how the session may Influence learner performance
FGAP1	• **Conservation of linear momentum (Grade 12)**	**Conservation of linear momentum** **1. Teacher's knowledge and skills:** The teacher started by giving an experimental background. He explained that the momentum of an object is determined by two variables, namely mass and velocity. Furthermore, it was explained that linear momentum (i.e. momentum in a straight line) can be defined as the product of mass and velocity. The verification of conservation of linear momentum can be determined experimentally during an explosion and a collision, the teacher explained. This practical work aimed to verify the conservation of linear momentum during a simulated explosion.	It was discovered, according to the teacher participants, that learners will be inspired to carry out this practical exercise and finish it appropriately. Additionally, learners are managing their learning and may improve their practical skills. Olusegun (2015) asserts that learners must take an active role in their learning process. The observation revealed that there are numerous chances for teachers and learners to participate in exciting and innovative learning activities when doing practical work (Albarrak, 2011).

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		2. Teacher's effective use of time during a demonstration The teacher was well prepared, and it is evident that the experiment worked properly to achieve the desired outcomes. The practical session was set up and performed for a minimum period of 20 minutes and it functioned properly without any interruption during the observation. **3. Reliable functionality of the apparatus/practical equipment used:** The teacher placed two trolleys, one of which contained a compressed spring, against each other on a smooth horizontal floor. The teacher seemed to know how to use apparatus (i.e., trolley track, trolleys, meter ruler & wooden plank). The teacher did measurements by placing two sturdy wooden planks on either side of the set-up. Time was set accordingly, then he/she released the spring of one trolley so that the two trolley systems moved apart. Collision against the wooden planks was listened to and it was observed that trolleys hit wooden planks at different times due to their different motion affected by their mass.	

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Table 4.10: Practical session performed and demonstrated by the second participant (FGAP2) for the researcher to observe

Code for the participant	Practical work/ experiment selected for demonstration & Grade	Observed practical session	PLC perspective on how the session may Influence learner performance
FGAP2	**Heating and Cooling curve of water (Grade 10)**	**Heating and Cooling curve of water (Grade 10)** **1. Teacher's knowledge and skills:** The teacher first explained the aim of the experiment, namely, to obtain the heating curve of water. The teacher participant hinted that it is advisable to first test how long it takes to melt the ice and boil the water before deciding on the time interval. Furthermore, he explained that depending on the heat source, intervals for taking temperature may vary from 30 s to 2 minutes.	According to the teacher participants, it was indicated that if or when learners have seen the apparatus it will be easy for them to remember and label them' should they be asked about them in a test. Learners can understand easier when interacting with the apparatus by touching, feeling and using them. If they are hands-on it is easier for them to remember. Through that practical session, the teacher participants indicated that learners can easily perform this practical on their own, following precautionary measures. As learners get used to using this new equipment to communicate their thoughts, Hall (2007) claims that this kind of practical exercise modifies and transforms learners' thought processes. These tools are changing the educational process and how learners learn, and learners find these hands-on lessons to be interesting and distinctive. According to Haury & Rillero (2004), the benefits of the hands-on approach include: learners remember the material better, learners involved in practical work are empowered in their own learning process, and amongst others, it makes teaching fun; "I

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		2. Teacher's effective use of time during a demonstration: The teacher used 30 minutes to complete the practical demonstration and all the objectives were achieved as per the lesson plan. **3. Reliable functionality of the apparatus/practical equipment used:** The teacher participant was able to set up apparatus appropriately to start with the practical demonstration. Apparatus were firstly introduced to other participants (i.e. glass beaker, crushed ice, thermometer and burner). The temperature was measured and recorded accordingly while observing the ice melting to show phase change. As a result, the teacher participant was involved and active in using practical equipment.	hear and I forget, I see and I remember and I do, I understand." Science is a process and if learners are not actively engaged in the process, they are not doing science (Tamir, 2007).

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Table 4.11: Practical session performed and demonstrated by the third participant (FGAP3) for the researcher to observe

Code for the participant	Practical work/experiment selected for demonstration & Grade	Observed practical session	PLC perspective on how the session may Influence learner performance
FGAP3	**Newton's second law of motion**	**Newton's second law of motion** **1. Teacher's knowledge and skills:** The teacher clearly outlined that the experiment aimed to investigate the relationship between the net force and acceleration on a trolley. The experiment was performed based on the commercial kits that were available since not all apparatus were available, and it was carried out well. Forces of different magnitudes were used to accelerate the same trolley, and the acceleration of the trolley was determined by analysing the ticker tape (i.e. one of the apparatus used). Data was fully collected and the graph from obtained results was drawn on the board. The teacher then concluded from the results that acceleration is directly proportional to the net force if the mass is constant. **2. Teacher's effective use of time during a demonstration:** The teacher used time effectively. He assembled all the available apparatus properly and managed to perform and demonstrate the practical work as per the allocated time.	According to the participants, learners learn best from observing and watching how things are done. Watching a practical being performed in their presence will become easier for them to remember and recall the events. Furthermore, the participants alluded that learners learn by participating in interactive social systems in which individuals interact with resources designed by teachers (Salomon & Perkins, 2006). For these reasons participants felt that as teachers, they should encourage each other to do practical work in schools as it is a way that will not only assist learners in their academic

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		3. **Reliable functionality of the apparatus/practical equipment used:** Most of the apparatus used were working very well although there were minor struggles with the ticker timer in the beginning. However, it became easy for the teacher to perform the experiment and show other participants how it can work with some other improvised equipment.	performance but will also increase their teaching effectiveness (Ottenbreit-Leftwich, 2010).

Table 4.12: Practical session performed and demonstrated by the fourth participant (FGAP3) for the researcher to observe

Code for the participant	**Practical work/experiment selected for demonstration & Grade**	**Observed practical session**	**PLC perspective on how the session may Influence learner performance**
FGBP4	**Preparation of esters**	**Preparation of ester** **1. Teacher's knowledge and skills** The teacher explained what the aim of the experiment is, namely, to produce different esters by using a range of carboxylic acids and alcohols. The teacher cautioned you not to put your nose near the chemicals and explained the process of wafting, a technique of using one's hand to draw the air over the opening of a container in the direction of your nose. For the first step of the practical work, the teacher used methanol and methanoic acid then methanol	According to the participants, it was established that performing this particular experiment, especially for the grade 12 learners, was a fun and interactive educational session which will assist learners to understand the esterification reaction (reaction of acids and alcohols) even better than as

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		and propanoic acid. The results were later interpreted, and a pleasant odour was established. **2. Teacher's effective use of time during a demonstration:** The teacher took 30 minutes to complete the practical session and all the objectives were achieved as per desired outcomes. **3. Reliable functionality of the apparatus/equipment used:** Chemicals were handled with care, alcohols and acids were labelled to easily identify them and all the apparatus were clearly explained and what they are used for.	explained in their theoretical textbooks. The practical work itself helps learners to progress at their own pace and on their own level.

Table 4.13: Practical session performed and demonstrated by the fifth participant (FGBP5) for the researcher to observe:

Code for the participant	**Practical work/experiment selected for demonstration & Grade**	**Observed practical session**	**PLC perspective on how the session may Influence learner performance**
FGBP5	**Internal resistance**	**Internal resistance** **1. Teachers' knowledge and skills:** The teacher explained that the experiment aimed to determine the internal resistance of the battery. He further explained that the internal resistance of	According to the participants, practical work can also support learners who are ready to explore topics that might not be explicitly covered in the content. During

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		the battery can be treated just like another resistor in series in the circuit, that the sum of the voltages across the external circuit plus the voltage across the internal resistance is equal to the electromotive force (Emf). The teacher strongly advised other participants to use Phet simulations as they also assist a lot in schools that lack equipment or have no laboratories to do practical work. **2. Teacher's effective use of time during a demonstration:** It took the teacher approximately 20 minutes to do the practical work, address all other participants about the experiment and state the conclusion. **3. Reliable functionality of the apparatus/equipment used:** The teacher had an electric board in position and a laptop for the demonstration of PhET simulations. While connecting the board, he cautioned that the switch shouldn't be kept on for too long since it will heat the battery and cause it to run down. Results were later tabulated, interpreted and fully discussed.	the observation, the other participant mentioned that learners usually search for any topic on physical sciences on their cell phones by connecting to the internet, especially if they are struggling with certain aspects of the topic. McPake and Stephen (2010) are of the view that practical work promotes collaboration, problem-solving, communication, experimentation, and exploration of identities. As a result, Nolan and McBride (2014) posited that without play, education becomes a force of compliance, not intelligence.

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Table 4.14: Practical session performed and demonstrated by the sixth participant (FGBP6) for the researcher to observe:

Code for the participant	Practical work/experiment selected for demonstration & Grade	Observed practical session	PLC perspective on how the session may Influence learner performance
FGBP6	**Titration**	**Titration** **1. Teacher's knowledge and skills:** The teacher explained that the concentration of a basic solution can be determined by titrating it with a volume of a standard acid solution (of known concentration) required to neutralize it. He furthermore explained that the purpose of titration is the detection of the equivalence point, the point at which the indicator changes colour and chemically equivalent amounts of the reactants have been mixed. **2. Teacher's effective use of time during a demonstration:** Although the teacher had equipment to do the practical work, he also recommended YouTube as one of the resources that can be used to expose learners to practical work and gave us both his demonstration and	Participants described an experiment on titration as a chat-based practical session where learners and teachers work as a team, cooperate, and share ideas. As a result, through the professional learning community, teachers also engage in a variety of forms of communication and cooperation with their colleagues (Li, 2016). Using PLC in the classroom can aid in fostering deeper learning and has a beneficial effect on developing a learner-centered teaching environment (Oncu & Cakir , 2011). The use of technological resources for learning, such as Phet simulations, YouTube, and others, promotes learner-centered learning, active, exploratory, and inquiry-based learning, collaborative work between learners and teachers, creativity, analytical skills,

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		YouTube videos. It took the teacher about 40 minutes to complete his practical session. **3. Reliable functionality of the apparatus/equipment used:** The teacher brought along all the necessary apparatus to do the practical work (i.e. burette, conical flask, acid and base solutions, clamp, tile, indicator). The method was correctly followed. The teacher was efficiently organised and ensured that all his apparatus were neat. Apparatus were handled with care and used correctly.	critical thinking, and informed decision-making (GDE, 2004).

Table 4.15: Practical session performed and demonstrated by the seventh participant (FGBP7) for the researcher to observe:

Code for the participant	**Practical work/ experiment selected for demonstration & Grade**	**Observed practical session**	**PLC perspective on how the session may Influence learner performance**
FGBP7	**Magnetic field around a bar magnet.**	**Magnetic field around a bar magnet.** **1. Teacher's knowledge and skills:** The teacher explained that the experiment aims to examine the magnetic field around and associated with a bar magnet and construct the magnetic field lines. **2. Teacher's effective use of time during a demonstration:**	According to the participants, it is this type of practical work that makes it easy for learners and teachers to connect inside and outside of school premises. Learners can create, collaborate and do their own

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		The experiment was completed in time, and efficiently and apparatus were used correctly. **3. Reliable functionality of the apparatus/equipment used:** The teacher used two bar magnets, iron fillings, a sheet of paper and small compasses. He placed a sheet of paper on top of a bar magnet, sprinkled iron filings evenly over a sheet of paper then taped the paper lightly with a finger until a clear pattern was observed. Outlines of the bar magnet were drawn and the pattern of the iron filings in the form of curved lines was observed in the space provided.	explorations based on the information they have gathered in the classroom/laboratory. Harden-Thew (2012) posits that learners who have observed and taken part during the demonstration of a practical activity engage in the classroom activities at a faster pace. Practical work is, amongst others, used to differentiate learning materials among learners, communicate more directly with learners, and provide influence on learner performance.

Table 4.16: Practical session performed and demonstrated by the eighth participant (FGBP8) for the researcher to observe:

Code for the participant	**Practical work/experiment selected for demonstration & Grade**	**Observed practical session**	**PLC perspective on how the session may Influence learner performance**
FGBP8	**Flame tests**	**Flame tests** **1. Teacher's knowledge and skills:** The teacher explained that this is an "old and tested experiment" but when dealing with colour and chemistry it would be difficult to leave it out. He furthermore explained that it is possible to create a variety of coloured flames by burning	According to Rabah (2015), applications (APPs), including educational technology, allow teachers to connect with the local classroom. This practical session

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		a small quantity of different metal salts in a fire; this is the basis of fireworks. He encouraged Phet simulations for demonstration. **2. Teacher's effective use of time during a demonstration:** The teacher could not finish the rest of the demonstration due to a power failure resulting from load shedding. The teacher wanted to show more flaming tests through his laptop which could not operate without electricity. However, his demonstrations showed the method followed, and it was efficient, organised and neat. **3. Reliable functionality of the apparatus/equipment used:** The apparatus (i.e., nichrome wire, wash bottle, Bunsen burner, concentrated hydrochloric acid, metal salts like table salt and calcium chloride) were used correctly and with care. The teacher dipped the clean wire into a small amount of powdered metallic salt in a watch glass. He held the wire in the cooler part of a non-luminous flame, i.e., the bottom of the flame, and the characteristic colour of the flame was observed when the wire was at the edge of the flame. The teacher showed at least one PhET simulation demonstration before the electricity failed him and it became interesting for all the participants to observe.	has helped participants to engage in a learning scenario and produce meaningful learning. According to the participants, it was indicated that learners can use PhET simulations to watch these kinds of experiments. Bizi and Shittu (2014) mentioned the benefit of using APPs in education which can help in the design and development of learning materials.

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4.8 MEASURES TO ENSURE TRUSTWORTHINESS

The researcher took the following measures to ensure the validity of the study:

Amongst other methods, two of the methods the researcher used to collect data to address the study questions were focus group interviews (FGI) and direct observations (DO). In order to verify the accuracy of the coding, the researcher classified and made categories from the text (Maree, 2016). After the FGI, the researcher forwarded the transcripts to the participants for evaluation and revision. The researcher returned participants' FGI recordings so they could verify the general conclusions. As a consequence, the researcher verified whether the shared information was interpreted correctly.

In order to ensure the validity of the research findings, the researcher also requested feedback from the participants on whether the research findings and interpretations were in line with what they had tried to say during the FGI. The conclusions were thus confirmed and supported.

4.9 PROPOSED FRAMEWORK FOR THE ROLE OF PLC IN TEACHING PRACTICAL WORK TO IMPROVE LEARNER PERFORMANCE.

The goal of this section was to create a framework for the use of PLC for teacher professional development and to share instructional strategies to improve learner success in practical work in the physical sciences. This section focuses on this framework and offers recommendations for how to put it into practice. The PLC is a tool or method that has demonstrated proficiency and attributes that teachers should value, according to research findings from the literature study (cf.2). PLC participants' teachers concur that PLC is a development technique that results in success, change, and better learner performance. Because of this, PLC ought to direct the development of practical activities, as well as of teaching, learning, and evaluation strategies.

The PLC framework for the teaching of physical sciences practical work seeks to provide guiding principles to ensure that teachers in the community have a common understanding of the group and its implementation. To ensure that teachers achieve their academic and professional goals, the framework explicitly outlines the range of skills and knowledge required. It also discusses the significance of imparting practical knowledge and its effects on enabling learners to succeed in both the scientific discipline and everyday life.

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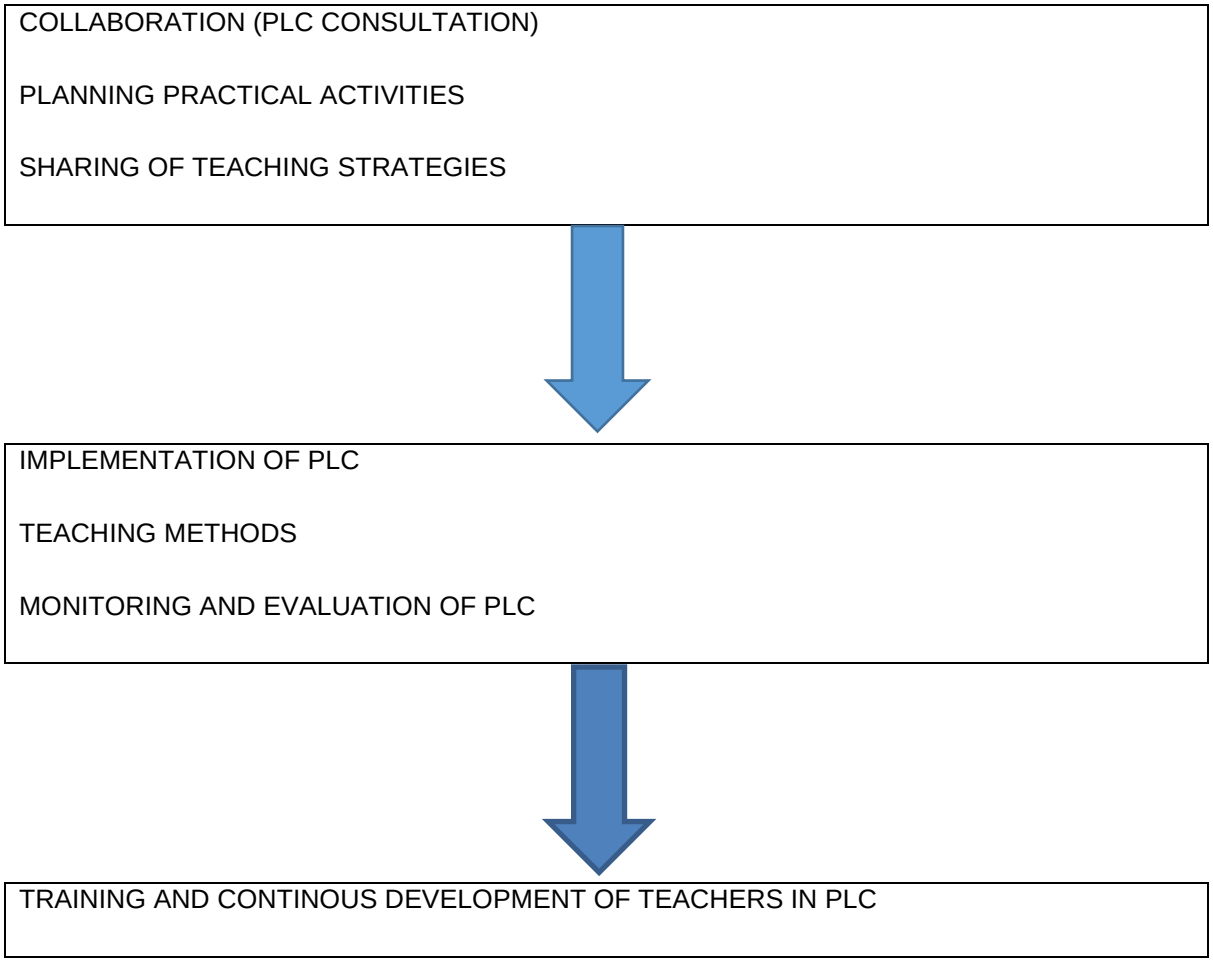


Figure 4.7: Framework for the utilization of plc for the development of teachers to improve learner performance.

4.9.1 Discussion for the framework for the role of PLC in teaching practical work to improve learner performance (Fig. 4.7)

Following is a short discussion of the elements guiding the framework for teaching practical work to improve learner performance.

Clarity regarding the primary objective of the professional learning community and the justifications for coming together are necessary for the collaboration process. Teachers must comprehend the PLC's goals and how the collaborative process can be used to quickly address problems with learners performing poorly on practical work in the physical sciences. Together, they must organize the duties, responsibilities, and time frame for the activities.

To equip teachers with the necessary teaching skills, the PLC should coordinate the instructional approaches and obstacles that stand in the way of learners' success in the actual

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application of the physical sciences. As a result, the teachers were more equipped to contribute to the existing PLC. Teachers were prepared to benefit from the ongoing changes to the CAPS through the development and execution of the PLC. During the PLC, teachers shared and discovered new, successful ways of providing practical work that strongly rely on their own professional development and subject-matter expertise.

To achieve its stated objectives, the PLC must include or recruit members who possess the required skills, knowledge, and expertise. Through the latter process, PLC teachers should be able to experience a peaceful, welcoming learning atmosphere that encourages learners to learn effectively. Since excellent learners result from excellent teaching, this becomes the PLC's top priority.

Lastly, after identifying the knowledge, skills, and abilities they wish to instil in their learners, teachers must consider those challenges when determining specific learning outcomes. The teachers could accomplish this by stating that at the conclusion of a specific PLC session, they should be able to show a specific set of skills.

4.10 CONCLUSION

Before the study of the qualitative and quantitative data and the interpretation of the results in chapter four, participant biographies were given. Data for this research were gathered using eight FGI from a study population group. A thematic qualitative analysis method was then used to address the effect of PLC in improving learner performance in practical work in the physical sciences. The qualitative results were categorized into themes derived from the FGI based on the study's objectives. The emerging topics and categories were presented and interpreted. The qualitative data were arranged in accordance with the topics after the direct observations were presented and explained in table form.

Quantitative information from the questionnaires was presented, analysed, and interpreted in order to better handle the study's objectives and the research questions. The quantitative data was initially presented using charts and figures. Data were presented as numbers and percentages in the second step, using descriptive statistical methods. In the descriptive statistics, the rates and percentages of the responses on the five-point Likert-type scales were displayed. The chapter's end covered measures to guarantee reliability.

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CHAPTER 5

DISCUSSION OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

This chapter discusses the study's conclusions before going on to make recommendations based on them and the extra data discovered during the investigation. The suggestions take into account and acknowledge the themes that emerged from the qualitative and quantitative data. Data from focus group interviews, questionnaires administered to teachers in circuit 6 of TMED, FS and on-site observations of physical science teachers in the PLC are all taken into account in this respect. In semi-structured interviews, two teachers from the four sampled schools are also questioned, and they offer comments and suggestions for other things they would like to see happen in the PLC.

It is crucial to remember that the opinions expressed by participants and the conclusions drawn from this study should not be viewed or interpreted in a manner that excludes consideration of how the professional learning community contributes to learner performance in practical work in the physical sciences. The results of this study suggest that there needs to be a greater understanding of how PLCs might enhance learner performance by fostering the professional growth of teachers. The performance improvement might be reinforced by the teachers' guidance in the PLC, which could focus teachers' attention on elements that they do not usually consider in an attempt to teach practical work. Attention should be paid to the difficulties which teachers encounter when attempting and approaching practical work in physical sciences.

5.2 RESEARCH FINDINGS

Discussions of the study's findings follow the research questions presented in chapter one. The purpose of this research was to assess the role that professional learning communities play in the practical work teaching of physical sciences in order to improve learner performance. As a consequence, the discussion and presentation of the results use both the primary and secondary research questions listed below.

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Main research question:

- How can PLCs be used to improve the learners' performance in the practical work of physical science?

Sub-questions:

- What notions do FET physical sciences teachers attach to PLCs, specifically in the South African context?
- What are the issues and challenges faced by physical sciences teachers when attempting practical work in FET science?
- Which strategies for processing may be used to implement PLCs for practical work in FET science?

5.3 RESEARCH QUESTIONS' FINDINGS

5.3.1 MAIN RESEARCH QUESTION FINDINGS: How can PLCs be used to improve the learners' performance in practical work of physical sciences?

The suggested method for enhancing learner performance in physical science practical work involves creating a professional learning community where teachers may collaborate and share ideas as they are in charge of teaching practical work. It is better to establish teacher cooperation through a planned procedure for exchanging perspectives and content, to the point where even teacher-to-teacher collaboration can benefit learners. The proposed tool can achieve its goals if teachers agree that all learners can learn by being hands-on, which will help them come up with ways to make physical sciences engaging, and if they also acknowledge that they need professional development to be effective leaders.

Teachers should see themselves as lifelong learners who collaborate with colleagues to develop lessons and share teaching strategies. Being a member of a professional learning community is necessary because teachers should support one another and allow for the assistance of other teachers while transferring knowledge to learners. Additionally, a teacher should promote teamwork among learners. Team teaching and result analysis are crucial since integrating learner achievement will benefit not just the teacher but the entire school (Wagner, 2002).

Using various forms of technology to encourage teachers' progress is a part of professional development for teachers in this technological age. The learning environment should be made more vibrant and active by including a collaborative, communal approach (Johnson, 2012).

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5.3.2 What notions do FET teachers attach to PLCs, specifically in the South African context?

To avoid teachers wondering why a PLC must be used to solve the high failure rate in physics practical work, the use of a PLC to reduce the difficulties teachers confront in practical work should be clear and understandable. Holding only one or two points of view is insufficient to persuade teachers of the importance of the vision; instead, it should be a constant topic of conversation. It is important to take precautions to ensure that PLCs are highly qualified to lead the transition because a lack of support from other stakeholders and inadequate communication channels could lead teachers to return to their old ways of doing things.

The first sub-question examined the participants' motivation for comprehending how PLCs can enhance student success in practical work in the physical sciences. This research acknowledges the effectiveness of PLC in raising student performance. The research underlined the importance of collaborating when teaching students how to do practical work so that they can experience science first-hand. This can help students comprehend science better, make learning faster, and explore practical tools and apparatus to enhance learning performance.

The benefit of working as a team over doing things alone should also be mentioned. To overcome the difficulties, they are encountering in their practical work, physical sciences teachers should cooperate and work as a team (c.f. 3.4.8). Teachers must be aware of the objectives for PLC sessions because they should be guided, persuaded, and prepared for the desired outcome by a clear vision's underlying principles. In order to encourage leadership from all teachers in the PLC, the vision needs to be simple to use and simple to discuss.

Findings also emphasized that teachers in PLC can work remotely, and they do not have to be frustrated when having to administer practical work in their classrooms/laboratories to improve performance. Teachers can start in group meetings to plan together to create a platform for interaction to take place for good practices and strategies to be shared. Therefore, teachers may engage in an exchange of ideas including their methods of teaching, however, the commitment, involvement and regular communication amongst the PLC members are vital to stimulate, uphold and sustain the envisaged goal which is to improve learner performance. It was established during the focus group interviews that teachers performed well when supported by their peers during PLC discussions (cf. 4.4.5). It was also discovered that schools equipped with laboratories, sufficient practical equipment, and access to technological resources have a better chance of learner results improvement (cf. 2.5).

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The focus group discussions made it obvious that the physical sciences PLC's secondary goal is to promote long-term academic progress in real-world application (cf. 2.8). Sustained academic development aims to continuously maintain high academic performance because test results for learners shouldn't drop or change. In order for success to take hold and be sustained, PLC should be used as a measurement tool where commitment to continuous development, shared vision, and collective learning are prioritized.

Concerning the research question (how can PLCs be used to improve learner performance in the physical sciences practical work?) through which the above research question emanates, the following findings were discovered:

- The majority of the teacher participants mentioned the fact that there are other existing PLCs in which they partake and they assist a lot in terms of doing lesson preparations together, setting question papers, and giving learners quality daily activities.
- Concerning physical sciences practical work, 75% of respondent teachers pointed out that they perform practical work but at a limited rate, also 25% of the teacher participants indicated that they were unable to, totally, due to the absence of science laboratories, chemicals and science apparatus/equipment. As a result, learners are forever referred to ePhET simulations and YouTube for practical demonstrations. However, teachers showed great concern that learners are not exposed to the practical part of physical sciences which forms an integral part of learner continuous assessment in that learners miss the opportunity to be hands-on in proving theories addressed in the classroom set-up.
- Practical work is necessary for learners' scientific development, stimulates learners' interest and motivates them to realise that science is enjoyable; teacher participants have therefore indicated that practical work should at least have space in the school's day-to-day timetable, preferably once a week for about an hour (cf. 2.4.2). Furthermore, teacher participants have alluded that PLC encourages co-operative learning and develops communication skills like following instructions since it is important for learners to follow a certain method when doing practical work (cf. 4.4.5).
- When learners are doing practical work to clarify certain concepts, it was directly observed and highlighted that it is important for the teacher to first demonstrate before allowing the learners to be hands-on (cf. 4.6).
- Most teacher participants mentioned that through direct observations they have realised that PLC allows them an opportunity to directly improve their teaching and learning in terms of the following:

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- ✓ In the PLC one can learn from his/her mistakes and other people's mistakes and correct them
- ✓ One can realise his weakness and strong points
- ✓ One can realise his/her role as an educator
- ✓ You can learn from other teacher's presentations
- ✓ You can understand better when you see others demonstrate and perform practical work lessons
- ✓ PLC allows one to assess yourself
- ✓ Shortcomings can be revisited by watching other people's presentations
- ✓ You can learn new techniques
- ✓ Through PLC one's confidence can be easily improved to do practical work
- ✓ One can compare his/her approach to others to improve oneself
- ✓ Through PLC one can correct his/her errors by watching others
- ✓ One can determine what to improve and how
- ✓ You can see different teaching approaches
- ✓ It helps one to shift from an old approach to the new approach
- ✓ Through PLC one's attitude towards practical work is improved
- ✓ The teacher can learn how to use different strategies and improvise in cases where there is a shortage of apparatus.

- Through semi-structured interviews with the principals concerning their support towards improving learner performance and understanding of professional learning communities, the following was revealed by principal participants:

  - ✓ Setting an example by school leaders is crucial if you want to encourage academic progress.
  - ✓ Leaders should practice ethical leadership if they want to see results increase.
  - ✓ It is the duty of the principal to be at the forefront of change by setting the direction and fostering staff development.
  - ✓ The Professional Learning Community (PLC) is a tool that promotes proper planning, strategies for improvement, and standards-setting to improve teaching and learning.
  - ✓ To support efficient teaching and learning, principals should form partnerships with the professional learning groups.
  - ✓ The principal must exhibit personality traits that demonstrate support for the PLC, including being a good listener, having effective communication skills, being transparent, being compassionate, and being a team player.

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5.3.3 Findings regarding research question 2: What are the issues and challenges faced by teachers when attempting practical work in FET science? (cf. 2.5, 2.8, 4.3.1 and 4.3.5)

In order to better understand the difficulties physical sciences teachers face when dealing with practical work in FET, this study question explored those difficulties. In this research, the literature was reviewed to examine various types of obstacles that affect PLC's ability to improve learner performance in physical sciences practical work (cf. 2.7) and the South African notions associated with PLC. The focus group interviews revealed that while grades 10 and 11 received nothing, teachers of physical sciences in grades 12 were given some equipment for the practical work that is required in the CAPS document for formal assessment. However, the equipment was only sufficient to demonstrate two experiments out of four.

One teacher participant (FGAP1) mentioned that he was part of the workshop and had hoped for a session specifically on practical work as it was his weakness (cf. 4.4.5). Findings revealed that some teachers experienced an attitude obstacle; a fear of things going wrong when doing practical work and the anxiety of shame in front of the learners. Teachers admitted that they experience difficulties in some practical work, setting up equipment correctly, operating them and calibrating them if necessary (cf. 4.4.3).

This poses a great challenge because if apparatus are available at school but the teacher cannot perform practical work due to lack of practical skills then no practical work will be done at school. It emerged from the FGI that not all schools have laboratories/practical work equipment, it was found that some schools were using only basic practical equipment, such as a few chemicals, one test tube, and one glass beaker, among other things. (cf. 4.3.8).

The lack of workshops organized by the department of basic education to support teachers of physical sciences, especially in practical work, was another issue that was discovered. During FGI a need for organised workshops was highlighted since they empower teachers in terms of skills and learners can benefit from teachers during the process of teaching and learning (cf. 4.4.5). Teachers will be able to transform an experiment into a practical inquiry, project, or even just a simple demonstration if skills, strategies, or approaches are effectively taught in practical work workshops.

As a result, this makes it possible for teachers to employ the proper strategies when necessary. Another challenge is overcrowding found in the classrooms (cf. 4.3.8). Due to a shortage of equipment, teachers are unable to organise learners into meaningful small groups as an alternative to execute the practical work intended for the day. The other interesting finding as a challenging factor is time (cf. 4.3.8). Teachers were going beyond school hours to

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catch up with learners during afternoon classes where the teacher made an effort to do demonstrations to assist learners to conceptualise the scientific concepts more effectively and where learners are challenged to connect theories to actual practice.

The lack of assistance for teachers, which is something that most teachers have mentioned, is the first factor that principals or the SMT should take into account when looking at poor performance. It should be mentioned that teamwork is preferable to working independently. In order to solve the issue of subpar performance, managers at schools should give the teachers enough assistance.

5.3.4 Findings concerning research question three: Which strategies for processing may be used to implement PLCs for practical work in FET science?

The PLC was examined in research question three as a means of enhancing teachers' professional growth. The focus of this research's primary objective was to find potential professional development approaches that teachers might use to implement the PLC and improve learner performance. Collaboration is beneficial, according to the historical overview of PLC. An examination of the past demonstrates how the PLC fosters cogent, responsive practice change and creates a collective accountability for student learning.

The FGI revealed that teachers need to be prepared so they can support learners through developmental workshops. It was discovered that some teachers needed more insight into practical work in addition to professional development in practical skills to improve learner performance during teaching and learning (cf. 4.4.4). The existence of Subject Education Specialists (SES), who provide assistance to other teachers within their educational institutions, was discovered. Furthermore, it was determined that when requested for assistance in the PLC, subject experts also offer practical skills support.

It appears that 87.5% of teacher participants think that the PLC cultivates an atmosphere of learning, which in turn prepares learners for lifelong success. A fair number of teacher participants (50%) seemed to be convinced that participation in the PLC helped them in interacting and building sound social relationships with each other. Teacher participants in most schools have started using YouTube videos and PhET simulations for practical work demonstrations due to the lack of equipment at schools, however, some of the teachers were reluctant about the idea stating factors like data shortage and Wi-Fi not being available in their schools.

Some teachers showed a negative attitude towards the use of technology for professional development. It was established during the FGI that there is a growing need for teacher

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training institutions to improve the training of prospective teachers in practical work, both hands-on skills and the use of digital platforms (cf. 4.4.4.1). On the other hand, the PLC, according to teacher participants (75%), develops teachers in their professional learning space (Hord, 2012) since teachers need to be in an environment that is appropriate for support. In such spaces, teachers discuss the situations and specific challenges they face daily in their academic activities where a set of shared norms, beliefs and values are developed (Kruise, 2014).

5.4 RECOMMENDATIONS FOR THE STUDY

The researcher summarizes and offers suggestions for further reading in this part after reviewing the chapter's critical discussions. The study's main argument is restated in this section, along with some critical recommendations about PLC's suitability as the best course of action for improving learner performance in physical sciences practical work. In addition to describing the study's limitations and contributions, the researcher clarifies the section's purpose, goals, and findings.

The basic unit of investigation was successfully addressed by the study's findings within its conceptual framework. PLC should give teachers clear signals about the quality of their teaching and the direction for progress in order to effect change in the teaching of practical work. PLCs help teachers improve their effectiveness by retraining them in new teaching techniques that will better engage learners. To improve practical work teaching and produce high-calibre learner outcomes in practical work, teachers must engage in critical self-evaluation that identifies best methods, places for development, and other necessary interventions.

5.4.1 Recommendations for the Free State Department of Basic Education (FSDoBE) (cf. 2.10 and 4.3.3).

- It is advised that the Free State Department of Basic Education (FSDoBE) offer teachers professional development workshops with a particular emphasis on hands-on work. Departmental Heads (DHs) must also see to it that practical work is done in classrooms to encourage deeper learning and a positive effect on developing a learner-centred teaching environment where learners are engaged in hands-on learning. Encouragement of practical work is necessary to guarantee that learners acquire the necessary scientific practical skills for their future job.

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- It is advised that the FSDoBE make an effort to develop and enhance the proper use of PLC for the teaching of practical work, which will lead to a more significant improvement in learner performance.
- Teachers teaching the same subject in the school should come together, plan, and assist each other on how to tackle different topics according to their strengths.
- It is advised that the FSDoBE should ensure that all schools have the necessary basic practical equipment prescribed for formal assessment even if they cannot afford to provide for all of the practical experiments.
- The FSDoBE should attempt to implement an ongoing PLC professional inquiry-based strategy and assist SMTs and teachers in enhancing and developing their professional development.
- It has been observed that the physical sciences Annual Teaching Plan's (ATP) design has a negative impact on learner success in practical work settings. Teachers emphasized that the DBE's expectations are unreal and that their responsibilities are heavy due to the overloaded ATP. It is advised that the ATP be created in a manner that allows for and supports the teaching and learning of practical work, with enough time set aside for it.

5.4.2 Recommendations for the Principals and SMT (cf. 2.10).

- In order to foster collaboration and enhance school and learner performance, the principals should also create professional learning communities within their educational settings.
- The department heads of the science department should create policies that are effective in monitoring and tracking the academic action plans, and the principals should make sure that the reporting formats reflect performance in practical work in the physical sciences.
- In order to boost learner achievement, it is also advised that school principals make sure PLCs are utilized well and supported by targeted interventions. In order to improve learner performance, teachers' motivation will increase as well as their understanding of the necessity of embracing the PLC. Teachers will receive support from school principals once they have acquired a useful talent, which will motivate them to boost learner performance.
- Lastly, the SMT may provide teachers with training in inquiry-based and problem-solving activities that will help learners develop the skills required for practical work in

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the physical sciences. These research abilities also involve manipulating objects, drawing conclusions, and analysing data.

5.4.3 Recommendations for physical sciences teachers (cf. 2.9).

- Capacitation in ICTs towards the development of fourth industrial revolution (4IR) skills and modalities such as robotics
- Since the theft of school resources has reached a crisis level, it is advised that teachers and community members hold meetings to discuss the significance of school safety policies inclusive of laboratory safety and regulations, where all stakeholders including parents are involved in playing a role in defending school premises like laboratories.
- The PLC should be used in practical work as a teaching strategy for problem-solving. The latter incorporates the various of the teaching strategies and abilities and metacognitive skills that teachers of physical sciences who employ constructive active and learner-centred methodologies should be aware of.
- It is advised that through the planning and implementation of practical work, teachers in the PLC prioritize and maintain the scientific methos and developmental skills like observational skills, recording skills, deduction skills, synthesis skills, generalization skills, and communicating results.
- By entering learners in science-related project contests like science expos and quizzes where models are constructed and practical work is actively encouraged, teachers can therefore motivate their learners to learn through hands-on activities which can support self-efficacy and self-directed learning. This might help to fix the issues with learners performing poorly on practical tasks in the physical sciences.

5.5 LIMITATIONS OF THE STUDY

The Thabo Mofutsanyana Education district, which only included four secondary schools in circuit 6 served as the study's location. Furthermore, the researcher discovered some restrictions and flaws while performing this study. The following deficiencies were observed and felt throughout this study:

- Due to the corona virus outbreak, the researcher was forced to conduct focus group interviews over conference calls. Some teacher participants would raise the issue of a lack of data, as a result of which they would leave the room before the discussion was finished.

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- Participants in one of the focus groups were too eager to respond to the questions, limiting the responses from other teacher participants, leading to loss of interest.

5.6 RECOMMENDATIONS FOR FURTHER RESEARCH

Physical sciences practical work teaching focuses primarily on the opinions and difficulties that teachers face at work. The study could be repeated, and the findings could be the same or different depending on how it is done. Therefore, more in-depth research is necessary to fully comprehend PLC's efficacy in the teaching of practical work for the development of teachers and better learner performance in practical work in a larger area, such as a region or province.

5.7 CONCLUSION

The objective of this reflective study was to examine how professional learning communities (PLCs) can improve teachers' confidence and effectiveness in practical work by increasing their participation in PLCs with the goal of improving learner performance on practical work. PLCs are designed to help teachers improve their practical work practices and knowledge base.

Teachers' professional development, acquisition of new research and technological tools, teaching skills, and ability to reflect on ideas are improved as a result, and students' academic success and motivation in physical sciences may also be enhanced. Therefore, the researcher claims that PLCs can be used as an efficient teaching and learning method, particularly in rural South African schools that are located in disadvantaged environments.

The study's conclusions effectively addressed the main goals of the inquiry within its bounds. For the purpose of effectively using them in the teaching of physical sciences practical work, the professional learning community should have as its goal to provide teachers with clear indicators of the quality of their teaching and the direction for advancement. These findings confirm the widespread scientific view that practical work teaching is the key factor affecting learner academic development (Smith & Goodwin, 2014). This result is consistent with earlier study by Spaull (2013), who suggested that the calibre of teachers has a significant impact on learners' lives.

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ANNEXURE A

A letter to the Principal asking permission to conduct research

818 Petsana

Reitz

9810

The Principal

Kgotso-Uxolo S.S.

P.O. BOX 670

Reitz

9810

Re: Permission to conduct research

I am a student at the Central University of Technology, Free State, registered for a Master's degree and wish to conduct research at your school. The topic of my study is:

The role of Professional Learning Communities (PLCs) in the teaching of Physical Sciences practical work in the diverse high school settings of the Free State province.

The participants of this research are learners and educators in your school. The research will be conducted according to all stipulated ethics of research and the School Management Team of the school will be informed continuously about the developments of the research.

Yours sincerely and respectfully

X

S.M Ndesi (Researcher)

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ANNEXURE B

INVITATION LETTER TO ALL PARTICIPANTS

Re: Invitation letter to participate in an academic study.

Date: August 2020

Title of the study: The role of Professional Learning Communities (PLCs) in the teaching of Physical Sciences practical work in diverse high school settings of the Free State province.

Dear educator

My name is Mpho Ndesi (student no: 208014578). I am a part-time postgraduate student at the Central University of Technology, Free State, in the Faculty of Humanities. I am currently registered as an M. Ed student at the Bloemfontein campus. My research focus is on **the role of Professional Learning Communities (PLCs) in the teaching of physical sciences practical work in the diverse high school settings of the Free State province,** a topic on the FET practical work. The attached questionnaire will enable me to gather your valuable input on the research topic.

Authorisation for this research is approved by the Faculty Research and Innovation Committee (FRIC) at CUT, FS and will be conducted according to the ethical guidelines and principles of Ethics in Education Research. Your school is selected to participate in this survey. I therefore kindly request your assistance in completing this questionnaire. The completion of the questionnaire will take you approximately 45 minutes.

Please note that your participation is entirely voluntary and you may withdraw from participating any time. If you withdraw, this will not affect you negatively in any way whatsoever.

Kind regards

X _____

S.M. Ndesi (Researcher)

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ANNEXURE C

INFORMED CONSENT LETTER TO THE TEACHERS IN THABO MOFUTSANYANA DISTRICT

TITLE OF THE RESEARCH STUDY: THE ROLE OF PROFESSIONAL LEARNING COMMUNITIES (PLCs) IN THE TEACHING OF PHYSICAL SCIENCES PRACTICAL WORK IN DIVERSE HIGH SCHOOL SETTINGS OF THE FREE STATE PROVINCE

Project Supervisor: Dr. M.A. Lekhu

Master Student: Mr. S.M. Ndesi.

Request for participating in this research.

I am currently registered as an M. Ed student at the Central University of Technology, Free State at the Bloemfontein campus. My research focuses on the role of professional learning communities in the teaching of physical sciences practical work in the diverse high school settings of the Free State province, a topic on the FET practical work.

The attached questionnaire will enable me to gather your valuable input on the research topic. Authorisation for this research is approved by the Faculty Research and Innovation Committee (FRIC) in CUT, FS Bloemfontein campus and will be conducted according to the ethical guidelines and principles of Ethics in Education Research. Your school is selected to participate in this survey. I therefore kindly request your assistance in completing this questionnaire. The completion of the questionnaire will take you approximately 45 minutes.

Your participation is entirely voluntary and you can withdraw to participate anytime. If you withdraw, this will not affect you negatively in any way whatsoever.

Principles, Processes, Structures and other ethical guidelines applicable to this study:

1. **What is this study all about?**

This study considers learners' poor performance (that is, from grades 10-12) in practical work and this raises a big concern, hence the study. Professional Learning Communities as envisaged in the Integrated Strategic Planning Framework for Teacher Education and Development (ISPFTED) can assist new teachers to learn from experienced teachers on how to deal with specific learner difficulties. At the same time, experienced educators can benefit from these interactions, as it requires them to make their own thinking clear. The study encourages collective participation in professional activities for professional development and

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strengthens the progress made in teacher development and addresses challenges in improving teacher quality.

2. Aim of the study

To use existing Physical Sciences Professional Learning Communities (PLCs) for educators to share strategies, teaching and learning methods or ideas on how to perform practical work to improve learners' performance in the practical work.

3. Objectives of the study

- ✓ To determine the issues and the challenges faced by FET science teachers when attempting practical work.
- ✓ To explore the effect of PLC on learners' performance in the practical work component of science.
- ✓ To develop strategies to be used to implement PLCs for practical work in FET physical sciences in diverse school settings in the Free State.

This study will be conducted in the Thabo Mofutsanyana District. The study explores the role that the professional learning community may fulfil in enhancing or improving learners' performance in practical work, particularly grades 10-12. Eight participants teaching physical sciences will be involved in this study. I, the researcher intend to conduct interviews with the said participants to gather information about practical work and professional learning communities as a way of mitigating challenges faced by educators.

4. Why have you been invited to participate?

You have been invited to take part because you are a teacher responsible for the physical sciences syllabus in your school and that includes practical work as it forms part of the learning area. Your contributions will be beneficial to this study.

5. What will be expected of you?

As a participant in this study, you will be expected to cooperate, within the limits of your discretion, with the requirements of this study. The researcher intends to conduct a focus group interview with you that will dwell on the role of the PLC in teaching practical work and any other related areas that are pertinent to this study. However, at no point in these interviews will the researcher request information that is beyond your scope or expertise.

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6. **Will you gain anything from taking part in the research?**

Not directly, personal benefits will be accrued by you in this study. However, the basic education fraternity and society at large will benefit from this study.

7. **Are there risks involved in your taking part in this study and what will be done to prevent them?**

At this point, it can be stated with considerable confidence that the study does not pose any discernible risks to you.

8. **How will your confidentiality be protected?**

Information gathered from this study will only be used for academic purposes. Your personal contribution will not be divulged or made public. All the participants' contributions will be pooled together to avoid any individual being personally identified with the information he/she provides. Your privacy will be respected ensuring that the information provided will only be used for this study's purpose and access will be limited to the study leaders (supervisors) and the Master's student (researcher). Only the researcher and the supervisors will be able to look at your contribution. Findings will be kept safe by locking hard copies in locked cupboards in the study supervisor's office and electronic data will be password-protected.

9. **What will happen to the findings or samples?**

The findings of the study will only be used for academic purposes. The results will be presented in the form of a Master's degree dissertation. Under no circumstances will the information be used for commercial purposes.

10. **How will you know about the results of this research?**

The results will be made available when the researcher has completed the study. It is envisaged that the study will be completed before 31 January 2021. The researcher pledges to inform the participants about the findings that will be derived from this study by means of a summary and presentation at a start-up workshop meeting.

11. **Is there anything that you need to know or say?**

You can contact the researcher, Mpho Ndesi, on the cell-phone number; 0723347779 if you have any further questions or email me at providencempho@gmail.com or email my supervisor at mlekhu@cut.ac.za.

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12. Declaration by the participant

By signing below, I ……..
agree to take part in the research study titled “the role of professional learning community in the teaching of practical work”.

I declare that:

- I have read this information and/or it was explained to me by a trusted person in a language in which I am fluent and comfortable.
- The research was clearly explained to me.
- I have had a chance to ask questions to both the person getting the consent from me, as well as the researcher and all my questions have been answered.
- I understand that taking part in this study is voluntary and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be treated negatively if I do so.
- I may be asked to leave the study before it has finished if the researcher feels it is in the best interest, or if I do not follow the study plan as agreed to.

Signed at (place)……. on (date)…….20…….

X _____
signature of participant

X _____
signature of witness

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13. Declaration by researcher

I, (name)……. declare that:

- I explained the information in this document to ……
- I did not use the interpreter.
- I encouraged him/her to ask questions and took adequate time to answer them or I was available should he/she want to ask any further questions.
- I am satisfied that he/she adequately understands all aspects of the research, as described above.
- I am satisfied that he/she had time to discuss it with others if he/she wished to do so.

Signed at (Place)……...on (date)……20…….

X _____

Ndesi S.M (Researcher)

X _____

signature of witness

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ANNEXURE D

STRUCTURED QUESTIONNAIRE COVER PAGE

Instructions to respondents:

- This questionnaire is supposed to be completed by all selected participants.
- Please complete all questions as honestly as possible.
- The questionnaire comprises two sections.

Your identity and that of your school will be kept anonymous, as you do not have to indicate them on this form. Feel free to ask for clarification on any matter about this questionnaire and the study in general.

Thanking you in advance for agreeing to answer this questionnaire.

Researcher: Mr S.M. Ndesi

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ANNEXURE E

Questionnaire (A1)

Complete the questionnaire by placing a cross (X) in the appropriate space for Section A and by giving a written response in the spaces provided in Section B.

Section A: BIOGRAPHICAL DETAILS

1. These questions are about your biographical details. In responding to the questions, please mark the appropriate box (x) and/or fill in the space provided.

1. Gender

Male		Female	

2. Age in years

20-25 yrs.		26-30 yrs.		31-35 yrs.		36-40 yrs.		41-50 yrs.		51-60 yrs.		61+ yrs.	

3. Overall teaching experience in years.

1 yr.		2-5 yrs.		6-10 yrs.		11-15 yrs.		16-20 yrs.		21-30 yrs.		30+ yrs.	

4. Teaching experience as a physical sciences teacher in the FET band in years.

1 yr.		2-5 yrs.		6-10 yrs.		11-15 yrs.		16-20 yrs.		21-30 yrs.		30+ yrs.	

5. Your highest teaching qualification

Diploma		Degree		B.Ed. / Hons. Degree		M. Degree		PhD Degree	

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6. Your highest qualification in Physical Sciences/Physics/Chemistry.

1st yr. tertiary level		2nd yr. tertiary level		Diploma		Diploma + HED (ACE)/ Degree		B.Ed./ Hons Degree		Masters Degree		Doctoral Degree	

7. Your position at your school.

Teacher		Head of Department		Deputy principal		Principal	

8. Location of your school?

Rural		Urban	

9. Is electricity available at your school?

Yes		No	

10. Is running water available at your school?

Yes		No	

11. For which grade(s) do you teach physical sciences this year?

10		11		12	

12. The highest number of physical sciences learners in any of your classes?

10-20		21-30		31-40		41-50		51-60		61-70	

13. Does your school have a science laboratory?

Yes		No	

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14. Do you have any kind of apparatus or equipment to do practical work (experiments) in your school?

Well equipped		Moderately equipped		Only a few		None	

15. How often do you conduct practical work in your classroom?

Never		Rarely		Often		Every-time	

16. Do you conduct the required practical activities as prescribed by CAPS across all the grades?

Yes		No	

17. Which medium of instruction do you use to teach physical sciences at your school?

English		Afrikaans		Alternating between English & Afrikaans		Alternating between English & Sesotho		One of the other official languages	

18. For the majority of the learners you teach, the medium of instruction is their…

Mother tongue		1st Add. Language		2nd Add. Language	

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ANNEXURE F

QUESTIONNAIRE (A2): STRUCTURED QUESTIONNAIRE

2. Please complete the following the questionnaire by ticking in the appropriate block with specific regard to **practical work development session on the basis of improving learner performance on physical science practical work.**

To what extent do you agree with the following statements?

No.	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	The subject advisers (as subject experts) facilitate the process of learning and provide guidance and help where necessary. The subject advisers do only 25% of the work	1	2	3	4	5
2	Sessions with clearly defined outcomes	1	2	3	4	5
3	A session where teachers take responsibility for their own learning and work independently.	1	2	3	4	5
4	A session meant to enable teachers to reach and explore their maximum learning potential.	1	2	3	4	5
5	An activity-based session, doing science practically, discovering about science.	1	2	3	4	5

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6	A session where teachers participate actively and think critically.	1	2	3	4	5
7	A session where teachers are able to demonstrate an understanding of concepts and principles and acquired knowledge in physics.	1	2	3	4	5
8	A session where teachers are expected to investigate, solve problems, do experimental work, class-work, and practical demonstrations.	1	2	3	4	5
9	A session which focuses on the development and use of science process skills in a variety of settings, the development of scientific knowledge and understanding, appreciation of the relationship and responsibilities between science, society and environment.	1	2	3	4	5
10	An investigative session	1	2	3	4	5
11	A session where there is integration of knowledge.	1	2	3	4	5
12	A session that defines essential competencies, attitudes and values which teachers should acquire and develop.	1	2	3	4	5
13	A session that is interactive.	1	2	3	4	5

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14	A session that enables teachers to apply scientific methods, skills and knowledge to problems in innovative ways.	1	2	3	4	5
15	A developmental workshop which consists of phase organisers, programme organisers, specific outcomes, various practical experiments/activities, methods and time frames.	1	2	3	4	5
16	A session based on the philosophy that all teachers can learn.	1	2	3	4	5
17	A session that encompasses both what teachers learn and are able to do at the end of the learning process.	1	2	3	4	5
18	A session that promotes scientific literacy.	1	2	3	4	5
19	A session based on scientific inquiry.	1	2	3	4	5
20	A session that aims to develop teachers' basic skills, focusing and planning, investigation, gathering, manipulating and analysing data, and communicating findings.	1	2	3	4	5
21	A session that prepares teachers for scientific research.	1	2	3	4	5

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22	A session driven by society's needs.	1	2	3	4	5
23	A session that includes all types of teaching methods	1	2	3	4	5
24	A session that describes concretely and in detail teaching, learning and assessment activities that are to be implemented.	1	2	3	4	5
25	A session where outcomes are achieved through practical work and asking questions.	1	2	3	4	5
26	A session that enables teachers to formulate and utilise ideas and knowledge.	1	2	3	4	5
27	A session that takes teachers' differences into account.	1	2	3	4	5
28	A session where teachers learn things practically with the help of the subject advisers.	1	2	3	4	5
29	A session with different assessment methods.	1	2	3	4	5
30	A session that encourages teachers to be more creative.	1	2	3	4	5
31	A session that develops self-confidence because of being able to discover the outcomes of the activity.	1	2	3	4	5

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SECTION B

1. Do you teach practical work in your school? Enumerate the problems that you encounter when teaching physical sciences practical work.

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2. What is your opinion regarding a suggestion of incorporating/using the professional learning community to improve learners' performance on practical work?

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3. In your opinion, what form of support should the Department of Basic Education extend to senior secondary schools to promote the teaching and learning of physical sciences practical work?

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4. From your experience, in your opinion, what advantages if any, are there when teaching physical sciences practical work thoroughly in senior secondary schools?

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5. Share your opinions on how the professional learning community can be implemented in the senior secondary phase to address challenges faced by educators in teaching physical sciences practical work and how, if possible, will it improve learners' performance?

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6. What are the benefits of being a PLC member?

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7. How can PLCs be used to improve learners' performance in physical sciences practical work?

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8. What challenges do you experience when conducting practical activities? Please list them.

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ANNEXURE G

FOCUS GROUP INTERVIEWS: DISCUSSION QUESTIONS

Introductory question

Briefly tell me about yourself as a physical sciences teacher/ principal of the school.

Guiding questions

1. What aspects of practical work were covered during the training? How do they contribute (What value do they add) to your classroom practice?
2. Briefly outline your understanding of the professional learning community.
3. What do you think about the professional learning community in terms of its effective implementation towards practical work at the FET band in high schools?
4. What challenges do you experience when supervising practical activities in your physical science classroom? How can you overcome them?
5. How diverse are learners in your classroom? Describe the level of science practical work of your learners. Do they come from similar backgrounds? Cultural, socio-economic, traditional, religious belief? Are there any barriers to learning? Explain your response.
6. How do you value the professional learning community in terms of learner progress in physical sciences practical work?
7. **Concluding question**

Would you like to add anything to what we have discussed?

Interview questions for the Principal participants:

1. Briefly outline your understanding of leadership and what leading in school entails?
2. What leadership approach have you employed as a principal in order to change initiatives at your school?
3. What does sustainable academic improvement in school entail?
4. How can leaders lead the curriculum activities in their schools to positively affect the academic performance of learners?
5. How do leaders facilitate change towards sustainable academic improvement in schools?

Concluding question

Would you like to add anything to what we have discussed?

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ANNEXURE H

OBSERVATION SHEET AND NOTES

Participant's name:	**(Use participant's code)**
Date:	
Beginning time:	
Ending time:	
Nature of the practical work	

Observation notes
1. Teacher's knowledge and skills in the practical work Observation: Knowledge --- --- --- --- --- --- --- Observation: Skills --- --- --- --- --- --- --- ---

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2. Teacher's effective use of time during a demonstration

Observation:

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3. Reliable functionality of the equipment/apparatus used

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4. General comments

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