

Experiences of female learners in Grade 12 Physical Sciences classes in the selected rural and urban schools of the Capricorn District in Limpopo Province, South Africa: Improving theory and practical offerings

**BY
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DECLARATION

I declare that the study titled *Experiences of female learners in Grade 12 Physical Sciences classes in the selected rural and urban schools of the Capricorn district in Limpopo Province, South Africa: Improving theory and practical offerings* is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

A handwritten signature in black ink, consisting of several stylized, overlapping letters and a long horizontal stroke extending to the right.

19 June 2024

DEDICATION

This work is dedicated to my loving husband, my bubbly son, my sweet daughter, and my very supportive father. You have all kept me going through this research journey.

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Firstly, I would love to thank God and my angels, who saw me through this journey.

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ABSTRACT

The experience of female learners in Physical Sciences classes is a topic that has been neglected by researchers in the past. However, with the advent of feminist movements, the topic has gained momentum. There are numerous factors that affect female learners' experiences in Physical Sciences classrooms. These include teachers, parents, peer involvement, and the availability of resources in schools. This study reports on the experiences of female learners in Grade 12 Physical Sciences classes in rural and urban schools within the Capricorn District of the Limpopo province in South Africa, with an intention to improve theory and practical offerings. To this end, the researcher used the Feminist Science Theory to frame the study. The study was guided by the interpretivist paradigm within qualitative research, which entails the adoption of a phenomenological research design to investigate the experiences of female learners in Physical Science classrooms. A purposive sampling strategy was used to recruit twelve Grade 12 female learners from four schools (three from rural private schools, six from rural public schools, and three from urban public schools) who were enrolled in Physical Sciences in the Capricorn District of the Limpopo Province. Data was collected through open-ended interviews, observations, and document reviews. The main finding of the study is that female learners' experiences in their Physical Sciences classes are largely negative. The causes include a lack of resources, lack of support from parents, teachers and peers, lack of correlation of theory into practice, poor performance, and an unmanageable workload. This study makes the following recommendations: Workshops should be conducted to provide parents with information on how to support their female learners during their grade 12 year. Additionally, the government should provide teachers with resources such as laboratories to aid teaching. The Limpopo Provincial Department of Education should build laboratories for all schools that are currently without laboratories. Female role models should be invited to schools regularly to motivate learners. It is important to note that the negative experiences of female learners, as observed within the Capricorn South District, is not a generalisation, but a notable finding within the selected study population.

KEYWORDS: Female learners, Physical Sciences, experiences, Feminist Science Theory

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CHAPTER ONE: BACKGROUND TO THE STUDY

1.1 BACKGROUND AND MOTIVATION

The female learner has long been excluded from the mastery of Physical Sciences by virtue of being “female” (Newall, Gonsalkorale, Walker, Forbes, Highfield, & Sweller, 2018). Governments across the world have attempted to curb this anomaly for decades, but their interventions have not yielded sustainable solutions (Burnette, Hoyt, Russell, Lawson, Dweck, & Finkel, 2020), leading to male learners continuing to receive advantages that their female counterparts are deprived of (Lee, Shin & Bong, 2020). Gender stereotypes regarding female learners’ affinity for science-related subjects are perpetuated by teachers and parents simultaneously (Ullah, Ullah & Allender, 2020). Additionally, the sciences are dominated by men in the workforce and are therefore seen as unsuitable prospective career options for female learners (de las Cuevas, García-Arenas & Rico, 2022).

Issues surrounding science and gender should be tackled with tact and transparency in order to create an environment where disproportionality and other indicators of power and privilege can be addressed at the secondary school level (Abbas & Smith, 2023). While the world is battling with the notion of gender inequality in Science, Technology, Engineering and Mathematics (STEM), scholars including Boulicault, Reiches, Richardson, Bruch, Noll, and Shattuck-Heidorn, (2020) have suggested that the lack of gender parity in STEM may be a result of female learners not having a desire to participate in STEM courses. Which is a direct result of their experiences while learning science in the lower grades at school. It can therefore be said that the factors affecting female learners’ interest in science include their experiences in science classes (Leaper, Farkas, & Brown, 2012). Maltese, Melki, and Wiebke (2014) reiterate that girls’ experiences in science classes directly influence their decision to either pursue science beyond secondary school and ultimately enter the STEM fields or choose a different career path. It is therefore important to understand female learners’ experiences when studying Physical Sciences at school.

Christidou (2011) posited that a comprehensive and integrated investigation of the experiences of female learners in science classrooms is needed. Female learners' voices need to be heard if their experiences are to be understood better (Hazari, Sonnert, Sadler, & Shanahan, 2010). There have been numerous interventions to improve the experiences of female learners studying Physical Sciences. They include affording girls with out-of-school activities (Chambers & Schreiber, 2004), metacognitive self-management programmes (Ayazgök & Yalçin, 2014), creating all-girls study groups as an alternative to mixed-gender study groups (Bennett, Hogarth, Lubben, Campbell, & Robinson, 2010) and using didactic interventions to improve the attitudes of girls (Aguilera & Perales-Palacios, 2020). However, the interventions employed were unable to fully explore the experience of female learners in Physical Sciences in grade 12.

Information about female learners' experiences is crucial, given the existing notion that bad experiences lead to the academic underperformance of female learners in science (Canning, Muenks, Green, & Murphy, 2019). The voices of female learners in Physical Sciences classrooms have not received adequate attention, especially in a patriarchal society like South Africa (Thobejane & Luthada, 2019). The Capricorn district of the Limpopo province is known for the poor performance of female learners in Grade 12 Physical Sciences (National Department of Basic Education, 2021), so a study of this nature addresses Sustainable Development Goal (SDG) number 5, which is the pursuit of equity and equality for women and girls.

1.2 RESEARCH PROBLEM

Existing research on female learners' experiences in Physical Sciences classrooms (Letsoalo, Masha & Maoto, 2019) proves that there are numerous factors affecting their success in the subject. These include socioeconomic factors (Letsoalo, 2017), natural phenomenon (Jochim, Cluver, & Meinck, 2021), the teaching strategies of educators, content knowledge, and motivation (Mji &

Makgato, 2006). Despite these observations, information about the experiences of girls in science classes, as expressed through their own voices, is limited (Etzkowitz, Kemelgor, & Uzzi, 2000). More information is needed if we are to address the problem of poor performance in Grade 12 Physical Sciences, especially by female learners (Letsoalo, Masha, & Maoto, 2019). The researcher in the current study believes that the documentation of female learners' experiences in science classes could help policymakers and teachers to design programmes to support learners, especially in the Limpopo province. The researcher's experience as a female teacher and a former Physical Sciences learner has shaped her research focus, which is the exploration of the experiences of female Physical Sciences learners currently in Grade 12, with the intention to offer theoretical and practical solutions.

1.3 LITERATURE REVIEW

1.3.1 History of women in science

Women are underrepresented in science globally (Clark Blickenstaff, 2005). A "leaky pipeline" is a metaphorical statement referring to the phenomenon of gender parity in secondary schools' science classes not translating to females pursuing science-related undergraduate courses and careers (Almukhambetova, Torrano & Nam, 2021). In secondary schools, both females and males enrol in science subjects. When they reach tertiary institutions, most women change from science to other streams, while those who choose science qualifications opt to change majors (Trusz, 2020). The phenomenon of a "leaky pipeline" has been around for years (Resmini, 2016). It is incorrect to suggest that female learners are not participating in science, but it is important to realise that they do not reach the same heights as men. Blickenstaff (2005) has suggested reasons why women are subjected to a "leaky pipeline":

“Biological differences between men and women, girls’ lack of academic preparation for a science career, girls’ poor attitude toward science and

lack of positive experiences with science in childhood, the absence of female scientists as role models, science curricula are irrelevant to many girls, the pedagogy of science classes favours male students, a 'chilly climate' exists for girls in science classes, cultural pressure on girls to conform to traditional gender roles, and an inherent masculine worldview in scientific epistemology”.

Most of the explanations are observable in a classroom setting, like the 'chilly climate' existing for girls in science class (Hughes, 2014). These phenomena can be explored in pursuit of improving theoretical and practical solutions.

1.3.2 Female learners' experiences of learning Physical Sciences

Shirazi (2017) asserts that female learners have reported a negative experience in science class and that their experience in science has made them conclude that science is difficult (Jones, Howe & Rua, 2000). Since a negative experience in science class is directly proportional to the lack of females in STEM careers (Shirazi, 2017), this may be the logic behind few women entering these fields, and thus, a leaky pipeline. Camilla, Christopher and Rowan (2020) state that in their study, female learners report experiencing gender bias in the classroom. The bias emanates from teachers, parents (Chávez, & Mitchell, 2020) and male classmates, with the latter assuming that females cannot naturally be knowledgeable in science content (Grunspan, Eddy, Brownell, Wiggins, Crowe, & Goodreau, 2016). In Uganda, female learners experience gendered sexual vulnerability in schools (Muhanguzi, 2011), which contributes to poor academic performance. Therefore, the study became crucially important to the researcher to undertake, to try to gain insight into the experiences of female learners in their Physical Sciences class.

1.3.3 Policies on gender and science

There are numerous policies that advance female participation in science, including 1) National Policy Framework for Women's Empowerment and

Gender Equity (NPFWEGE), 2) Convention on Elimination of All Forms of Discrimination Against Women (CEDAW), 3) Southern African Development Community (SADC) Declaration on Gender and Development and 4) Millennium Development Goals (MDG). The NPFWEGE is guided by the human rights vision which incorporates “acceptance of equal and inalienable rights of all women and men” (Kornegay, 2000). It requires action to be taken to remedy the historical disadvantages faced by women and girls (Women UN, 1979), through interventions from different stakeholders, including academics.

Elimination of discrimination against females is the core focus of CEDAW (Women UN, 1979) and it is important to note that discrimination comes in different forms (National Academies of Sciences, Engineering, and Medicine, 2020). Discrimination hinders females from advancing in science-related careers (Carr, Helitzer, Freund, Westring, McGee, Campbell, Wood, & Villablanca, 2019). SADC monitors the progress of females’ gender equality for the 2030 goal (SADC, 2022). The Millennium Development Goals (MDGs) that advance women’s participation in politics (Durokifa & Ijeoma, 2018), would ultimately open doors for more women in science. As one female is allowed in a sector and gets an acceptable experience, they may pull more females in. These policies advocates for the equal representation of females in different spheres, hence the need to consult them regarding the experience of female learners in Physical Sciences. Their stance is that females should be afforded an environment that nurtures their experience in science subjects.

1.4 ROLE OF THEORY IN THE STUDY

A theoretical framework is based on a propositional statement which helps the researcher to organise the study, examine the problem within a specific context, and gather data to be analysed using existing theory (Brink, Van der Walt & Van Rensburg, 2012). The Feminist Science Theory (FST) has been used in this study to obtain a participant sample relevant for the research objective: obtaining female learners’ experiences in Physical Sciences classes. Sandra

Harding is said to be the steerer towards the development and sustenance of FTS (Harding, 1986). The key tenet of FST that resonates with this study is, the representation of females in science subjects (Harding, 1986), a tenet that advocates for a better experience of female learners in science subjects (Harding, 2001).

Feminism is an ideology that challenges patriarchy, capitalism and sexism (Delmar, 1986). It opposes patriarchal norms and calls for the restoration of fairness and equality for all (Okin, 2005). It does not demand that women to be seen as superior to men, but calls for gender equality, equal opportunity and equal protection to all (Minow, 2021). McNutt (2015) asserts that if the world would give women the same platforms and opportunities as men, then women would accomplish more. Feminist Standpoint Theory (FST) has been used as a framework to explore the experiences of female learners in Physical Sciences in pursuit of improving theoretical and practical support for learners. FST has assisted the researcher to unpack the planning, execution, and reporting of the envisaged study.

1.5 PURPOSE OF THE STUDY

1.5.1 Purpose

The purpose of this study is to explore the experiences of female Grade 12 Physical Sciences learners in the Capricorn district of the Limpopo province. The researcher sought to identify specific challenges and support needed to enhance both theoretical understanding and practical applications in the subject, ultimately providing actionable recommendations for educators, administrators, and policymakers, to improve educational outcomes.

1.5.2 Research questions

1.5.2.1 Main research question

- What are the experiences of female learners studying Physical Sciences in Grade 12 classrooms in the Capricorn District of Limpopo?

1.5.2.2 Sub-questions

- What are the factors that affect female learners' experiences in Grade 12 Physical Sciences classrooms in the Capricorn District of Limpopo Province?
- Which recommendations can be made and implemented to improve the theoretical and practical support offered to female learners studying Physical Sciences in Grade 12 classrooms?

1.5.3 Objectives

- To determine the factors affecting female learners' experiences in their Grade 12 Physical Sciences classes in the Capricorn District of Limpopo Province.
- To propose recommendations that can improve the theoretical and practical support offered to female learners studying Grade 12 Physical Sciences in the Capricorn District of Limpopo Province.

1.6 RESEARCH METHODOLOGY

1.6.1 Research paradigm

This study is located within the interpretivist paradigm. This refers to a humanistic worldview (Pilarska, 2021) in which the lived experiences of participants are captured, with the belief that knowledge is influenced by those experiences within a particular context (Pretorius, 2024). An interpretivist paradigm paves the way for researchers to focus on the lived experiences of participants within that context and to use the generated data from participants

to make meaning of those experiences (Tisdell, Merriam, & Stuckey-Peyrot, 2025). It permits the researcher to interact with participants through various methods such as interviews and observations.

1.6.2 Research approach

A qualitative research approach was employed in this study. A qualitative research approach is an approach that gathers non-numerical data on participants' perceptions, attitudes, and beliefs (Oranga & Matere, 2023). The qualitative research approach suits the study as it allows the researcher to explore the experiences of female learners studying Physical Sciences, through their own voices. Additionally, it allows the researcher to contextualise the experiences of the participants and gives a localised understanding of those experiences.

1.6.3 Research design

The research design is the plan for gathering data in a research study (Creswell, 2021). A phenomenological research design, which is an exploratory design aimed at understanding the unique experiences of a certain population, was undertaken in this study (Oranga & Matere, 2023). A phenomenological research design was suitable for this study as it allowed the researcher to learn about the experiences of female learners in Physical Sciences classes and how theoretical and practical classes could be improved through listening to the female learners' voices. Their first-hand experiences have shed light on how the Department of Education's goal of equity and equality in classrooms is being achieved (Maree, Condy & Meda, 2023).

1.6.4 Population and Sampling

A population is a complete set of people or objects with common characteristics that are of interest to the researcher (Kostyrka-Allchorne, Creswell, Byford, Day, Goldsmith, Koch, & Sonuga-Barke, 2021). In this study, the population is Physical Sciences female learners in secondary schools of the Capricorn South

district of Limpopo Province of South Africa.

Purposive sampling was employed to select participants for this study. Purposive sampling was appropriate as it allowed the researcher to choose schools that offer Physical Sciences as a subject in Grade 12 and located in the Capricorn South district (Tisdell, Merriam & Stuckey-Peyrot, 2025). Schools in the Capricorn South District were purposively sampled from both rural and urban areas; three schools from a rural area, two of which are public schools and one of which is a Christian private school, and one school which is a public school from an urban area. The rationale behind selecting 2 schools that are public and in the rural areas was that, during the piloting stage of the study, the researcher observed that female learners from a rural public school were reserved in terms of expressing themselves as compared to the female learners from the urban school. Hence, there was a need for more than one rural school to aid in data saturation. The third rural school was a private school, which was needed to enrich the data collection so that the experiences of female learners may not be only limited to public school going learners. The rural private school uses the same curriculum as the public schools. The total number of schools sampled was four. Three female learners from each school were sampled and data was collected until data saturation was reached. The following inclusion and exclusion criteria applied:

Inclusion criteria

- Female learners currently enrolled in Grade 12 Physical Sciences classes in Capricorn District, Limpopo Province.
- Female learners who were willing to share their experiences, perspectives, advantages, and challenges related to their Grade 12 Physical Sciences education.

Exclusion criteria

- Female learners not enrolled in Grade 12 Physical Sciences classes in Capricorn District, Limpopo Province.

- Female learners unwilling or unable to share their experiences regarding Grade 12 Physical Sciences education.

1.6.5 Data collection

Data was collected using naturalistic observation, open-ended interviews and document reviews. Both the Physical Sciences theory and practical classes were observed during the data collection period. The observer was seated before classes commenced and wrote down field notes on what transpired during the classes using a notepad and a pen. This was done to prevent interference with the behaviour of learners. As the researcher was once a Physical Sciences learner, observation has assisted in understanding the female learners' experiences (Eastwood, Davies, & Rees, 2022). In addition, data was collected using open-ended individual interviews. The interviews ensured privacy and freedom to speak without being listened to by a third party (Osborne & Grant-Smith, 2021). The individual interviews were used to understand female learner's voices as they give a detailed experience in their Physical Sciences classrooms. Voice recorders were used to collect data; participants were notified when the recorders were switched on and off. The interviews were conducted in English and Sepedi, the dominant languages in the area. Data was collected and analysed before continuation. Interviews allowed all participants to contribute to the adequacy of the data (Hamilton & Bowers, 2006) and provided a fuller picture of the experiences of female Physical Sciences learners (Natow, 2020). Documents were also reviewed, *i.e.* learner scripts and question papers. Notes were obtained from the information collected from documents relating to the study. The documents used in the study are female learner scripts for formal assessments from term 2, the Annual Teaching Plan, Question papers and informal workbooks. Data collection was done until data saturation was reached. Data saturation was reached at the fourth school.

1.6.6 Data analysis

Audio data was transcribed and aligned chronologically; field notes from observations and notes from documents reviewed were also aligned chronologically. The filing system arranged raw field data in an orderly format. Data was analysed by using Tesch's (1990) method of data analysis. The researcher employed different steps leading to the themes and sub-themes. Transcriptions of the recorded interviews were read to get a sense of the content discussed in the interview sessions. After the completion of all transcripts, a list of comparable topics was assembled. Data was categorised according to themes and sub-themes.

1.6.7 Quality Criteria

Trustworthiness is the process of ensuring that the research findings are credible, transferable, confirmable, and dependable (Mays & Pope, 2000). The following criteria were ensured:

1.6.7.1 Transferability

Transferability in this study was ensured through thick description, purposive sampling and data saturation:

Thick description was ensured by detailed enquiries about the female learners' experience in Physical Sciences.

Purposive sampling was used to include female learners doing Physical Sciences in Grade 12.

Data saturation was reached when additional participants were no longer providing new information.

1.6.7.2 Credibility

Credibility in this study was ensured through prolonged engagement, triangulation, member checks, and iterative questioning:

Prolonged engagement – This was ensured through the researcher familiarising herself with the study site before the interviews were conducted. The researcher visited the schools to get a feel of the environment.

Triangulation – This was ensured through asking questions differently and using different methods to collect data. The methods used to collect data were in-depth interviews, observations, and document reviews.

Member checks – After data was analysed, the emerging findings of the study were taken back to the participants for confirmation of the adequacy of the data and the conclusion.

Iterative questioning – This was done through probing to elicit detailed data and iterative questioning in which the researcher rephrased questions to matters which were previously raised by the participants.

1.6.7.3 Confirmability

Confirmability was ensured by written field notes and voice recordings to confirm the data.

1.6.7.4 Dependability

Dependability was ensured through stepwise replications and inquiry audits. *Stepwise replications* clearly described research methods to enhance the possibility of repeating the study by another researcher. *Inquiry audit* - an independent auditor has reviewed all the activities undertaken by me including field notes, audios or tape recorders to see how well the activities and the techniques for meeting credibility and transferability have been followed.

1.7 SIGNIFICANCE OF THE STUDY

The researcher is of the view that the findings of this study will prompt fellow researchers to consider other contexts and settings in which challenges regarding Physical Sciences education exist, particularly regarding theoretical and practical classes.

This study has not involved broad claims but invites readers to make connections between elements associated with female learners in line with their own experiences. The researcher offers interventions under which the findings of this study may be applied (i.e., transferred) to other settings to contribute to the building of new knowledge in academia. It is envisaged that the contextualisation of the developed recommendations will be disseminated to relevant stakeholders and other parties interested in clearly understanding the experiences of female learners in Grade 12 Physical Sciences classes in the selected rural and urban schools of the Capricorn district in the Limpopo province of South Africa.

This study has further established gaps in the experiences of female learners and made recommendations. These recommendations can be demarcated into the following:

1.7.1 Empirical contribution

The dearth of literature within the subject of Curriculum Studies is limited, an observation this is based on specific gaps, inconsistencies and/or controversies that were identified in the literature.

This study aimed to close the gap by providing more detailed information in terms of providing existing experiences of female learners in Grade 12 Physical sciences classes in the selected rural and urban schools of the Capricorn district in the Limpopo province of South Africa, focusing on theory and practical classes. This study stands as a source of reference for future academics in these field and other relevant stakeholders, where they could draw best practices from it, the results of this study can be further transferred to provinces interested in exploring the experience of either female or male learners in either of the science subjects.

1.7.2 Theoretical contribution

The study has contributed theoretically utilising the Feminist Science Theory (FST) in unpacking the experiences of female learners through their own voices.

1.8 ETHICAL CONSIDERATIONS

1.8.1 Seeking permission

Ethical clearance to conduct the study has been requested and received from the Turfloop Research and Ethics Committee; permission to conduct the study has been obtained from the Department of Basic Education of Limpopo Province, from principals and School Governing Bodies (SGB) of selected schools in the Capricorn district.

1.8.2 Informed consent

Permission to participate in the study has been requested from female learners using informed consent. No participant was below consenting age, therefore there was no need to seek consent from their guardians/parents. The researcher explained the purpose and objectives of the study to the participants prior to them voluntarily consenting to participate in the study. The participants were made aware of the significance, aims and objectives of the study, including the fact that they could terminate their participation at any point of the study.

1.8.3 Voluntary participation

The participants were informed about the aims and objectives of the study, including the advantages and disadvantages of participating. This was done with informed consent so that participants could decide whether to participate, without coercion or fear.

1.8.4 Confidentiality, privacy and anonymity

Confidentiality was ensured by sharing information obtained from participants only with people who were involved in the study, namely the researcher and the supervisor.

Privacy of participants was maintained by interviewing learners and teachers in school offices and not in public or on the streets.

Anonymity was ensured by guaranteeing that the participants are not identifiable by their names. The researcher did not use participants' real names when reporting results.

1.8.5 Risk

There might have been a possible risk of evoking undesirable emotions as the researcher was asking about the subject of Physical Sciences. Such instances would have been prevented by asking questions with tact and sensitivity. However, in cases where learners or teachers are triggered, local social workers would be enlisted to assist with counselling. However, there was no incident where a social worker was needed through the data collection process.

1.8.6 Research integrity

The researcher is a qualified teacher committed to adhering to the sampling procedure as outlined in the research method of this study when collecting data and adhering to ethical principles by reporting results accurately and honestly without manipulation. She also holds a Master's degree through which she received thorough training in data collection methods. She is knowledgeable in terms of avoiding bias by preventing influencing participants to respond in a particular way.

1.9 SUMMARY

This chapter introduced the study and gave the background as to why this study is important to be sought after. The purpose, which is to ultimately improve theory and practical offerings for female learners in Physical Science classes has been thoroughly explicated. Studies focusing on female learners' experience in the classroom are scarce and dispersed, especially those documenting these experiences as expressed through their own voices. The next chapter will give a glimpse of existing literature.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

In the previous chapter, the background to the study was highlighted. In this chapter, key concepts that shape the research study will be discussed, and how they will be used in the study. The historical background of female learners in schools will also be looked at. This will highlight how females have been treated in Physical Sciences classes around the world, in Africa and eventually dive into the South African context. It will also highlight how the inclusion or exclusion of females evolved in recent years and how it affected their experience in Physical Sciences classes. There will be a highlight of empirical studies that have looked at the experiences of female learners in Physical Sciences classes. How the experience has shaped female learners' performance, career choices, perception of science, and ultimately their life choices. Lastly, there will be a glance into previous studies that have looked into the experiences of female learners in Physical Sciences classes in other parts of the world and in South Africa.

2.2 CONCEPTUALISATION OF THE STUDY

According to Stevenson (2010), a learner is an individual seeking to acquire knowledge and skills related to a specific subject, either through formal instruction or self-study. In this study, female learners are defined as young girls between the ages of seventeen and twenty-three who are in grade 12 and studying Physical Sciences. While learners in grade 12 are typically eighteen years old (Ajayi, Moosa, & Aloka, 2022), the broader age range of seventeen to twenty-three is used to account for factors that may cause students to be retained in either of the lower grades. Female learners in this context aspire to pass grade 12 and subsequently enrol in a tertiary institution.

Physical Sciences is a subject taught in South Africa that encompasses two

main areas: Physics, which explores physical phenomena, and Chemistry, which explores chemical phenomena (CAPS, 2011). Although Physical Sciences is not a compulsory subject in South Africa, some students choose to study it. There is no set enrolment ratio for boys and girls; any student who is interested in the subject may study it. Physical Sciences is allocated four-and-a-half (4.5) hours per week in every class. In countries like Thailand, it is a mandatory subject (Brickhouse, 2004), whereas in Malawi and other countries, it is referred to as science (Mbanjo & Nolan, 2017). The subject in South Africa is divided into six main knowledge areas: Matter and Materials, Chemical Systems, Chemical Change, Mechanics Waves, Sound and Light, and lastly, Electricity and Magnetism (CAPS, 2011). Physical Sciences instruction includes both theory and practical classes. Theoretical concepts are taught in theory classes, while practical demonstrations or experiments are conducted in practical classes. It is essential to integrate practical classes with theory to reinforce the concepts being taught (CAPS, 2011). Fully equipped and functioning laboratories are necessary for conducting practicals safely and efficiently. The use of Indigenous Knowledge Systems (IKS) is encouraged in the subject.

The term "experience" has diverse definitions across different disciplines (Larsen, 2007). Every experience is represented in the mind as information, making an experience a form of data stored in the mind (Csikszentmihalyi, 1990). Experiences can also be subjective, as two individuals at the same place and time may perceive an event differently (Csikszentmihalyi & LeFevre, 1989). Mannell and Iso-Ahola (1987) distinguish between immediate experience and re-experience, which occurs after the actual event. It is important to recognise that an individual can experience an event multiple times due to the phenomenon of re-experience. Experiences are contextual and, in this study, are defined as either positive or negative feelings that a female learner experiences in either theory or practical classes. Experiences may result from interactions with teachers and classmates, internal communication, external factors, or other factors affecting the Physical Sciences classroom context.

Having provided the conceptualisation of the current study, the researcher will provide a brief historical background regarding females in science.

2.3 HISTORICAL BACKGROUND OF FEMALES IN SCIENCE SUBJECTS

Females have been underrepresented in Physical Sciences globally for years (Holman, Stuart-Fox & Hauser, 2018). The underrepresentation of females in Physical Sciences education has been a longstanding issue, with a rich history of exclusion (Francis, Archer, Moote, DeWitt, MacLeod, & Yeomans, 2017), discrimination (National Academies of Sciences, Engineering, and Medicine, 2020), and prejudice (Avraamidou, 2022). There were movements that assisted in shaping the current discourse of females in science, these include the feminist movement (Harding, 1991). Feminists were much concerned about empowering females. The core of empowerment of females lies in the ability of females to control their own fate (Baumgardner, & Richards, 2010). Hence, if a female wanted to study science, they should be able to choose to do so. There has been a much-needed change in the face of science, from that of a masculine (Carey, 2001) to a no-gender face. However, that change has not been reached (Hayes, 2023). When females were given a choice to choose if they wanted to embark in the science field, many chose to do so (Baumgardner, & Richards, 2010). Signalling that females may have always had interest in science. There were just gatekeepers who were excluding them from the science field (Husu, 2004). There are also different developments of women in science internationally.

2.3.1 International perspective

Carey (2001) asserts that existing historical accounts of Australian science schools reveal little about women's participation in the field of science. In Australia, the first woman to ever graduate in the science field was Edith Dornwell in 1885 at the University of Adelaide (Ramiah, Godinho, & Wilson, 2022). The woman opened a path to many women to embark on science

qualifications in Australia. Not only did the guidance and encouragement of a few male scientists propel women in science, but intelligence, interest, determination, and capacity for hard work were the traits that were mentioned to have assisted two Australian women without qualifications to excel in science (Allen, 1992). This is another evidence that women in science have historically been under the shadow of males.

The first women to be allowed to embark on scientific experiments in America had to do so under the guidance of males because women experienced a “lack of independent credibility” (Kohlstedt, 1978). No woman was deemed “fit” enough to be on their own in a laboratory. Hence, they experienced exclusion from the science community. Female contributions to science were put at the background where they were supposed to be put at the forefront with other contributions from male scientists (Oreskes, 1996). Additionally, women in science experienced the “triple penalty” (Zuckerman, & Cole, 1975). First, it was culturally unacceptable for a woman to be a scientist. Secondly, for those that surmounted the first penalty to become a scientist, they were regarded as less competent than men (Hanson, 2004). Lastly, the discrimination against women was a norm (Rossiter, 1974), hence women’s ambivalence towards their work, which made them loose motivation and commitment. Lack of motivation and commitment could be mistaken by the public as a lack of interest in science.

The famous Marie Curie was interested in science to the point that she left Poland after experiencing exclusion from local universities and went on to conduct her scientific discoveries outside of Poland (Curie, 1938). This is where she won numerous accolades including the Nobel Prize (de Hevesy, 1996). She was a lifelong teacher (Frontczak, 2023) who sacrificed her time to the advancement of women in science while fulfilling familial roles as a married woman with children (Giroud, 1986) Curie became a role model to many women as her life proved that it is possible to be a woman scientist with a “normal life”. This goes to show the struggles that European women went through to make a breakthrough in the scientific community. She, however, did not forget her

home country even in fame. She went back to her home country, Poland, to start the first cancer research institute in 1932 (Wagner, Finkielstein, & Czarnacka, 2017). This goes to show how humane Marie Curie was. However, European women seem to be at a better advantage than those in Asia.

In South Asia, where education is not effectively mandatory, parents decide whether and how much to educate their children (Herz, & Unicef, 2006). When education costs too much, and when good-quality education is hard to come by, parents, especially those in poverty, may feel that the future returns may not justify the present costs. Also, where many girls 'marry out' and parents rely more on sons for help and support in their old age, the benefits of educating girls may seem particularly "distant and uncertain" (Herz, & Unicef, 2006). Studies show that one third of girls of school going age do not go to school, while only one in four girls attend primary school (Herz, & Unicef, 2006). Hence most girls are out of school in South Asia. For those that are in school, taking up science as a major is still at minimal. South Asia is also regarded as one of the parts of the world that houses the highest number of out- of-school girls (Niaz Asadullah, Alim, & Anowar Hossain, 2019). One factor that accounts for a minimal attendance of school by girls is because over a third of girls marry before the age of eighteen in Asia (Arooje, & Burr ridge, 2021). Since education is not mandatory to all, and parents have the deciding power to educate girls, many choose not to do so. Since India is part of South Asia, it holds the same trend in terms of educating girls.

Arooje, & Burr ridge, 2021 mentions that in India, the struggle is still on getting girls to school, giving them a primary and secondary education. In 2011, the literacy rate of girls in India was 65.5% while of boys in India was 82.1%, even though girls took up 58.65% of the population (Census Data, 2011). This is because of many factors and beliefs. One of the beliefs was that a girl that can read and write will soon become a widow after marriage (Sahoo, 2016). Hence many parents who do not want to expose their children to such a risk do not take

them to school. Based on the evidence provided here, it shows that education is not mandatory for girls in India. However, that is not the case for girls in Bangladesh.

A study by Naher, Tanim, & Sultana, 2019 shows the recent increase of women in science in Bangladesh, even though the increase is at minimal. This is because girls drop out of school before completion, either in the science or non-science related field. The single most frequent reason is because of marriage (Schurmann, 2009). Millennium Development Goal (MDG) 3 of the United Nations World Summit agreed for in 2000, “promote gender equality and empower women” was said to have been attained by the Bangladesh government (Raynor, 2007). Raynor (2007) states that the “claim is simply not true”. Hence if the government believes that they have reached the MDG, they will do little to genuinely reach it. However, this pattern is different from that of China.

In China (East Asia), the “one-child-policy” where parents had to have only one child, improved gender equality in terms of girls’ education overall and in science (Fong, 2002). Because it was only then that most parents had to take their children to school since girls had no brothers to compete with for parental investment (Liu, 2006). Studies show that less girls choose STEM subjects in China, and this may be attributed to the Experiences of girls in science classes (He, Zhou, Salinitri, & Xu, 2020). Even though girls started to go to school in numbers, that does not mean all of them would study science. However, currently, the China government has invested in girls’ education to break poverty in China’s rural areas (Zhu, 2020). Although there is an improvement in gender equality when coming to girls’ education, this is contrary to that of Japan.

In Japan, there exists few women in science. This may be attributed to the fact that girls believe in the stereotype that girls generally have a low aptitude for hard sciences (Ikkatai, Minamizaki, Kano, Inoue, McKay, & Yokoyama, 2020). And the one remedy seems to be to come up with measures to prevent girls from disliking science at an early age, and to improve their experience in science

classes (Ikkatai, Inoue, Kano, Minamizaki, McKay, & Yokoyama, 2021). And another remedy seems to be to consider individual experiences of females in science subjects (Santos, 2020) with an intention to improve their experiences. Studies show that Japan is a perfect example of a leaky pipeline, which results with fewer women in science at the end of secondary education (Peng, Kawano, Lee, Tsai, Takarabe, Yokoyama, Ohtsubo, & Ogawa, 2017; Yang-Yoshihara, & Maekawa, 2021). Thailand has the opposite trend as compared to that of Japan in the proportionality of girls in science.

In Thailand, the discourse is different from many countries in Asia. Girls enrol and participate in Physical Sciences as much as boys and the reason for this is that Physical Sciences was mandatory for everyone regardless of gender, even before the 1980s (Brickhouse, 2004). Varma, Falk, & Dierking, 2023 attest to the parity that is reached in Japan in terms of enrolment of both girls and boys in science. The mandatory rule gives both girls and boys an opportunity to take up science and also gives them the same opportunity to excel in science. The experience of female learners in Asia in general is not too different from that of Africa.

2.3.2 African perspective

In some of the African countries, science in schools started to be taught later as compared to other continents. In Ghana, the government started building their first science centres in the 1960s (Osseo-Asare, 2013). The centres were accepting both female and male learners. Lawer & Kwesi 2022 stated that gender did not play a role in the experience and attitude of learners towards science in Ghana. In Egypt, females are few in the STEM field and they experience traditional gender dynamics (Karim, & Karim, 2021). In Nigeria, females are underrepresented in science, and they experience exclusion because of “cultural beliefs, tradition, early marriage, parental educational background and religious belief” (Abdullahi, Abubakar, Abubakar, & Aliyu, 2019). Female learners that are doing science are targeted more than those that

are not doing science. They are experiencing abductions based on subject choice; hence, 110 girls were abducted from the Government Girls Science Technical College in Dapchi, Yobe State in February 2018 (Verjee, & Kwaja, 2021). Religion intolerance is one of the reasons behind the abductions of girls (Olaniyi, & Aminu, 2021).

In Zimbabwe, cultural believes is the main reason behind girls experiencing exclusion in science classes in secondary schools. Hence a few female students in science in tertiary institutions, and consequently at work. The government of Zimbabwe encourages gender parity in terms of positions at a higher rank based on merit. Women can only apply if they qualify, hence a few females that occupy higher positions. Zimbabwe gained independence in 1980 and subsequently adopted a “leave no one approach”. However, girls are still excluded from science through stereotypes that are still evident (Gweshe, & Chiware, 2023).

In South Africa, gender parity has been reached in terms of enrolment in all subjects including Physical Sciences. The focus of this study is the female learners' experience in Physical Sciences classes. Jawitz, Case, & Tshabalala, 2000 reiterated the correlation between female learners' positive experience in a Physical Science class and the pursuit of science at tertiary level. Also, Traxler, Cid, Blue, & Barthelemy, 2016 highlighted the need to study the experiences of female learners as part of Physics Education Research (PER) to include it in the holistic understanding of the intersectionality of female learners in science.

The above discussion provided a historical background of women in the field of science. The aim of the researcher was to provide an international and African perspective on the history of women in science, with the aim of showing when female learners develop an interest in science subjects. The researcher believes that the experiences of female learners is of paramount importance since they were historically excluded from science subjects, especially African females. There is a need to explore the experiences of female learners in Grade

12 Physical Sciences theory and practical classes in the Capricorn district of the Limpopo province in South Africa.

2.4 EXPERIENCES OF FEMALE LEARNERS IN LEARNING PHYSICAL SCIENCES EDUCATION

The learning experiences of female learners in Physical Sciences can be influenced by several factors, including positive reinforcement, supportive learning environments, overcoming challenges, engagement and interest, a sense of belonging, and feelings of exclusion. Positive reinforcement plays a critical role in encouraging female learners to pursue physical sciences and other STEM related subjects. Research has shown that mentorship and role modelling are effective ways to positively reinforce female participation in Physical Sciences education (González-Pérez et al., 2020; Kricorian et al., 2020). When female learners receive positive reinforcement and encouragement from teachers, parents, and peers, it can boost their confidence and motivation to succeed in their studies (Rumfola, 2017). Additionally, creating a supportive learning environment that promotes gender equality and inclusivity can be highly beneficial for female learners (Guerrero & Guerrero-Puerta, 2023). This can include providing access to female role models and mentors, encouraging participation in STEM clubs and programs, and offering support and resources to succeed in their studies.

Despite these positive aspects, some female learners may face challenges in learning Physical Sciences, such as gender stereotypes and biases, cultural and social barriers, and limited access to resources and opportunities (Islam & Asadullah, 2018; Galsanjigmed & Sekiguchi, 2023). Liani, Nyamongo, & Tolhurst, 2020 confirms the idea that there is a myriad of challenges facing women in science. However, with determination, perseverance, and support from teachers, parents, and peers, these challenges can be overcome. Furthermore, female learners may develop a strong interest and engagement in Physical Sciences, leading to a deeper understanding of the subject and a desire to pursue further studies and careers in STEM fields (González-Pérez et

al., 2022). Additionally, female learners may experience a sense of belonging with other female learners in Physical Sciences classes and programs, fostering a supportive community that encourages collaboration, learning, and success. However, some female learners may feel excluded or isolated in Physical Sciences classes and programs, where they are often underrepresented due to the myriad challenges they face (Rainey et al., 2018). This can impact their sense of belonging and their ability to succeed in their studies. The next section will be on the challenges faced by female learners in Physical Sciences education.

2.5 CHALLENGES FACED BY FEMALE LEARNERS IN PHYSICAL SCIENCES CLASSROOMS

Female learners enrolled in Physical Sciences face a myriad of challenges, which can significantly impact their confidence, motivation, and ability to succeed. These challenges include gender stereotypes and biases, lack of access to role models and mentors, limited access to resources and opportunities, cultural and social barriers, lack of support and encouragement, limited access to quality education, and feelings of isolation and exclusion.

2.5.1 Gender stereotypes and biases

One of the most significant challenges experienced by female learners in Physical Sciences is gender stereotypes and biases (Islam & Asadullah, 2018). These stereotypes may include beliefs that females are less capable or less interested in science and technology. According to Burkam, Lee and Smerdon (1997) female learners believe that science has no relevance to their lives, however, this stereotype seems to impact female students more than males, who do not tend to view this as a great disincentive. Such stereotypes can negatively impact female learners' confidence and motivation to pursue physical sciences and STEM fields, leading to self-doubt and underperformance. Research shows that challenging these stereotypes and promoting a growth

mindset can help female learners overcome these biases and develop a positive attitude towards physical sciences and STEM education (Wang& Degol, 2017).

2.5.2 Lack of access to role models and mentors

Female learners lack access to female role models and mentors in Physical Sciences and other STEM fields (Kricorian et al., 2020). This can make it difficult for them to envision themselves in these fields and to receive the support and guidance they need to succeed. Research shows that exposure to female role models and mentors can inspire female learners to pursue careers in STEM fields and provide them with valuable insights and advice on navigating the challenges they may face (Gladstone & Cimpian, 2021). Therefore, efforts should be made to increase the visibility of female scientists and to create mentoring programs that connect female learners with experienced professionals in the field.

2.5.3 Cultural and social barriers

Female learners may also experience cultural and social barriers that discourage them from pursuing physical sciences and other STEM fields (Prieto-Rodriguez et al., 2022). These barriers may include societal expectations about gender roles and responsibilities, as well as discrimination and harassment in educational and professional settings. Research shows that addressing these cultural and social barriers is crucial for promoting gender equality and inclusivity in Physical Sciences (Prieto-Rodriguez et al., 2022). This can include creating policies and programs that promote diversity and inclusion, providing training and education on unconscious and subtle bias and discrimination, and creating safe and supportive environments for female learners to succeed.

2.5.4 Lack of support and encouragement

Female learners may also experience a lack of support and encouragement from teachers, parents, and peers to pursue Physical Sciences and other STEM fields (Kibirige & Modjadji, 2022). This can make it difficult for them to stay motivated and to overcome challenges they may face in their studies, making them give up easily. Research shows that support and encouragement from teachers (Meece, Glienke, & Askew, 2009), parents (Rabenberg, 2013), and peers (Aschbacher, Li, & Roth, 2010) can play a crucial role in female learners' success in physical sciences and other STEM fields (Kibirige & Edith Modjadji, 2022). Therefore, efforts should be made to create programs and initiatives that provide female learners with the support and encouragement they need to succeed in Physical Sciences and other STEM fields.

2.5.5 Limited access to quality education

Female learners may also face limited access to resources and opportunities, such as scholarships, internships, and research opportunities, which can hinder their ability to pursue Physical Sciences and other STEM fields (Aina & Adedo, 2013). Research shows that providing female learners with access to resources and opportunities can help them develop the skills and knowledge they need to succeed in STEM fields and can increase their confidence and motivation to pursue careers in these fields (Aina & Adedo, 2013). Therefore, efforts should be made to create programs and initiatives that provide female learners with access to scholarships, internships, and research opportunities in Physical Sciences and other STEM fields.

2.5.6 Isolation and exclusion

Female learners may also experience isolation and exclusion in Physical Sciences, where they are often underrepresented (Rainey et al., 2018). This can impact their sense of belonging and their ability to succeed in these fields. Research shows that creating supportive communities and networks for female learners in Physical Sciences can help them feel connected and included and

can increase their sense of belonging and motivation to succeed (Rainey et al., 2018). Therefore, efforts should be made to create programs and initiatives that foster collaboration, networking, and a sense of community among female learners studying Physical Sciences. For example, science clubs at school level.

Having discussed current research pertaining to the challenges faced by female learners studying Physical Sciences as a Grade 12 subject, the researcher believes that interrogating the experiences of these learners as they pursue their final year of secondary schooling before tertiary education, is of the utmost importance in research. There is therefore a need to discuss the overview of gender equity and equality in education.

2.6 OVERVIEW OF GENDER EQUITY AND EQUALITY IN EDUCATION

Gender equity and equality in education refers to the fair treatment and equal opportunities for all individuals, regardless of their gender, in educational settings (Jurado de Los Santos, Moreno-Guerrero, Marín-Marín, & Soler Costa, 2020) with more or less of the same experience in class. This includes ensuring that both girls and boys have access to quality education and the resources and support they need to succeed. Many countries around the world have implemented policies and programs aimed at promoting gender equality in education (Leal Filho, Kovaleva, Tsani, Țîrcă, Shiel, Dinis, Nicolau, Sima, Fritzen, Lange Salvia, & Minhas, 2023) and increasing access to education for female learners and women (Mbanjo & Nolan, 2017). These initiatives have led to increased enrolment of female learners in schools and have contributed to narrowing the gender gap in science educational attainment. However, England, Levine, & Mishel, (2020) suggests that there was a dramatic progress in movement towards gender equality between 1970 and 2018, but since 2018, the needed change has slowed down or stalled. The slowing down on some indicators of progress is a negative indication for experiences of women in science and hinders the movement for gender equity and equality in education.

Despite these achievements, gender disparities persist in many parts of the world. Female learners and women continue to face barriers to education, including cultural and social norms, poverty, and discrimination (Stamarski & Son Hing, 2015). These barriers can limit their access to quality education and their ability to participate fully in educational settings. Gender equity and equality in education are important for a number of reasons. It is a fundamental human right, as outlined in various international conventions and agreements, including the United Nations Convention on the Rights of the Child and the Convention on the elimination of all forms of discrimination against women. Additionally, gender equity and equality in education is linked to broader social and economic benefits (Sahin, 2013). For example, increasing access to education for female learners and women has been shown to improve health outcomes, reduce poverty, and promote economic growth. There is still much work to be done to achieve gender equity and equality in education. This includes addressing the root causes of gender disparities, such as discriminatory laws and policies, cultural and social norms, and lack of access to resources. It also involves creating inclusive and supportive learning environments that address the unique needs and interests of all learners, regardless of their gender. In the next section, impact of gender equity and equality initiatives on female learners' experience is discussed. Which is significant to note, since this study is focusing on the experiences of female learners in one of the science subjects, which is Physical Sciences.

2.7 IMPACT OF GENDER EQUITY AND EQUALITY INITIATIVES ON FEMALE LEARNERS' EXPERIENCES

Gender equity and equality initiatives have had a significant impact on female learners' experiences in educational settings (Simmonds, 2017). These initiatives aim to ensure that all individuals, regardless of their gender, have access to quality education and the resources and support they need to succeed. One of the key impacts of gender equity and equality initiatives has been increased access to education for female learners (Guthridge, Kirkman,

Penovic, & Giummarra, 2022). Many countries have implemented policies and programs aimed at promoting gender equality in education and increasing access to education for girls and women. These initiatives have led to increased enrolment of girls in schools and have contributed to narrowing the gender gap in science educational attainment.

Gender equity and equality initiatives have also contributed to creating more inclusive and supportive learning environments for female learners, which have improved their experience in science classrooms. These initiatives often include measures aimed at addressing the unique needs and interests of female learners, such as providing access to female role models and mentors, promoting gender-sensitive teaching practices, and creating opportunities for collaborative learning (Possi & Milinga, 2018). These measures can help to foster female learners' engagement and interest in education and can also help to boost their confidence and motivation to succeed.

Additionally, gender equity and equality initiatives have helped to raise awareness about the importance of gender equality in education and the contributions of women in various fields (Llorens, Tzovara, Bellier, Bhaya-Grossman, Bidet-Caulet, Chang, Cross, Dominguez-Faus, Flinker, Fonken, & Gorenstein, 2021). This has helped to challenge and change societal norms and stereotypes that often discourage girls from pursuing certain fields, such as STEM. By providing female learners with access to female role models and mentors, and by highlighting the achievements and contributions of women in these fields, gender equity and equality initiatives can inspire female learners to pursue careers in these fields and to achieve their full potential (Guevara-Ramírez et al., 2022).

2.8 FEMALE LEARNERS' ASPIRATIONS AND MOTIVATIONS IN PHYSICAL SCIENCES

Female learners' aspirations and motivations in Physical Sciences can be

influenced by various factors including personal interests, career goals, positive role models, societal expectations, support and encouragement, and access to resources and opportunities (Abe & Chikoko, 2020). Personal interests in Physical Sciences can drive female learners' motivation to learn and succeed in the subject (Talley & Martinez Ortiz, 2017). Modjadji (2016) noted that personal interests motivate learners to choose Physical Sciences as a subject. Encouraging and nurturing these interests is essential for supporting their aspirations and motivations. Career goals and aspirations in STEM fields may also motivate female learners to pursue Physical Sciences (Makarova, Aeschlimann, & Herzog, 2019). Providing information about diverse career opportunities in Physical Sciences and other STEM fields can inspire and motivate female learners. Exposure to positive role models, such as female scientists, engineers, and educators, can provide female learners with a vision of what is possible in the physical sciences (Aschbacher, Li, & Roth, 2010) and encourage them to pursue their interests. Societal expectations and stereotypes about gender roles and abilities in physical sciences can impact female learners' aspirations and motivations (Dimitriadi, 2013). It is important to challenge and change these expectations and stereotypes to support female learners. Female learners' aspirations may also be improved by improving their experience in class (Andoh, Bosiakoh, & Afranie, 2012).

2.9 DEVELOPMENT OF FEMALE PARTICIPATION IN PHYSICAL SCIENCES

The development or advancement of female participation in Physical Sciences is explored from international, African, and South African viewpoints. These advancements encompass various aspects, including enrolment, access, gender-sensitive curricula, attitudes towards STEM, the enhancement of teacher capacity, empowerment, and monitoring and evaluation processes. This comprehensive examination sheds light on the multifaceted nature of female experience in STEM fields and underscores the importance of concerted efforts to foster inclusivity and equality in education.

2.9.1 Enrolment and access

Over the past few decades, there has been a global shift towards increasing the enrolment of females in Physical Sciences classes. This trend is largely attributed to a range of initiatives aimed at promoting gender equality in education and encouraging girls to pursue careers in STEM. These initiatives recognise the critical importance of closing the gender gap in STEM fields and ensuring that girls and women have equal opportunities to participate in and contribute to these fields. International organisations, such as UNESCO (United Nations Educational, Scientific and Cultural Organization) and UNICEF (United Nations Children's Fund), have played a pivotal role in advocating for the inclusion of female learners in STEM education. They have launched various campaigns, programs, and projects to raise awareness about the importance of gender equality in education and to promote the participation of girls and women in STEM fields (UNESCO, 2020). Moreover, these organisations have provided funding and support to governments and NGOs to implement initiatives aimed at increasing the enrolment of females in Physical Sciences classes.

Many countries, including Canada, Sweden, and the United States, have implemented policies and programs to address the gender gap in STEM fields and to promote the participation of female learners and women in Physical Sciences education and careers (Makarova, Aeschlimann, & Herzog, 2019). These initiatives have included role modelling, scholarships and financial incentives for female students, targeted recruitment and outreach efforts, mentorship and support programs, and curriculum reforms to make STEM subjects more accessible and appealing to girls (González-Pérez et al., 2020; Kricorian et al., 2020). In addition, there has been a growing recognition of the need to challenge and change societal norms and stereotypes that often discourage girls from pursuing the STEM field. Efforts have been made to raise awareness about the achievements and contributions of women in STEM, to provide female role models and mentors, and to create inclusive and supportive learning environments that encourage girls to excel in physical sciences and

other STEM subjects (Guerrero & Guerrero Puerta, 2023).

In Africa, efforts to increase the enrolment of females in physical sciences classes have been underway for several years, although the progress varies across countries. Many African countries have introduced policies and programs to promote gender equality in education and to encourage the participation of girls in STEM fields. Organisations such as the African Union (AU) and the African Academy of Sciences (AAS) have also launched initiatives to support girls and women in STEM education and careers (Okeke et al., 2017). The AU, for example, has developed the African Union Strategy for Gender Equality and Women's Empowerment, which includes a focus on promoting gender equality in education and increasing the participation of women in STEM fields (AU, 2020). The AAS, on the other hand, has implemented programs such as the African Women in Science (AWIS) program, which aims to increase the visibility and participation of women in science and to promote gender equality in the scientific community (AAS, 2020).

Despite these efforts, challenges such as cultural and social barriers, lack of resources, and limited access to quality education continue to hinder progress in some regions (Donohue, & Bornman, 2014). Cultural and social norms in some African countries may discourage girls from pursuing STEM fields, and girls may face discrimination and bias in the classroom and in the wider community (Prieto-Rodriguez et al., 2022). Additionally, many African countries face challenges in providing adequate resources and infrastructure for STEM education, including trained teachers, laboratory equipment, and learning materials. Limited access to quality education and opportunities for skill development may also limit the potential of girls and women to excel in physical sciences and other STEM subjects (Matete, 2021). To overcome these challenges, it is important to continue raising awareness about the importance of gender equality in education and to promote the participation of girls and women in STEM fields. Furthermore, it is essential to invest in resources and infrastructure for STEM education, to provide training and support for teachers,

and to create inclusive and supportive learning environments that encourage girls to excel in Physical Sciences and other STEM subjects.

In South Africa, the enrolment of females in physical sciences classes has been steadily increasing over the years, reflecting a positive trend towards gender equality in education and the participation of girls in STEM fields. This increase is a result of various policies and programs implemented by the government to promote gender equality in education and to encourage the participation of girls in STEM fields. In addition to these initiatives, partnerships with non-governmental organisations and the private sector have facilitated access to resources and support services for female learners in Physical Sciences classes. These partnerships have provided funding, mentorship, and other forms of support to schools and learners, helping to create conducive learning environments and to address some of the challenges faced by female learners in Physical Sciences classes (Volmink, & van der Elst, 2017).

One of the key initiatives that have contributed to the increased enrolment of females in Physical Sciences classes in Limpopo Province is the implementation of programs and projects aimed at improving access to resources. These initiatives have provided funding, equipment, and learning materials to schools and learners, helping to create conducive learning environments and to address some of the challenges faced by female learners in Physical Sciences classes. In addition to improving access to resources, efforts have been made to provide support services for female learners in Physical Sciences classes. These support services may include tutoring, mentoring, counselling, and other forms of academic and psychosocial support.

2.9.2 Gender-sensitive curriculum

A gender-sensitive curriculum in Physical Sciences aims to create a learning environment that is inclusive and responsive to the needs and experiences of both male and female learners (Akhigbe & Adeyemi, 2020). It challenges

gender stereotypes and biases and promotes equal opportunities for all learners to succeed in Physical Sciences and other STEM subjects. Creating a gender-sensitive curriculum in Physical Sciences education involves designing and implementing instructional materials, teaching strategies, and assessment methods that take into consideration the different needs, experiences, and perspectives of both male and female learners.

In the United Kingdom, the government and various organisations have implemented initiatives to promote gender equality in Physical Sciences education and careers. These initiatives include the creation of a gender-sensitive curriculum that takes into consideration the different needs and experiences of male and female learners, as well as efforts to challenge and change societal norms and stereotypes that often discourage girls from pursuing STEM fields (Wilkinson, & Penney, 2023).

In European countries, various initiatives have been launched to promote gender equality in Physical Sciences education and careers. These initiatives include the European Union's Gender Equality Strategy, which aims to promote gender equality in education and to increase the participation of women in STEM fields (Ovseiko et al., 2017). Additionally, various European countries have implemented policies and programs to promote gender-sensitive curricula in Physical Sciences education, including curriculum reforms, targeted recruitment and outreach efforts, mentorship and support programs, and efforts to raise awareness about the achievements and contributions of women in STEM (Kalpazidou Schmidt, et al., 2020).

In China, for example, the government has implemented policies and programs to promote gender equality in education and to encourage the participation of girls in STEM fields. These initiatives include curriculum reforms to make Physical Sciences and other STEM subjects more accessible and appealing to girls, as well as efforts to provide female role models and mentors, and to create inclusive and supportive learning environments (Wang & Degol, 2017;

Liu, Wen-qin, & Chao, 2021). In Nigeria, Liberia, Botswana, Zimbabwe, and South Africa, various initiatives have been launched to promote gender equality in Physical Sciences education and careers. These initiatives include policies and programs aimed at increasing the participation of girls and women in STEM fields, providing female role models and mentors, creating inclusive and supportive learning environments, and challenging and changing societal norms and stereotypes that often discourage girls from pursuing STEM fields (African Union, 2020; African Academy of Sciences, 2020). Furthermore, in South Africa, teacher training programs and professional development opportunities have been implemented to equip educators with the knowledge and skills needed to create gender-sensitive learning environments and to address the specific needs and challenges faced by female learners in Physical Sciences classes (Kollmayer et al., 2020).

2.9.3 Attitudes towards Physical Sciences education

Strengthening teacher capacity in Physical Science education is vital for enhancing the quality of education and ensuring students experiences and are provided with effective and engaging learning opportunities (Munna & Kalam, 2021). A pivotal aspect of this enhancement is the emphasis on fostering gender inclusivity, particularly in female participation in Physical Sciences and other STEM fields, which is essential for advancing gender equality in education and inspiring more girls and women to pursue careers in these domains. Teachers play a pivotal role in refining students' attitudes and perceptions towards physical sciences, and their ability to establish inclusive and supportive learning environments significantly impacts the participation and achievement of female learners.

In Europe, a range of initiatives have been introduced to boost teacher capacity for promoting gender inclusivity in Physical Sciences education. These initiatives encompass training and professional development programs for teachers, curricular reforms aimed at gender-sensitive teaching practices, and

endeavours to heighten awareness about the significance of gender equality in education (Darling-Hammond et al., 2019).

In Africa, measures have been taken to bolster teacher capacity for enhancing gender inclusivity in Physical Sciences education. These measures include training and professional development programs for teachers, curricular changes for encouraging gender-sensitive teaching practices, and initiatives to amplify awareness about the importance of gender equality in education. As an illustration, the African Union (AU) has formulated the African Union Strategy for Gender Equality and Women's Empowerment, which concentrates on fostering gender equality in education and augmenting the participation of women in STEM fields (African Union, 2020). Furthermore, several African nations have instituted policies and programs to offer training and support for teachers in gender-sensitive teaching practices.

In South Africa, various initiatives have been introduced to strengthen teacher capacity for fostering gender inclusivity in Physical Sciences education. These initiatives comprise training and professional development programs for teachers, curricular reforms to advocate gender-sensitive teaching practices, and efforts to accentuate the importance of gender equality in education. For instance, the South African Department of Basic Education has devised the National Strategy for Gender Equality in Education, which focuses on advancing gender equality in education and boosting the participation of girls in STEM fields (South African Department of Basic Education, 2020). Additionally, organisations such as the South African Women in Science and Engineering (SAWiSE) and the South African Council for Educators (SACE) have launched initiatives to assist teachers in championing gender equality in the classroom and to offer training and resources for gender-sensitive teaching practices.

2.9.4 Empowering female learners

Empowering female learners in Physical Sciences education is crucial for

promoting gender equality in education and for increasing the participation of girls and women in STEM fields (Guevara-Ramírez et al., 2022). Empowering female learners to increase their participation in Physical Science education involves creating an environment that fosters their engagement, interest, experience and achievement in Physical Sciences and other STEM fields (García-Ramos et al., 2022). A multi-faceted approach is required to achieve this, including providing positive reinforcement and encouragement from teachers, parents, peers, and mentors. This support can boost female learners' confidence and motivation to succeed in Physical Sciences and other STEM fields. Another critical strategy is promoting gender-sensitive teaching practices, which can create an inclusive and supportive learning environment that addresses the unique needs and interests of female learners (Possi & Milinga, 2018). This includes using diverse and inclusive examples and case studies, creating opportunities for collaborative learning and providing feedback that focuses on effort and improvement.

Furthermore, offering access to female role models and mentors in Physical Sciences and other STEM fields can inspire female learners to pursue careers in these fields and provide them with the support and guidance they need to succeed (Kricorian et al., 2020). Providing resources and support, such as scholarships, internships, research opportunities, and other forms of financial and academic support, can help to remove barriers to female learners' participation and achievement in physical sciences and other STEM fields (Pierszalowski, Bouwma-Gearhart, & Marlow, 2018). Raising awareness about the importance of gender equality in education and the contributions of women in physical sciences and other STEM fields can help to challenge and change societal norms and stereotypes that often discourage girls from pursuing these fields. Creating inclusive and supportive learning environments that promote collaboration, respect, and a sense of belonging can help to foster female learners' engagement and success in physical sciences and other STEM fields (O'Leary et al., 2021).

2.9.5 Monitoring and evaluation

Monitoring and evaluation are critical components of any initiative aimed at promoting inclusivity and female participation in physical sciences education (Darling-Hammond et al., 2020). Monitoring and evaluation involve the systematic collection and analysis of data to assess the progress, effectiveness, and impact of programs and policies designed to foster gender inclusivity and increase female participation in Physical Sciences and other STEM fields. They can help to identify areas of improvement, measure the success of interventions, and inform decision-making and policy development (Ortiz-Martínez et al., 2023).

To ensure inclusivity and female participation in Physical Sciences education, it is essential to establish clear goals and indicators for monitoring and evaluation (Lewin, 2015). These goals and indicators should be specific, measurable, achievable, relevant, and time-bound (SMART) and should align with the objectives of the initiatives aimed at promoting gender inclusivity and increasing female participation in Physical Sciences and other STEM fields. Data collection methods may include surveys, interviews, focus group discussions, and observations, among others. The data collected should be disaggregated by gender, and other relevant demographic characteristics, to allow for a comprehensive analysis of the impact of interventions on female learners.

Regular reporting and analysis of monitoring and evaluation data can help to identify successes and challenges, inform decision-making and policy development, and ensure that programs and policies are responsive to the needs and interests of female learners (Dipela & Mohapi, 2021). It is also important to involve key stakeholders, including teachers, parents, mentors, educational institutions, and other partners, in the monitoring and evaluation process to ensure that their perspectives and insights are considered.

2.10 POLICIES TO ENSURE EQUITY AND EQUALITY IN PHYSICAL SCIENCE EDUCATION

2.10.1 International policies

International policies for inclusive education, particularly in Physical Science education, are designed to ensure that every student, regardless of their background, abilities, or characteristics, has equal access to quality education and opportunities to participate and succeed in Physical Sciences and other STEM fields. These policies acknowledge the significance of closing the gender gap in STEM fields and ensuring that girls and women have equal opportunities to participate in and contribute to these fields. Some of the key international policies for inclusive education in Physical Sciences and other STEM fields include:

2.10.1.1 United Nations Convention on the Rights of Persons with Disabilities (CRPD):

The CRPD is an international treaty that champions and safeguards the rights of individuals with disabilities, including their right to education. The CRPD emphasises the importance of delivering inclusive education that accommodates the needs of all students, including those with disabilities.

2.10.1.2 United Nations Sustainable Development Goals (SDGs):

The SDGs are a collection of global objectives that aim to address a broad range of social, economic, and environmental challenges. Goal 4 of the SDGs focuses on achieving inclusive and equitable quality education and fostering lifelong learning opportunities for everyone. This encompasses increasing access to quality education for girls and women and ensuring gender equality in education.

2.10.1.3 UNESCO Education 2030 Framework for Action:

The Education 2030 Framework for Action is a blueprint for implementing the education-related targets of the SDGs. It emphasises promoting gender equality in education and increasing access to quality education for girls and women in STEM fields.

2.10.1.4 Organisation for Economic Cooperation and Development (OECD) Gender Equality in Education, Employment, and Entrepreneurship (GEEE) Initiative:

The GEEE initiative aims to promote gender equality in education, employment, and entrepreneurship, including increasing the participation of women in STEM fields.

2.10.2 South African policies

South African policies for inclusive education, particularly in Physical Science education, have been formulated to encourage inclusive education and enhance the participation of all students, including females, in Physical Sciences and other STEM fields. These policies underscore the importance of closing the gender gap in STEM fields and ensuring that girls and women have equal opportunities to participate in and contribute to these fields. In addition, the policies ensure that female learners experience their Physical Sciences education positively. Some key South African policies for inclusive education in Physical Sciences and other STEM fields include that contributes a positive experience in class include:

2.10.2.1 National Strategy for Gender Equality in Education:

The National Strategy for Gender Equality in Education is a policy document that lays out the government's commitment to promoting gender equality in education and ensuring that girls and women have equal opportunities to participate in and contribute to Physical Sciences and other STEM fields. The

strategy emphasises increasing the participation of girls in STEM subjects and providing support and resources to help girls succeed in these fields.

2.10.2.2 South African Schools Act (SASA):

The SASA is the primary piece of legislation governing education in South Africa. It stresses the importance of delivering quality education to all students, irrespective of their background, abilities, or characteristics, and promoting equal opportunities for all students to participate in and succeed in education.

2.10.2.3 National Development Plan (NDP):

The NDP is a long-term plan that outlines the government's vision for the country's development. It includes a focus on improving education and skills development, including increasing access to quality education in STEM fields and promoting gender equality in education.

2.10.2.4 National Curriculum Statement (NCS):

The NCS is the curriculum framework for South African schools. It emphasises the importance of providing quality education that is relevant and responsive to the needs of all students, including those from underrepresented groups. The NCS focuses on promoting the participation of girls in Physical Sciences and other STEM subjects and providing support and resources to help girls succeed in these fields.

2.10.2.5 Department of Science and Technology's (DST) National Youth Development Strategy:

The DST's National Youth Development Strategy aims to promote the participation of young people, including girls, in science and technology. The strategy includes a focus on increasing access to quality education in STEM

fields and providing support and resources to help young people succeed in these fields.

These policies serve as a framework for promoting inclusive education and ensuring that girls and women have equal opportunities to participate in and contribute to Physical Sciences and other STEM fields in South Africa. They emphasise the importance of providing quality education that is accessible and tailored to the needs of all students, including those from underrepresented groups, and of challenging and changing societal norms and stereotypes that often discourage girls from pursuing STEM fields.

The above-mentioned policies were developed with the hope of creating a more inclusive world in all aspects, with a special focus on women in science. The knowledge of these policies is beneficial to this study, as its focus is on the experiences of female learners in Physical Sciences classes in the Capricorn District of Limpopo Province in South Africa.

2.11 SUMMARY

Female learners face a variety of challenges and barriers in pursuing Physical Sciences education, including gender stereotypes and biases, lack of access to resources and support, and feelings of exclusion and isolation. However, with determination, perseverance, and support from teachers, parents, and peers, these challenges can be overcome. Gender equity and equality initiatives have had a significant impact on female learners' experiences, providing them with increased access to education and resources, as well as more inclusive and supportive learning environments. Female learners' aspirations and motivations in physical sciences can be influenced by personal interests, career goals, positive role models, and societal expectations. There has been a positive trend towards increased female participation in Physical Sciences, but there is still much work to be done to achieve gender equity and equality in education and to ensure that girls and women have equal opportunities to succeed in physical

sciences and other STEM fields. The next chapter discusses research methodology of this study.

CHAPTER THREE: THEORETICAL FRAMEWORK

3.1 INTRODUCTION

In the previous chapter, an overview of the literature review was outlined. This chapter presents the theoretical framework underpinning this study. A lens through which the whole study was illuminated. Contrasting as well as supporting views are discussed. Other theories under the feminist umbrella are also briefly explained.

3.2 FEMINIST THEORY

Feminist theory, a diverse and interdisciplinary field, is dedicated to comprehending and redressing the inequalities prevailing in social, political, economic, and cultural realms between genders (Ferguson, 2017; Kaunda, B.E. & Shereni, N.C., 2024). It arose in response to the historical subjugation of women, aiming to scrutinise and challenge the structures and ideologies perpetuating gender-based discrimination (Kannake & Kapoor, 2024).

Key facets of feminist theory encompass an analysis of gender inequality, delving into the uneven distribution of power, resources, and opportunities (Ojwala, Buckingham, Neat, & Kitada, 2024). The theory acknowledges intersectionality, recognising the interplay of gender with race, class, sexuality, and ethnicity, emphasising the interconnectedness of various forms of oppression (Biana, 2020). Patriarchy, discussed frequently in feminist discourse, delineates a societal system where men wield primary power, systematically disadvantaging women (Gupta, Madabushi & Gupta, 2023). Feminist theorists asserts that gender is a social construct shaped by cultural norms, not an innate characteristic (Ferguson, 2017). Historical perspectives are explored to trace the roots of gender inequality and comprehend the evolution of women's roles. Activism is integral to feminist theory, as theorists actively engage to rectify gender-based injustices (Shefer, 2019). Moreover,

feminist theory critiques traditional disciplines for perpetuating gender bias and advocates for the inclusion of diverse perspectives. The field encompasses various strands, such as liberal feminism, radical feminism, socialist feminism, ecofeminism, postcolonial feminism, and queer feminism, each offering unique approaches to addressing gender issues. It is essential to recognise that feminist theory is not a monolithic perspective (Bryant, Enns, & Tsong, 2024) but a dynamic framework encompassing diverse viewpoints and ongoing debates.

3.3 FEMINIST SCIENCE THEORY

Feminist science theory refers to an interdisciplinary field of study that applies feminist perspectives to the philosophy and practice of science. It critically examines how gender influences the production of scientific knowledge, the methods employed in scientific inquiry, and the representation of gender within scientific disciplines (Bluhm, 2015).

3.3.1 Aspects of feminist science theory

3.3.1.1 Representation of women:

Feminist science theory critically addresses the underrepresentation of women in scientific fields, emphasising the multifaceted challenges they face due to gender stereotypes and systemic barriers (Llorens, 2021). The concern extends beyond numerical imbalances, encompassing societal expectations, biases, and obstacles hindering women's full participation in science. From early education to professional settings, gender stereotypes subtly influence career choices and perceptions of women's suitability for specific roles (Tabassum, & Nayak, 2021). In academia, glass ceilings impede women's progress, limiting access to leadership roles (Chisholm-Burns, Spivey, Hagemann, & Josephson, 2017). Feminist scrutiny also extends to the undervaluation of women's contributions, perpetuating a cycle of underrepresentation. Advocating for systemic changes, feminist science theorists call for dismantling stereotypes

(Buchanan, & Wiklund, 2021), implementing inclusive policies (Hudson, & Rönnblom, 2020), and fostering equitable environments (Resurrección, & Elmhirst, 2020) to ensure a more representative and supportive scientific community.

3.3.1.2 Gendered language and imagery:

Feminist science theory critically examines gendered language and imagery in scientific communication, highlighting their role in reinforcing gender norms and excluding women from scientific narratives (Solbes-Canales, Valverde-Montesino, & Herranz-Hernández, 2020). The analysis extends to linguistic biases, particularly the default use of masculine pronouns (Stormbom, 2024), which can marginalise women in scientific discourse. Gendered metaphors are also scrutinised for perpetuating stereotypes about gender roles and abilities. In addition, feminist science theorists address visual representations, emphasising the need for more diverse and accurate depictions of women in scientific illustrations to challenge limiting stereotypes (Santoniccolo, Trombetta, Paradiso & Rollè, 2023). The call is for inclusive and neutral language, challenging default masculine terms, and promoting alternatives that do not perpetuate gender biases. This critical examination aims to transform the culture of scientific communication, fostering inclusivity and reflecting the diverse contributions of scientists regardless of gender.

3.3.1.3 Ethics of scientific research:

Feminist science theory emphasises the ethical dimensions of scientific research, with a focus on addressing gender-based discrimination and preventing harm or inequalities (Jaggar, 2013). It acknowledges the potential for research to perpetuate gender biases and calls for intentional, inclusive approaches that consider the impact on all genders. Ethical considerations extend to dissecting research methodologies to avoid reinforcing stereotypes and marginalisation (Oladoyinbo, Olabanji, Olaniyi, Adebisi, Okunleye, & Alao, 2024). Transparency and reflexivity are promoted, urging researchers to

acknowledge biases and power dynamics. In human subject research, obtaining informed consent and treating participants with dignity are highlighted (Fleming & Zegwaard, 2018). Beyond individual projects, feminist science theory encourages scholars to consider societal implications, fostering collaboration and ensuring research benefits all genders. In summary, it advocates for an ethical and socially responsible scientific enterprise committed to dismantling discriminatory practices and promoting inclusivity (Resnik & Elliott, 2016).

3.3.1.4 Intersectionality in science:

Intersectionality in science, within feminist science theory, acknowledges the intricate interplay of social categories like race, class, sexuality, and gender in scientific practices (Bauer, Churchill, Mahendran, Walwyn, Lizotte & Villa-Rueda, 2021). Stemming from Kimberlé Crenshaw's broader concept, it emphasises the need to understand and address the complexity of social identities (Fehrenbacher & Patel, 2020). In the scientific domain, intersectionality challenges simplistic views of gender, recognising that individuals' experiences are shaped by the convergence of multiple factors (Baylor, Bamer, Brown, Jin, Teixeira, & Nuara, 2024). It is vital for examining diverse experiences within the scientific community, especially for individuals facing intersecting challenges, such as women of colour. In research, it prompts a re-evaluation of methodologies to capture diverse perspectives and challenges the notion of a universal scientific perspective, advocating for inclusivity. Intersectionality extends to analysing institutional structures, revealing how systemic inequalities intersect and create barriers within scientific institutions (Jackson, Mohr & Kindahl, 2021). Overall, integrating intersectionality in feminist science theory aims for a more equitable and inclusive scientific community, enhancing our understanding of complex dynamics and promoting diversity in scientific knowledge.

3.3.1.5 Feminist methodologies:

Feminist methodologies in feminist science theory represent a transformative shift in research, prioritising inclusivity and collaboration to address historical biases (Parry, 2020). Participatory research involves active engagement with participants, challenging traditional hierarchical structures (Roura, 2021). Feminist ethnography delves into lived experiences through immersive fieldwork and qualitative methods (Schrock, 2013). Collaborative research fosters partnerships with community members, recognising their unique insights (Linabary, Corple, Cooky, 2021). Intersectional analyses consider how social categories intersect, providing a comprehensive understanding of individuals' experiences (Misra, Curington, & Green, 2021). These methodologies challenge traditional objectivity, emphasising reflexivity to mitigate biases. By advocating for these approaches, feminist scientists contribute to a more inclusive and equitable research landscape, amplifying voices historically marginalised in scientific inquiry and promoting social justice.

3.3.1.6 Science, technology, and society (STS):

The intersection of feminist science theory with Science, Technology, and Society (STS) offers an interdisciplinary perspective on the complex relationship between science, technology, culture, and gender (Grzanka, Brian, & Bhatia, 2023). It emphasises that scientific and technological practices are embedded in societal contexts, shaping and being shaped by gender norms. Scholars explore how gender biases affect technological design (Wellner, & Rothman, 2020), influence the adoption of technologies, and contribute to ethical considerations (Feine, Gnewuch, Morana, & Maedche, 2020). The intersectional lens considers gender in conjunction with other social categories, promoting a nuanced understanding of the impact of scientific and technological advancements on diverse identities (Tavener et al., 2022). This interdisciplinary approach fosters discussions on inclusivity, challenges historical biases, and envisions a more equitable future in science and technology.

3.4 PHILOSOPHERS AGAINST FEMINIST SCIENCE THEORY

While feminist science theory has gained acceptance and prominence in various academic and intellectual circles, there are individuals, including some philosophers, who hold opposing views or critiques of certain aspects of feminist science theory. It's important to note that these critiques are not necessarily uniform, and perspectives may vary among critics. Some common points of critique include:

3.4.1 Epistemic concerns

Epistemic concerns raised by critics pose a significant challenge to feminist science theory, particularly regarding the potential impact on the objective pursuit of knowledge (Mungwini, 2018). Critics, emphasising the pivotal role of objectivity in scientific research, fear that incorporating feminist perspectives might introduce subjective biases, thereby jeopardising the reliability and neutrality of scientific inquiry. The critique extends to the neutrality of scientific investigation, with traditional views advocating for detachment from societal or ideological influences (Stefanidou & Skordoulis, 2014). Sceptics argue that feminist perspectives could introduce ideological considerations, potentially diverting focus from an unbiased examination of empirical evidence. Concerns also arise about the potential for biased interpretation of data, as critics worry that embracing feminist viewpoints might lead to selective interpretations that align with preconceived gender-related theories, risking confirmation bias (Munro, 2021). Moreover, critics may question the rigor and reliability of alternative methodologies proposed by feminist scholars, expressing doubts about the validity of knowledge produced through participatory research or feminist ethnography. Some also fear an overemphasis on the social construction of gender within feminist science theory, which could limit the scope of analyses by downplaying biological or essentialist perspectives on gender differences. Proponents of feminist science theory argue that these concerns can be addressed through careful reflexivity, transparency, and a commitment

to rigorous research practices, asserting that acknowledging the situatedness of scientific inquiry can enhance, rather than compromise, the pursuit of knowledge (Ferguson, 2017). The researcher believes that the context of scientific inquiry can augment the understanding of the experiences of female learners in Physical Sciences in their grade 12 theory and practical classes. This ongoing debate reflects broader discussions about the nature and goals of scientific inquiry, emphasising the need to balance objectivity with inclusivity and the acknowledgment of multiple perspectives.

3.4.2 Methodological criticisms

Methodological criticisms of feminist science theory revolve around concerns that the alternative research methodologies it proposes may be perceived as less rigorous or objective compared to traditional scientific methods (Kivunja & Kuyini, 2017). Critics engage in a debate about the compatibility of qualitative, participatory, or feminist ethnographic approaches with established scientific standards, particularly emphasising the rigidity of scientific criteria associated with quantitative research and experimental design (Kaushik & Walsh, 2019). The tension between quantitative and qualitative research methods is a central theme, with critics prioritising precision and generalisability and viewing qualitative methods as potentially less objective due to their reliance on interpretation and subjectivity. Challenges to objectivity arise as traditional scientific methods aim for researcher detachment, leading critics to worry that alternative methodologies may compromise this objectivity by involving a more engaged or participatory role for the researcher (Kowalski, Redman, & Mrdjenovich, 2024). Doubts about replicability and generalisability of findings from alternative methodologies and concerns about potential advocacy within feminist science research are also expressed. Proponents of feminist science theory respond by emphasising the strengths of alternative methodologies, highlighting their ability to offer valuable insights into lived experiences, complex social phenomena, and power dynamics often overlooked by quantitative methods (Benschop, 2021). The valuable insights into the lived experiences

will come in handy for the current study as the focus is on the lived experiences of female learners in their grade 12 Physical Sciences theory and practical class. They stress the importance of transparency, reflexivity, and rigor to address concerns about subjectivity and bias. In essence, the methodological critique reflects a broader tension within the philosophy of science, fostering ongoing discussions about the epistemic value of different research approaches and the criteria used to define and assess scientific rigor and objectivity.

3.4.3 Concerns about essentialism

Concerns about essentialism critique certain feminist theories within feminist science theory, arguing that they risk oversimplifying gender to fixed, innate characteristics (Brown & Ismail, 2019). Critics caution against universalising women's experiences, emphasising the need to recognise the diversity among women to avoid reinforcing stereotypes and neglecting individual differences (Casad & Bryant, 2016). Essentialist perspectives may neglect intersectionality, overlooking how various social categories intersect with gender and resulting in a one-dimensional understanding of women's experiences. The reinforcement of traditional gender stereotypes is another concern, limiting possibilities for individual self-expression and reinforcing societal expectations (Ward & Grower, 2020). The critique underscores the importance of recognising and celebrating diversity within the category of "women" to avoid a narrow view of womanhood. Essentialist views may also lead to potential exclusion, marginalising those whose experiences do not align with assumed norms. Proponents of feminist science theory respond by advocating for approaches that embrace a nuanced, intersectional understanding of gender, moving away from essentialist perspectives to contribute to a more inclusive and expansive view of gender within feminist theory and research (Carbado & Harris, 2019).

3.4.4 Political critiques

Political critiques of feminist science theory revolve around concerns that it injects ideological considerations into scientific practice, potentially compromising the pursuit of objective truth and the autonomy of scientific disciplines (Harding, 2013). Critics worry that incorporating feminist perspectives may introduce bias and political goals, influencing research questions, data interpretation, and findings dissemination. This critique reflects debates about the role of ideology in scientific inquiry, with concerns about the impact on the objectivity and value neutrality of science (Maynard & Purvis, 2013). Proponents of feminist science theory respond by advocating for transparency and reflexivity, acknowledging the inherent influence of values in scientific inquiry (Lear, & Mackenzie, 2024; Macharia, 2024). They argue that making values explicit and incorporating diverse perspectives can enhance the scientific enterprise by addressing historical biases and political goals, and enriching research (Schönwitz, 2022). The ongoing dialogue reflects broader discussions about the nature and societal roles of scientific inquiry, navigating the tension between objectivity and the socially situated nature of scientific practice.

3.4.5 Resistance to activism in science

Resistance to the fusion of activism and science within Feminist Science Theory stems from the belief that scientific enquiry should prioritise objective investigation over advocacy or social change. Garcia-Gibson (2023) expresses concern about potential biases, the autonomy of scientific disciplines, and a perceived departure from traditional scientific norms. They worry that activism may compromise objectivity, prioritise ideological goals, and shift the focus from empirical discovery to advancing specific social or political agendas (Kaushik & Walsh, 2019). This resistance also involves fears of biased research outcomes and the politicisation of scientific research (Rehman et al., 2021). Proponents of activism in feminist science theory argue for the transformative potential of integrating science and advocacy, emphasising the acknowledgment of science's inherent values. They contend that activism allows researchers to

address inequalities, challenge oppressive structures, and contribute to social change (Ramasubramanian, & Sousa, 2021). Advocates stress transparency, reflexivity, and ethical considerations to ensure the rigor and integrity of activist science, engaging in a broader discussion about the role of science in society and researchers' responsibilities in promoting positive social change.

3.4.6 Biological determinism

Some philosophers, adhering to a traditional stance, argue that gender differences have innate roots, challenging social constructionist views that attribute variations solely to societal influences (Chaplin, 2015). Critics resist a perceived "blank slate" assumption, asserting that recognising biological factors doesn't negate the importance of societal influences on gender. The debate on nature versus nurture is central, with critics advocating for a balanced consideration of both. Concerns about political implications arise, as some fear that strong social constructionist views may align with certain ideologies, influencing policies and societal norms (Burr, 2015). Proponents of social constructionist views in feminist science theory emphasise the complex interplay between biology and society in shaping gender, advocating for a nuanced understanding that addresses gender-based inequalities and stereotypes (Jewkes et al., 2015). The ongoing philosophical debate reflects broader discussions on the nature of gender and its intricate connections to biology, culture, and societal norms.

3.5 PHILOSOPHERS SUPPORTING FEMINIST SCIENCE THEORY

Numerous philosophers and scholars support feminist science theory, recognising its contributions to addressing gender biases, promoting inclusivity, and enriching the understanding of scientific practices. Some of the notable philosophers who have expressed support for or engaged with feminist science theory include, but are not limited to:

Sandra Harding, born in 1935, has played a pivotal role in shaping feminist epistemology and feminist science studies. As a philosopher of science, she has critically examined the influence of gender on knowledge production, challenging traditional notions of objectivity and neutrality (Harding, 1986). Harding has been a proponent of Feminist Science Theory, asserting that individuals from marginalised groups offer unique perspectives that unveil hidden power dynamics in society. Her concept of "strong objectivity" emphasises the importance of situated knowledge and the incorporation of diverse perspectives to strengthen the objectivity of scientific inquiry (Guzman, 2018). Harding's contributions extend to feminist science studies, where she explores the impact of gender, race, and social factors on scientific knowledge (Harding, 2001). Engaging with postcolonial feminism, she advocates for decolonising knowledge and challenging Eurocentric perspectives. Harding critiques dualistic thinking in science, highlighting its role in marginalising certain groups, and consistently promotes diversity and inclusivity in scientific research. Her work continues to shape discussions on feminist philosophy of science, fostering a more inclusive and socially aware approach to understanding the complexities of knowledge production (Harding, 2013).

Donna Haraway, born in 1944, has significantly shaped feminist theory and the philosophy of science through her ground-breaking contributions. Her influential essay "A Cyborg Manifesto" introduced the concept of the cyborg as a metaphor to challenge fixed identities and disrupt conventional categories, particularly those related to gender and technology (Haraway, 2013). Haraway's rejection of essentialist thinking emphasises the fluidity of identity, advocating for a nuanced understanding that considers the intersections of various social, technological, and biological factors. The cyborg, in her work, represents a hybrid identity that blurs boundaries between humans and machines, nature and culture. Haraway's exploration of intersectionality acknowledges the complex interplay of gender, race, class, and technology in shaping individuals' experiences (Haraway & Goodeve, 2018). In her "Companion Species Manifesto," she delves into human-animal relationships, challenging

anthropocentric perspectives. Haraway's contributions extend to techno feminism, encouraging a critical engagement with technology and envisioning its potential for empowerment. Her concept of material semiotics emphasises the inseparability of materiality and meaning, challenging dualistic thinking (Haraway, 2016). Haraway's ideas also influence discussions on post-humanism and post-genderism, envisioning a future where traditional categories are destabilised, offering new possibilities for self-determination (Haraway, 2013). Overall, Donna Haraway's work transcends disciplinary boundaries, reshaping how scholars and activists approach questions of gender, technology, and social justice with an emphasis on complexity and the reimagining of identities.

Helen Longino, born in 1944, is a distinguished philosopher of science renowned for her contributions to social epistemology and feminist perspectives in the philosophy of science (Longino, 2017). Central to her work is the development of contextual empiricism, challenging the notion that scientific knowledge solely derives from empirical evidence by emphasising the influence of broader social contexts on scientific practices. Longino has been a leading figure in social epistemology, exploring how collective processes and social interactions contribute to knowledge production in scientific communities (Sheykhrezaee, & Bikaraan-Behesht, 2020). Engaging with feminist philosophy of science, she critically examines objectivity, addressing gender biases and societal influences on scientific inquiry. Longino advocates for diverse perspectives and a sense of community in science, asserting their importance for robust and socially responsible knowledge production (Stephenson, 2022). Emphasising democratic values, she promotes transparency, inclusivity, and participatory practices within scientific communities, shaping a more inclusive and socially aware approach to understanding knowledge production (Longino, 2017).

Nancy Tuana, a distinguished philosopher, has made substantial contributions to feminist epistemology and philosophy of science. Her work challenges

traditional epistemological frameworks by examining how gender biases influence knowledge production in scientific practices (Tuana, 2018). Tuana extends her exploration to values in science, emphasising the pivotal role values play in shaping research questions and interpreting data. Ethical considerations in scientific research are another focus, with scrutiny on the treatment of subjects and the broader social responsibilities of scientists. Tuana advocates reflexivity, urging scientists to critically reflect on biases throughout the research process (Tuana, & Sullivan, 2006). She underscores the significance of social contexts in knowledge production, exploring how power dynamics related to gender and other social categories impact scientific understanding. Tuana also engages with intersectionality, recognising the intersecting influences of gender, race, and class on scientific practices. Beyond feminist epistemology, her contributions extend to environmental ethics, examining ethical dimensions of climate change, and the philosophy of embodiment, challenging abstract conceptions of scientific inquiry (Velez & Tuana, 2020). Tuana's interdisciplinary approach has enriched our understanding of the complex interplay between values, ethics, and gender in scientific knowledge production, influencing discussions in the philosophy of science and related fields (Tuana, 2018).

Londa Schiebinger, a prominent historian and philosopher of science, has made significant contributions to the understanding of gender, science, and technology intersections (Mendick, 2011). Renowned for her work on "gendered innovations," Schiebinger advocates for integrating gender analysis into scientific research and technological advancements. Her historical perspectives reveal how cultural norms have shaped gender biases in scientific practices. In the realm of feminist philosophy of science, Schiebinger challenges traditional notions of objectivity, emphasising the need to address biases in scientific practices. Her research delves into the experiences of women in science, contributing to a comprehensive understanding of gender's role in shaping the scientific enterprise (Risi et al., 2022). Engaging with techno-feminism, Schiebinger explores the impact of technological advancements on

gender roles. Additionally, she investigates the gendered dimensions of medicine, highlighting biases in medical research and healthcare (Schiebinger, 2020). Taking a global perspective, her work extends beyond Eurocentrism, examining gender biases in diverse cultural contexts. With policy implications, Schiebinger advocates gender analysis in science and technology policies, promoting more equitable and inclusive outcomes. Her interdisciplinary approach, incorporating history, philosophy, and feminist theory, encourages a reflective and inclusive approach to scientific inquiry and technological development (Schiebinger, & Schraudner, 2013).

Karen Barad, a distinguished feminist theorist and physicist, has significantly influenced feminist philosophy of science and post humanist perspectives. Central to her work is the concept of agential realism, proposing a relational ontology that challenges dualisms between the material and the discursive (Barad, 2012). Agential realism emphasises the inseparability of the material world and discursive practices, highlighting the entanglement of matter and meaning in knowledge construction (Zavota, 2018). Barad introduces "intra-action" to underscore the dynamic interrelation between entities, emphasising their mutual constitution. Her post humanist approach challenges anthropocentric views, recognising the distributed agency across the material-discursive world. In feminist philosophy of science, Barad addresses the influence of gender and social categories on scientific practices, advocating for a more inclusive and reflexive scientific inquiry (Barad, 2012). She introduces diffraction as a methodology to analyse patterns of difference in scientific practices, and her work explores the materialisation of discourse, emphasising the real effects of language on the world. Agential realism has ethical implications, prompting a consideration of the responsibilities tied to recognising entanglement (Zavota, 2018). Barad critically engages with quantum physics, integrating quantum principles into her philosophical framework and reshaping discussions on agency, entanglement, and observation in scientific practices (de Freitas, Walshaw, & de Freitas, 2016). Overall, Karen Barad's contributions encourage a re-evaluation of dualisms, a

nuanced understanding of entanglement, and ethical reflections in the complex interplay of the material and the discursive in scientific endeavours.

3.6 DIFFERENT FEMINIST THEORIES

Feminist theory is a diverse and multidisciplinary field that encompasses a range of perspectives, each with its own focus and approach to understanding and addressing gender-based inequalities. Some key feminist theories include the following:

3.6.1 Liberal feminism

Liberal feminism, originating in the late 19th and early 20th centuries, aims to achieve gender equality through legal and political means within existing socio-political structures (Enyew & Mihrete, 2018). It asserts equal rights, opportunities, and liberties for individuals regardless of gender. Focused on legal and political reforms, liberal feminists work within democratic institutions to eliminate discriminatory practices and policies perpetuating gender inequality (Baehr, 2017). Key ideas include advocating for equal pay, reproductive rights, legal reforms in family and property laws, gender equality in education and the workplace, and protection against gender-based violence (Enyew & Mihrete, 2018). While criticised for not addressing deeper systemic issues, liberal feminism emphasises pragmatic and incremental changes as essential steps toward dismantling gender-based discrimination and ensuring women's fundamental human rights.

3.6.2 Radical feminism

Radical feminism, emerging during the second wave of feminism, uniquely challenges patriarchy as the root cause of women's oppression. Unlike other feminist perspectives, radical feminists aim not for reform but the complete dismantling of the patriarchal system (Mackay, 2015). Key ideas involve a

thorough critique of patriarchy's systemic nature, advocating for women-only spaces to foster collective consciousness and strategies for change, and analysing gender as a pervasive system of power Rowland & Klein, 2013). The focus is on restructuring societal foundations to eradicate entrenched power imbalances and achieve genuine gender equality.

3.6.3 Cultural feminism

Cultural feminism, emerging in the 1960s and 1970s, celebrates and promotes traditionally feminine qualities, aiming to establish a distinct "women's culture." Unlike other feminist perspectives, it focuses on affirming, rather than challenging, these qualities, including empathy and cooperation (Vasavada, 2012). Cultural feminists envision a society that values and celebrates women's unique contributions, emphasising women's spirituality and advocating for a women-centered society. The approach diverges from confrontational critiques, instead seeking to create spaces where traditionally feminine attributes are acknowledged and celebrated, contributing to a more inclusive feminist discourse (Ko & Ko, 2017).

3.6.4 Black feminism

Black feminism, emerging during the second wave of feminism, focuses on the intersectionality of race, gender, and class. It introduces the concept of intersectionality, emphasising the interconnected nature of these social categories and highlighting the unique struggles faced by women of colour. Black feminism critiques mainstream feminism for often overlooking the diverse forms of oppression experienced by women of colour and advocates for centering their experiences and voices in feminist discourse. This approach challenges the limitations of a singular lens and contributes to a more inclusive and intersectional understanding of women's oppression.

3.6.5 Postcolonial feminism

Postcolonial feminism, situated at the intersection of gender studies, postcolonial theory, and feminism, critically examines the interplay between gender oppression and colonialism/imperialism (Love, 2016). Focused on challenging Western-centric perspectives, it seeks to decolonise feminist discourse by amplifying marginalised voices, embracing intersectionality, deconstructing colonial narratives, and recognising the unique challenges faced by women in postcolonial societies (Taylor, 2017). Postcolonial feminism aims to create a more inclusive and globally aware feminist understanding by dismantling hierarchies perpetuated by colonial legacies (Steele, 2021).

3.6.6 Queer feminism

Queer feminism, at the intersection of feminist theory and queer studies, challenges heteronormativity and emphasises the interplay between gender and sexual identities (Marinucci, 2016). Key ideas include a critique of heteronormativity, active inclusion of LGBTQ+ perspectives, and recognition of diverse sexualities and gender expressions. Queer feminism aims to create an inclusive feminist framework that embraces the diversity of gender and sexual identities, challenging normative assumptions (Wiegman, 2014; De las Heras Gómez, 2019).

3.6.7 Ecofeminism

Ecofeminism, at the intersection of environmentalism and feminism, explores the interconnectedness of the oppression of women and the exploitation of the environment (Puleo, 2017). Key ideas include recognising the intersection of gender and environmental issues, critiquing capitalist exploitation, and advocating for sustainable and equitable practices. Ecofeminism challenges compartmentalisation, emphasising the need for a holistic approach to address the root causes of both environmental degradation and gender oppression

(Phillips & Rumens, 2015).

3.7 SUMMARY

This chapter discussed the feminist theory which guided this study. In brief, feminist theory is a dynamic and interdisciplinary field dedicated to understanding and addressing gender-based inequalities. Key facets include an analysis of gender inequality, acknowledgment of intersectionality, and a commitment to activism. The field encompasses various strands, such as liberal feminism, radical feminism, cultural feminism, black feminism, postcolonial feminism, queer feminism, and ecofeminism, each offering unique perspectives on gender issues. Feminist science theory extends this inquiry into the realm of science, critically examining how gender influences scientific knowledge production, methods, and representation. While some philosophers raise epistemic concerns and methodological criticisms, supporters like Sandra Harding, Donna Haraway, Helen Longino, Nancy Tuana, Londa Schiebinger, and Karen Barad advocate for inclusive and reflexive approaches in scientific inquiry. The diverse feminist theories collectively contribute to a richer understanding of gender dynamics including experiences of females, fostering inclusivity, and promoting social justice. The next chapter discusses the research methodology in detail. Starting from the research approach, design, data collection, data analysis, quality criteria and ethical considerations for the study.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 INTRODUCTION

The preceding chapter covered the theoretical framework that acted as the guiding framework for this study. In this chapter, the focus is on the research methodology that was implemented to answer the research questions of this study. The primary goal of this chapter is to offer a thorough comprehension of the approach, design, data collection, data analysis, quality criteria and ethical considerations for this study. It seeks to provide insights into the strategies used to address the research objectives as outlined in Chapter One.

4.2 RESEARCH PARADIGM

The study is located within an interpretive (Cohen, Manion, & Morrison 2018). They make meaning out of what the participant says with their own words. Subjectivism affirms that “reality is our perceptions, experiences and feelings” (Ryan, 2018). The researcher was on the right track by asking female learners how they perceive their experience to be in their theory and practical classes. Interpretivism values subjectivity as compared to positivism (Ryan, 2018). The researcher allowed the study to be subjective so that she could understand and equally document the experiences of female learners as they were in their Physical Sciences theory and practical classes.

4.3 RESEARCH APPROACH

In this study, a qualitative research method was employed. Grove, Gray, and Burns (2015) define qualitative research as a methodological approach that involves delving into the depth and context of a phenomenon without relying on numerical quantification. Some researchers critique qualitative research because it is subjective and susceptible to bias (Gillani, 2021). However, the researcher needed the subjective nature of the qualitative research to get to the aims of this study. By adopting a qualitative method, she had the opportunity to

thoroughly explore the experiences of female learners engaged in the learning of Physical Sciences in grade 12. This approach facilitated a nuanced understanding of the unique perspectives, challenges, and insights these learners encountered, providing a rich and detailed exploration of their educational journey in the specific domain of Physical Sciences.

Through qualitative methods such as observation, interviews and document reviews, the researcher aimed to capture the multifaceted aspects of the female learners' experiences, contributing to a comprehensive and contextually grounded analysis.

4.4 RESEARCH DESIGN

Creswell (2009) defines a research design as a comprehensive blueprint for data collection in a research study. In the present study, a phenomenological research design was chosen. Phenomenological research is characterised as an exploratory design that seeks to comprehend the unique experiences of a specific population (Nazari et al., 2018). This design was deemed suitable for the study because it helped me to delve deep into the distinct experiences of female learners. It also allowed me to gain profound insights into the lived experiences of female learners, shedding more light on their perspectives within the classroom setting.

Specifically, the study aimed to explore the experiences of female learners in their theory and practical classes in the learning environment of Physical Sciences. The first-hand experience of the female learners provided valuable information to discern whether the overarching goals of equity and equality set forth by the Department of Education were being realised (van Staden, 2021). Phenomenology focuses on the interpretation and exploration of people's experiences. The phenomenological research design, with its emphasis on exploring individual experiences, was instrumental in uncovering the nuanced aspects of the learners' perceptions and positions within the educational landscape, especially the biased texts in the curriculum. Phenomenological

research design allowed me to listen to the voices of female learners in their context, without any influence. Hence, the choice of the design facilitated a deeper understanding of the experiences of female learners in their theory and practical classes.

4.5 STUDY SETTING

A study setting refers to the physical, social, or organisational context in which a research study is conducted. It encompasses the specific location or environment where data collection occurs and where the participants or subjects involved in the study are situated (Houben, McCaffrey, Tiemersma, & Khan, 2024). In this study, the research was carried out within the schools in the Capricorn South District of Limpopo Province, South Africa. This educational setting was chosen deliberately as it offered a rich context for examining the experiences of learners, particularly female learners, in the field of Physical Science education. The schools within the Capricorn District were identified for their provision of Physical Science education to a diverse group of learners, with a specific focus on the experiences of female learners. The Capricorn District houses some of the most diverse schools, from quintile 1 to 5 in the government sector, to private schools, and also to religious schools. The quintile system is used in South Africa as a tool to redress the injustices of the now-abolished Apartheid system (Adams, 2020). As former white-only schools or model-C schools have an advantage of resources from the Apartheid era, they fall under quintile four and five, where they are permitted by law to collect school fees (Radebe, 2015). Quintile one schools are located in the most socio-economically disadvantaged areas, where the majority of parents are unemployed and the schools are located far from economic development hubs such as shopping centres (Bayat, Louw & Rena, 2014). Quintile two schools are also located in socio-economically disadvantaged areas, but better than those of quintile one. Quintile three schools are better resourced than those in quintile one and two but are mostly accommodating learners from disadvantaged areas. Quintiles one, two and three are not permitted by law to charge schools fees to

learners, although, the School Governing bodies (SGB) of those schools are allowed to source out funds in any other way. All the schools falling under quintile one to five receive government money to assist with the everyday running of the school. The South African government allocates a provisioned amount of money per learner to schools in quintile five to one (Mestry & Ndhlovu, 2014). Quintile one schools receive more funding per learner than all the other quintiles, with quintile 5 receiving the least funding. Four schools were selected for the study.

The first school was a Christian private school situated in the rural areas. Private schools are independent, they do not rely on the government for funding. Another school was situated in the deep rural areas, it is a quintile 2 public non-fee-paying school with a small enrolment. The third school was situated in town, it is a formerly Indians only school during the Apartheid era. It has a large enrolment of 1591 learners in the year 2023. The school is now a quintile 5 public fee-paying school. The last school was situated in the rural areas, a quintile 2 public non-fee-paying school. This was done to get rich data, as the first school with the same description did not manage to provide the researcher with data saturation from such a school. The focus was on female Physical Science learners who could provide valuable insights into the experiences faced by female learners.

4.6 POPULATION AND SAMPLING

According to Brink, Van der Walt, and Van Rensburg (2012), a population is a comprehensive group of individuals or objects sharing common characteristics that are of interest to the researcher. In this study, the population comprised female learners enrolled in Physical Sciences within the schools of the Capricorn District.

Sampling involves selecting a subset from a larger population for research purposes. For this study, purposive sampling, a non-random technique where participants are deliberately chosen based on specific criteria, was utilised.

Purposive sampling is a type of non-probability method used in qualitative research (Wowling, Yusuf, Gampu, & Sahala, 2024). This approach allowed me to target both rural and urban areas. Four schools were selected.

The researcher requested the teachers to assist with the distribution of parental consent forms and with the collection of the forms from the female learners. Learners were recruited from Physical Sciences classes, with the assistance of the Physical Sciences teacher. Purposive sampling was utilised, with one female top performer, one average performer and one bottom performer selected. Observation slots were requested from the school principals, with the finalisation from the Physical Sciences teachers based on the time their learners would be free. The sample size in this study was determined by data saturation, a point in qualitative research where new data ceases to provide additional insights. Data saturation was achieved when the collected data became repetitive and no further meaningful information was gained. In this study, data saturation occurred at female learner number twelve and school number four.

Inclusion criteria

- Female learners currently enrolled in Grade 12 Physical Sciences classes in Capricorn District, Limpopo Province.
- Female learners who are willing to share their experiences, perspectives, advantages, and challenges related to their Grade 12 Physical Sciences education.

Exclusion criteria

- Female learners not enrolled in Grade 12 Physical Sciences classes in the Capricorn District, Limpopo Province.
- Female learners unwilling or unable to share their experiences regarding Grade 12 Physical Sciences education.

4.7 DATA COLLECTION

Data collection is the systematic process of gathering, measuring, or obtaining information from various sources for the purpose of research or study (Brink et al., 2018). It involves the use of specific methods, tools, and techniques to collect relevant and accurate data that can be analysed to derive meaningful insights, draw conclusions, or answer research questions. The data collection process is discussed according to recruitment, procedure and data collection tool. Data was collected through one-on-one open-ended interviews, document analysis and observation.

4.7.1 Observations

Both the theory and practical classes of Physical Sciences were observed over the data collection period. However, the practical class was conducted in the normal theory class setting in all the four schools. The reason behind practical classes being conducted in the theory classes was because of the lack of laboratories in the four schools visited. The schools in the rural areas mentioned that they never owned a laboratory class since the inception of the schools. While the school from the urban area did have a laboratory, it needed renovations. Also, a stock up of replenished chemicals and breakable apparatus was needed. The private school from the rural area had a mobile laboratory that needed the replenishing of chemicals and breakable apparatus too. During the observations, the researcher was seated before classes commenced, documenting the proceedings using a notepad and pen. It was easier to be seated in class before learners could come in because learners had to leave classes with compulsory subjects to come to Physical Sciences class. They switched classes.

The researcher acted as a non-participant observer as she wanted to be present in the classroom but not be part of the class (Busetto, Wick, & Gumbinger, 2020). The researcher having been a Physical Sciences learner before, utilised

observation to grasp the learning atmosphere for female learners. The class environment was noted, the class ambiance was noted and the general participation of learners by gender. The conduct of the teachers was also noted with a clear focus on the communication between the teachers and learners. The theory and practical classes added on data collected to be analysed. Additionally, one-on-one interviews were conducted with participants.

4.7.2 Interviews

An interview is defined as a social endeavour where two or more people actively communicate, together creating knowledge about themselves and the social world as they interact with each other over time and in a certain habitation (Sparkes, & Smith, 2014). Open-ended interviews were utilised, they are defined as an exploratory interview (Ruslin, Mashuri, Rasak, Alhabsyi, & Syam, 2022). Moreover, it is an interview where one can get in depth understanding of the experiences of female learners. Most interviews were conducted at the school premises, in a quiet secluded place. At three schools, One-on-One open-ended interviews were conducted with no issues. However, in one school, grade 12 learners were said to be extremely busy, and they could not allocate more than 2 hours to researchers. The researcher then opted for focus group interviews to save and respect the school's decision to allocate only 2 hours for the interviews per researcher in an academic year. Hence, there was a focus group for female learners.

A focus group interview is the interaction of the participants with the data collector for data generation (McLafferty, 2004). The participants in the focus group were chosen, with the assistance of the teacher, because they would be able to talk to the researcher and to each other freely (Rabiee, 2004.) They were also good candidates as they had information on the experiences of female learners in the Physical Sciences theory and practical classes.

A voice recording tool was utilised to capture the responses of all participants, along with a backup sound recording application from a cell phone. Participants

were informed about the recording process, ensuring transparency in data collection. To put them at ease, participants were given an explanation as to why there were two voice recorders in use. The interviews took place in English and Sepedi, the dominant languages in the area. Data analysis preceded further data collection. Interviews, as per Hamilton and Bowers (2006), allowed all participants to contribute to data adequacy, offering a comprehensive understanding of the experiences of female Physical Sciences learners (Natow, 2020). Focus group interviews with homogenous participants allowed for a widespread understanding of the experiences of female Physical Sciences learners (Acocella, 2012).

4.7.3 Document analysis

The four schools provided needed documents for document review. Documents are written records that are kept by the participants or an organisation. Cohen, (2006) states that documents may be internal to a program or organisation or may be external to a program or organisation. Moreover, documents may be in hard copy or in electronic format in a cloud storage (Manthiramoorthy, & Khan, 2024). Documents may also be in a form of recorded staff meetings that was held virtually (Carradini, Getchell, Cardon, Fleischmann, Aritz, & Stapp, 2024). Data was retrieved from learner scripts, question paper, annual teaching plan (ATP) and learner books. Consequently, data was retrieved from documents to argument the data collection instruments for the study. Data collection persisted until reaching saturation, which is a point during the data collection process whereby no new data is emerging from the participants (Alam, 2021).

Data collection continued until redundancy occurred or new insights ceased to emerge, signifying theoretical completeness. Interviews were conducted in quiet school rooms or spaces arranged before ensuring privacy despite external noise. Probing during interviews was based on participant responses. The researcher-maintained flexibility, empathy, and objectivity, fostering an environment for participants to freely share experiences. Active listening

encouraged uninterrupted sharing, with minimal researcher remarks to promote participant input. Techniques like bracketing, intuition, and reflective remarks were employed to ensure unbiased engagement. Document review was done until no new data emerged from them.

4.8 DATA ANALYSIS

Data analysis involved inspecting, cleaning, transforming, and modeling data to unearth valuable information, draw conclusions, and support decision-making. Before the analysis, all interviews were transcribed. Data collected from interviews, observations, and document reviews underwent qualitative analysis using Tesch's open coding method, consisting of eight steps, as outlined by Creswell (2014). The data analysis process unfolded as follows:

- Transcriptions of the recorded interviews were read to get a sense of the content of each interview session.
- After the completion of all transcripts, a list of comparable topics was assembled.
- Data was gathered according to theme and sub-themes.
- Field notes were coded and categorised.
- A full summary of the developed themes and sub-themes was generated.

4.9 QUALITY CRITERIA

Trustworthiness is a concept in qualitative research which means that the study findings in question are proper and justified (Peels, & Bouter, 2023). Simply put, the findings are worthy of trust. When the findings come from a trusted author, that does not mean the findings can be trustworthy. Additionally, trustworthiness concerns itself with the development and implementation of policies and frameworks (Ahmed, 2024). The researcher ensured trustworthiness by not allowing my own experiences to steer responses from participants. I also went back to the schools to show them my transcripts and requested them to confirm with me if the transcribed words were what they meant or not. Moreover,

trustworthiness was ensured by getting an external analyser to analyse the data for the second time, after the researcher had analysed it. Trustworthiness is also increased by evidence for validity (Rose, & Johnson, 2020). It was maintained by ensuring that the research findings were credible, transferable, confirmable, and dependable (Mays & Pope, 2000). The following criteria were implemented:

4.9.1 Transferability

Transferability means that if the same research was done on the same participants, in the same way and under the same conditions, the findings will be the same as the current findings (Ghafouri, & Ofoghi, 2016). And it also means that the current findings should be usable in future research (Duong-Trung, Quach, & Nguyen, 2019). Transferability was addressed through thick description, purposive sampling, and data saturation. Detailed inquiries into the experiences of female learners in Physical Sciences theory and practical classes ensured thick description. Purposive sampling included participants with good, average and poor performance in Physical Sciences, with an acknowledgment that results would not be generalised to all schools in the Capricorn district. Data saturation was achieved when additional participants no longer provided new information during the data collection process.

4.9.2 Credibility

Credibility in qualitative research relates to the extent to which the research findings and conclusions can be viewed to be believable (Nassaji, H., 2020). It is also about the assurance between the participants' reality as mentioned through their voices and my reconstruction and representation of the participant's reality (Eldh, Årestedt, & Berterö, 2020). Credibility was upheld through prolonged engagement, member checks, iterative questioning, and triangulation. Prolonged engagement involved familiarising myself with the study site before conducting interviews and staying in the field for an extended period during data collection, by visiting the schools prior to data collection to ask for permission

to conduct research at their premises. Member checks involved presenting emerging findings to participants for confirmation of data adequacy and conclusions. Participants were called on their mobile phones to perform member checks. The researcher presented her findings to them and confirmed if what she had written was what they said and meant. Iterative questioning included probing for detailed data and rephrasing questions related to previously raised matters by participants. Moreover, triangulation was ensured by using various methods of data collection.

4.9.3 Triangulation

Triangulation aids in the confirmation and validation of the research findings (Bans-Akutey & Tiimub, 2021). It was employed through the use of three data collection methods, i.e., interviews (open-ended interviews and focus group interviews), observation and document review. Triangulation is not used to check the validity of data as being “true or false”, but to “ascertain the validity of the inferences” obtained from different data collection methods (Hadi, & José Closs, 2016). Moreover, triangulation aims to overcome the intrinsic bias that may arise during the data collection procedure (Ghafouri, & Ofoghi, 2016).

4.9.4 Confirmability

Confirmability implies how much other stakeholders in research confirm the research findings (Ghafouri, & Ofoghi, 2016). Written field notes and the use of voice recordings were also produced to confirm the data. The researcher showed how conclusions and interpretations were established by quoting exact phrases from the participants that were part of a particular theme. In this fashion, my viewpoints were blocked from being part of the conclusions.

4.9.5 Dependability

Dependability means that if the same research on experiences of female learners in Grade 12 was performed again at the same setting, participants and

context, the same results would emerge (Shenton, 2004). Dependability was assured through stepwise replications and inquiry audits. Stepwise replications included clear descriptions of research methods to enhance the possibility of repeating the study by another researcher. An inquiry audit involved an independent auditor reviewing all activities, including field notes and audio recordings, to assess how well the techniques for meeting credibility and transferability were followed.

4.10 ETHICAL CONSIDERATIONS

Ethical considerations are essential in any research study to ensure the well-being, rights, and dignity of participants are upheld. These considerations guide researchers in conducting their studies responsibly and ethically. The following ethical considerations were observed in this study:

4.10.1 Ethical approval

The study was approved by the University of Limpopo research committee known as Turfloop Research and Ethics Committee (TREC), and ethical certificate with project number TREC/643/2022 (See Annexure) was issued. Thus, giving permission to conduct research as stipulated in the research proposal.

4.10.2 Permission to conduct the study

Permission was requested from and granted by the Limpopo Provincial Department of Education, and at the sampled schools that participated in the study. A sample of permission letters was drafted and given to the school principals to sign. After agreeing to sign, a date was set to go to schools to get the permission letters to be signed.

4.10.3 Informed consent

Participants were all eighteen years and above. Thus, they were given a form a sign for the purpose of securing informed consent. Teachers were given their own informed consent with directives on how to carry themselves, and with information that they are not bound to see the project through. They were informed that they could pull out at any time they felt they wanted to do so. The same information of free will was given to learners on their own informed consent. There was no need to involve parents as there were no learners under the age of eighteen.

4.10.4 Privacy

The schools provided private and secluded classroom where one-on-one interviews were conducted. In the three schools, each learner was interviewed alone. In the fourth school, focus group interviews were conducted in private rooms too. Teachers were interviewed in private in order to protect their information and thoughts.

4.10.5 Confidentiality and anonymity

The researcher allocated pseudonyms to schools, learner participants and teacher participants to protect their identity. Everything that participants iterated was kept confidential and was shared only with the supervisor. The participants were aware of such an arrangement.

4.10.6 Harm

The participants were protected from harm by not taking them out of their safe habitat (school). No vulgar language was used, in order to protect the participants from mental harm. The data from the study was not shared, to protect their identity. Respect to participants – As participants were being interviewed, they were shown respect by not disturbing them as they gave answers. They were not steered in one direction by comments from the researcher. They were allowed their freedom of speech.

4.10.7 Conflict of interest

The researcher did not go to schools where she knew the teachers or learners personally.

4.11 LIMITATION OF THE STUDY

The researcher would have liked to interview participants from private schools in the urban areas, however, the school management did not agree to the plea to conduct data collection at their schools. Despite showing them the TREC certificate and permission from the department of education, they did not change their minds. However, the researcher did manage to get permission to conduct research at one private school in the rural areas. Documenting experiences of grade 12 female learners from an urban private school would have given the study richer data.

As the schools afforded the researcher time slots during break, when learners are outside eating, the voice notes had background noise which made it a little bit difficult to transcribe. Nonetheless, transcription was done after repeating the voice notes over and over until the exact words were heard.

4.12 SUMMARY

It was anticipated that the vast amount of data would act as an enabler to generate useful discussion that would assist in responding to the research questions in chapter one. The tools used in data collection had an enormous usage in shedding light on the purpose of the study, which is to explore into the experiences of Physical Sciences female learners in Grade 12 in the Capricorn District of the Limpopo Province in pursuit of improving theory and practical classes through recommendations to guide all stakeholders involved in a learner's education. The researcher believes that as the data is being presented

and analysed, which will be in the next chapter, answers to the questions asked in chapter one will become evident.

CHAPTER FIVE: DATA ANALYSIS AND PRESENTATION OF FINDINGS

5.1 INTRODUCTION

The preceding chapter provided a detailed exploration of the research methodology used to collect and analyse data. It discussed the data generation method in detail. The research strategy was explored, followed by an explanation of the qualitative research methods, population and sampling used in the study. Data collection methods and data analysis instruments have also been discussed. Moreover, issues of ethical and legal considerations and trustworthiness have been addressed in the preceding chapter.

This chapter delves into the analysis and presentation of findings derived from the data collected during this research project as guided by the purpose of the study and the research questions. The primary objective of the study was to investigate the experiences of Grade 12 female learners in Physical Sciences Classes in selected Rural and Urban Schools within the Capricorn District. The aim was to enhance both theoretical and practical offerings in the educational context.

Employing a qualitative and phenomenological exploratory design, the study involved Physical Sciences female learners, with a comprehensive review of relevant subject-related documents, the Annual Teaching Plan (ATP), June question papers (paper 1 and 2), learner scrips and informal workbooks (for classwork and homework). Data was collected from twelve female learners through purposive sampling and from observing the Physical Sciences classroom.

Open-ended interviews with participants took the form of one-on-one sessions, while focus groups were in addition utilised for learner engagement in one school, where one-on-one interviews were not possible due to time constraints and the school's policy. During interviews, meticulous field notes were taken,

and non-verbal cues were scrutinised through thematic analysis. Both the researcher and supervisor collaborated in the data analysis process, convening in a consensus meeting to finalise themes and sub-themes.

The chapter includes the socio-demographic background of participants gathered before interviews, data presentation and interpretation from interviews and observations, as well as data presentation and interpretation from document analysis. To protect confidentiality and anonymity, participants' real names remain undisclosed in these results, with numerical identifiers used instead.

5.2 DEMOGRAPHIC DATA OF PARTICIPANTS

The demographic data for the learners and teachers is presented below. It will further include those in focus groups.

Table 1: Sociodemographic profile of learners for one-on-one interviews and Focus groups.

N/A on the quintile column represents a private school.

Participant identifier	Gender	Age	Rural/urban school	Quintile
PFL1	Female	18	Rural	1
PFL2	Female	19	Rural	1
PFL3	Female	18	Rural	1
PFL4	Female	18	Rural	1
PFL5	Female	18	Rural	1
PFL6	Female	18	Rural	1
PFL7	Female	19	Rural	N/A
PFL8	Female	18	Rural	N/A
PFL9	Female	18	Urban	N/A
PFL10	Female	18	Urban	5
PFL11	Female	18	Urban	5

PFLFL12	Female	18	Urban	5
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5.3 DATA PRESENTATIONS AND INTERPRETATIONS DERIVED FROM INTERVIEWS AND OBSERVATIONS

The presentation and interpretation of data was derived from interviews and observations. The following themes and sub-themes were formulated from the research questions and were subsequently turned into the main theme of the study. The main theme is that female learners experience their Physical Sciences theory classes negatively. Different sub-themes emerged from the main theme. The following data presentation and interpretation reflect the individual participants' responses and data from interviews and observations.

Themes and Sub-themes

The themes and sub-themes regarding the experiences by female learners in Grade 12 Physical Sciences classes in selected rural and urban schools in the Capricorn district are presented below:

5.3.1 Paradoxical experiences of female learners related to Physical Science as a subject.

Theme	Sub-themes
1. Paradoxical experiences of female learners related to Physical Science as a subject	<p>1.1 Paradoxical experiences resulting in various feelings to different learners about Physical Science (PS) subject outlined.</p> <p>1.2 Existence of respect from teacher versus disrespect from learners experienced during classes.</p> <p>1.3 Explanation that respect</p>

	<p>experienced is not determined by Gender either on teachers and or learners' side.</p> <p>1.4 Positive versus negative daily relationship experienced amongst female learners outlined and vice versa.</p> <p>1.5 Positive versus negative relationship and treatment experienced between learners and various physical science teachers.</p> <p>1.6 The content of physical science taught manageable (coping with workload) versus unmanageable by female learners resulting in the need for revision to grasp.</p> <p>1.7 Manageable versus unmanageable workload is given to learners leading to different reactions by each learner.</p>
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Theme 1: 1. Paradoxical experiences of female related to Physical Science as a subject.

The theme explores the contradictory experiences of learners studying Physical Science, suggesting unexpected or conflicting aspects in their perceptions or engagement with the subject. These paradoxical experiences are reflected in the following sub-themes:

Sub-theme 1.1: Paradoxical experiences resulting in various feelings to different learners about Physical Science (PS) subject outlined.

The findings in Sub-theme 1.1 indicate diverse and contradictory emotions among female learners in Physical Science, ranging from satisfaction and excitement to sadness, fear, and anxiety. Learners also express uncertainty about their enjoyment of studying Physical Science. The findings underscore a dynamic where students experience a mix of competitive feelings and mutual assistance, as evident in the quotations below:

When asked, how do you experience your Physical Science class, this is some of the responses:

PFL3: *“It is okay. I can interact with other kids. We create friendships and bonds and other stuff.*

PFL10 *“Uhm, it is not very nice. Because our teacher can teach, but she is very fast and when we ask her questions, what did you mean when you said this? She kind of gets aggressive. Hai, you heard me (hai o nkutlwile). You know? She doesn't like going back. For me to actually get good grades in Physics I had to go to you tube and watch videos. But if I didn't go to you tube and just listened to what she was saying, I wouldn't be doing well in Physics”.*

PFL11 *“I have a similar experience to speaker one (PFL 10), even though she might be fun at times, for me she is a bit too fast as an individual. And then at the same time, it is not quite disciplined because we are a multiracial group in our class. So sometimes the other group would make noise, and they wouldn't really be reprimanded were else if we were to do the same it would be a different story. At the same time, I also went to extra classes to the same teacher who teaches us at school. It was the same person who taught us there, uhm I noticed that nothing really changed. She was still fast. She gave us the same point repeatedly, so it didn't really work out for me. But then I had to learn from other peers and yes sometimes You-Tube”.*

PFL8: *“It is so refreshing and educating, I love Physics class. It is fun to be in*

that class, I always learn new things, even though our teacher doesn't want us to touch some things in class”.

Different participants revealed different experiences resulting in different feelings in the Physical Sciences class. Some expressed having a negative experience, while some found it “okay” and some found it fun to be in the class. FST advocates for learners to have a positive experience in their science classes.

From the observation, the teacher seemed to be rushing through the syllabi, chasing coverage of the scope. In a sense that the researcher concurs with the female learners when they said that the teacher was a bit too fast.

Sub-theme 1.2 Existence of respect from teacher versus disrespect from learners experienced during classes.

Sub-theme 1.1 indicates the existence of respect from teachers to learners, and disrespect from some learners to teachers. As seen from learner participants' remarks from the interviews.

PFL1 *“She treats me based on the respect that I give her. If I respect her, she respects me back. There are many learners, boys and girls, that are disrespectful to her, and that makes me feel somehow because she respects me back since I respect her.”*

Additionally, the female learner has narrated that the teacher respects her back, since she is respectful to the teacher. A study by Okonofua, Paunesku & Walton (2016) shows that when an adult (teacher) respects learners, the respect is reciprocated. However, there are other learners, including female learners that are disrespectful to the teacher.

Sub-theme 1.3 Explanation that respect experienced is not determined by

gender, either on teachers' or learners' side.

Sub-theme 1.3 indicates respect is an individual entity, it is not determined by being a girl or a boy. Respect may be towards teachers or fellow classmates of different genders.

When a learner was probed further by being asked which teacher was stricter between the two teachers teaching her (male and female), this is what she had to say:

PFL5 *"They are both strict, but the male one is being disrespected by all of us. But with the female one, we even call her "boss lady" because we are afraid of her. When she is in class, the class is functional. Even with the male teacher, but we give the male teacher attitude. Especially girls. He teaches us well, but I struggle to understand him. But the female one is not teaching us. I do not prefer her. She will open a book, and we will stay on one page talking about one thing. We can take an hour and thirty minutes on one topic and not even understand what she is saying. So, the male one tries to explain, and when you don't understand, he will repeat it".*

From the observation, the researcher observed that when the male educator was in class, the Physical Science class was making noise, took time to settle down and were making unnecessary comments in class. As opposed to when the female teacher was in class. When the female teacher was in class, they automatically settled down without much hustle from the teacher.

When asked, can you relate with other learners in class? Can you assist each other where necessary? These were some of the responses:

PFL7: *"Yes, I can say we relate well, even though on some days there is no teamwork. They don't respect each other. If person A fights with person B, and person A is my friend, you will find that I am no longer talking with person B*

because person A is my friend. At the end of the day, it affects me”.

When asked, and what about any other boys in class? Have they ever given her any trouble? One of the responses was as follows:

Disrespect is proved to be existent from female learners. Female learners are disrespectful to the teacher and to one another. However, it is important to note that not all learners are disrespectful.

During observation, female learners seemed to work together and there was no sign of disrespect amongst each other.

Sub-theme 1.4 Positive versus negative daily relationship experienced amongst female learners outlined.

Sub-theme 1.4 indicates that there are some relationships which are positive among female and that there are some negative relationships among female learners.

When asked to think about a few female classmates and how they relate to her, these were some of the responses:

PFL1: *“They are not the type to be consulted. They are somehow. When you ask them something, they take you somehow. They will tell you that I don’t listen in class and stuff. Even though we all struggle, they will not explain to you the little they understand”.*

PFL4: *“There is this girl that I was friends with in grade 11, we had a fallout but now we are okay. We are no longer friends though. So, her new friends are giving me an attitude. They don’t like it when we get along.”*

PFL7: *“I am okay with them. I relate well with them. I do not have a problem.*

It's just that everyone in class takes advantage of me. So, I am no longer bothered."

PFL5 *"Yes, with girls...I don't think we are that open. Also, if you ask a girl a question, it will raise that thing, what will she think of me? Also, what will she say when she answers me? Like they are impatient they will say, I have been explaining this to you a lot. But with boys, they are okay. They will explain for you nicely that this, we do like this, without being impatient".*

The quote from PFL4 shows that there are negative relationships from her former friend's new friends, even though she is no longer fighting with her former friend. The relationships are different, some are positive, and some are negative (Wun, 2016). Negative relationships are not supported by the FST. Some relate well with their fellow female learners while some do not. Some female learners feel as though other female learners are being impatient with them.

Sub-theme 1.5 Positive versus negative relationship and treatment experienced between learners and various Physical Science teachers.

Sub-theme 1.5 indicates the presence of a negative relationship and treatment between learners and different Physical Science teachers.

When asked, how do you relate with your Physical Sciences teacher in class? The answers were as follows:

PFL11: *"I would honestly rather become invisible to her, so that I can get all the content. But if she spots me and says something which is positive, then no problem. It is just a normal teacher and learner relationship".*

A probing question was asked to the female learner after she said that the teacher favours boys, the question is: How do you see that? The following is the response given:

PFL7: *“Sometimes he chases us out of class. You see here at school; they have shared teachers amongst us. They are our parents. So those who are his children, he does not chase them out of the class. If there is something that they did today, he doesn’t chase them out. But if someone else does the same thing tomorrow, he will chase them out.”*

Learners had stated that they enjoy themselves in class before the teacher enters, so a probing question was asked: So, what about when the teacher enters the class? This is the response given:

PFL5: *“When the teacher enters, isn’t it that the behaviour is different, so there are some changes whereby we are not open with him. Even when we do have questions, we can’t ask him.”*

During observation in the school where learner PFL5 is from, learners got in class making noise and laughing amongst each other. They saw the researcher and the noise went down a little. But they continued laughing amongst each other. When the teacher entered the class, the class miraculously went silent.

A question was asked to participant FL 10, why does she stop enjoying herself when the teacher enters the class. The response was as follows:

PFL10: *“Because of how my teacher is. She is impatient, whereas other teachers take their time, and they can explain a hundred times until you understand, so I enjoy being babied”.*

PFL8: *“Because I learn something new every day. And I also always get very high marks in it. Thing is, I feel like my Physical Sciences teacher’s spirit and my spirit don’t mix. They just don’t get well. Even when he gets in class, I am not enjoying myself”.*

The female learners have provided both positive and negative relationship and treatment from their Physical Sciences teachers. Some believe that the

relationship they have with their teacher is a normal teacher and learner relationship. Some relationships are not good as the learners' moods change as the teacher approaches the class.

Sub-theme 1.6 The content of physical science taught manageable (coping with workload) versus unmanageable by female learners resulting in the need for revision to grasp content.

Sub-theme 1.6 indicates that the content of Physical Sciences is manageable to some and also unmanageable to other learners.

A question was asked, so when you are taught in class, are you able to grasp the content? The following were some of the responses:

PFL3: *“Yes, I do. I have no problem there. I think he understands that we have other subjects to do. He does not come with a big load. He makes sure we understand”.*

PFL10: *“I can only grasp 75% out of a 100%, for the 25% is lost because she is extremely fast, and I am afraid of asking more questions than I normally do.”*

PFL11: *“I feel like the class feels overwhelmed by what she says. She does not give you time to process what she taught. So, you lose more information than retain it. Let me say a good 95%. The other 5% is lost because she is fast. I get overwhelmed. In other subjects, I retain a good 100%”.*

Female learners are facing a serious challenge of unmanageable content in Physical Sciences as they feel like the content taught cannot all be grasped all at once as with other subjects. Whereas some female learners feel like the content is manageable.

Sub-theme 1.7 Manageable versus unmanageable workload is given to learners leading to different reactions by each learner.

Sub-theme 1.7 indicates that the workload given to learners is manageable for some and also unmanageable to others.

When asked, are you able to cope with the work given in Physical Sciences? The following were one of the responses:

PFL8: *“Yes. He gives us a short classwork that we write in class and a long homework to write at home. I have no problem with the workload given to me. If it is not a big chunk of work, I submit them on time, and I don’t copy other learners’ answers like some of my classmates do”.*

When asked, when you are given work, are you able to write it all? The following were some of the responses:

PFL2: *“When they give us a lot of work, I only write the ones I understand. Those I do not understand, I just leave them. I then write the other homework tasks from the subject that I understand.”*

PFL3: *“Sometimes they give us research today and wants to expect it to be done tomorrow. They give us small duration. While we have other homework to do. We are not only doing Physical Sciences. We would have other homework to do”.*

When asked, with the workload given to you when going home, are they okay or too much or too little? The following were some of the responses:

PFL10: *Too much. She gives us 10 activities and wants them in two days’ time, we are not machines. But I try to write them so that they don’t call my parents. For those that I don’t have enough time to complete, I just write any answer. As long as I wrote. What can I do? Because if I don’t write they call us names.*

PFL11: *I can't cope. We are given multiple activities after a topic is taught. And she wants them in a couple of days' time. While you didn't get time to do questions specifically in class. So, it adds pressure. And she demands them.*

PFL12: *I feel like homework tasks are exaggerated here at school. Because they expect us to have studying time, we knock off at 5pm, when we get at home we must also rest, when you get at home, you need to recap on what was taught in class, that time you need to prepare for trials, at the end of the day, you are scared that a homework can land you in the principal's office. Your parents will be called. So, I feel like it adds unnecessary pressure. We should answer questions in class, we will come back and ask questions when we don't understand. It makes you feel overwhelmed unnecessarily so. And they expect you to have studied enough for the tests. And I am like, but where is the time?*

During observation, the researcher did see the workload that was given to the learners, on that particular day, a 6 page worksheet was issued out on a Tuesday, the teacher told the class to submit tomorrow (Wednesday) morning.

When asked, do you think your teacher treats female learners and male learners equally? The following were one of the responses:

PFL5: *"They treat us the same. As I said, they treat us the same. If they did not treat us the same, the girls will always be sent out of the class because they are the ones giving the teacher too much trouble in class. They don't do homework. Like if we are given homework for Physical Sciences, another teacher will come and give us homework for their subject. When I get home, I must do all those homework tasks. Even if they tell us which topic we are going to focus on, we don't prepare for it."*

When asked, what about the workload when you go home? Homework tests, assignments, practical? Is it okay? This was one response:

PFL4: *"He gives us a lot of work over a short space of time. This is not good*

because I get tired, but I force myself to write them all because if I don't write, I will get in trouble. I end up writing things I don't understand".

Teachers seem to be giving learners too much work, according to the female learners. The work overwhelms some of them, while some female learners feeling like the workload given to them is manageable. Learners from both the urban, rural and rural private schools all mentioned that they were given too much informal work to be done at home. The open-ended questions assisted in attaining the responses above.

5.3.2 Explanation of performance of learners related to the subject Physical Science

Theme	Sub-themes
<p>2. Explanation of performance of learners related to the subject Physical Science.</p>	<p>2.1 Learners' performance differs resulting in uncertainty of exact ranking of performance levels.</p> <p>2.2 Required performance in various subjects including physical science outlined in relation to future career choice.</p> <p>2.3 An explanation that good performance provides one with confidence as opposed to poor performance that causes embarrassment and suffering at all levels.</p> <p>2.4 An explanation that extra-classes tutors assist to boost performance of learners as opposed to daily ones and vice versa.</p> <p>2.5 Descriptions that self-activities/home-work assignments given are done versus not done and reasons thereof.</p>

Theme 2. Explanation of performance of learners related to the subject Physical Science.

Sub-theme 2.1 Learners' performance differs resulting in uncertainty of exact ranking of performance levels.

Sub-theme 2.1 shows a plethora of levels attained in Physical Sciences, resulting

in uncertainty of exact ranking of performance.

When asked, Which level did you get in the June results? And are you satisfied with the results? The following were the participants' responses:

PFL1: *“Level one (with a sad face). No, I am not satisfied, some of my classmates were laughing at us that got level one. They laughed because they got level two and some level 3. It is not nice to be laughed at”.*

PFL2: *“Level one (with a sad face) No I am not satisfied”.*

PFL3: *“Level two (with a proud face) Yes, I am satisfied. I passed. I don't like failing, even at home they told me that I should not fail”.*

PFL4: *“Level three (with a sad face) and no I am not satisfied. I need level five so that I can pass with a bachelor. Level three is a pass, but it is not a good pass. I do not think that I can be able to go to university with level 3”.*

PFL6: *“Level three (with a proud face). I am very satisfied. I failed in term one, so with level three, it is improving. But I want level four next term”.*

PFL7: *“Level two (with a proud face). Yes, I am satisfied. But I need to do better than this so that I can pass more”.*

PFL8: *“Level six (with a sad tilted face, almost cried) I am not satisfied, at all. I am used to getting level seven in all of my subjects, so Physics is ruining it for me. Even my parents were asking me what was wrong, and I did not know what to say. I mean since when do I get a level six? It is not nice at all”.*

PFL10: *“Seven (with a proud and happy face) I am not entirely satisfied, though I am happy. I need to get my nineties, I got a level seven with an eighty. So, I'm like, it's bad but not too bad (laughs)”.*

PFL11: *“Six (with a sad face), and no I am not satisfied. I am a level 7 plus student. I can’t get sixes. That’s not who I am”.*

PFL12: *“Seven (did not show any emotions) I guess so. I am used to getting level sevens so yeah. It’s nothing new. It’s not like I’m getting recognised at home for it”.*

The performance of female learners differs from level one to three and level six to seven. This is performance from both bottom achieving learners and top achieving learners. Some female learners are failing the subject, as failure is obtaining level one. And some learners passed, as a pass is obtaining level two upwards. Learners from the rural urban school got high levels (between level 6 and 7) while learners from rural schools got the lowest marks (even though some were proud of getting those low levels). The FST advocates for a good performance of girls in science, hence, the female learners that are not bothered by their low levels are contradicting the stance of FST in terms of performance.

Sub-theme 2.2 Required performance in various subjects including physical science outlined in relation to future career choice.

Sub-theme 2.2 indicates the required performance in various subjects including physical science outlined in relation to future career choices.

When the female learners were asked, so what motivates you to study Physical Sciences? Some of their responses were as follows:

PFL11: *“The career that I have chosen requires a lot of attention on maths and science. And also, my APS should be better to meet the requirements. My teacher told me that the competition is high and that I should get the best results ever”.*

PFL8: *“Physical Sciences is fun. It is life. Even the career that I want to do needs science. Even when I was growing up, I enjoyed science. So yeah, I want to be a doctor, so science is something that you need to excel. Also, for me, things like*

chemistry are interesting things for me. When they talk about acids and basis, I find them interesting”.

PFL5: *“Because of the career that I want to do. It requires Physical Sciences. So, I am forced to study Physical Science”.*

When asked, which career do you want to have? The following were some of the responses:

PFL4: *“I want to study medicine. I see many doctors driving beautiful cars. It means that they have a lot of money. So, I also want to have a lot of money and drive nice and expensive cars”.*

PFL6: *“I want to be a doctor. I want to heal people when they are sick. Plus, doctors have lots of money and live a good life.”*

The career choices of female learners act as a motivator to some of them. Thus, it enables them to study hard to obtain marks that would enable them to enrol in their respective career choices.

Sub-theme 2.3 An explanation that good performance provides one with confidence as opposed to poor performance that causes embarrassment and suffering at all levels.

When a learner responded by saying that they are not enjoying themselves in class, a probing question was asked: why are you not enjoying it? And their response was:

PFL5: *“I only enjoy sometimes. I only enjoy it when I understand the topic that is being taught. Because if I don’t understand, I am not that open for me to ask questions.”*

A question was asked to the learner, are you enjoying your Physical

sciences class when being taught? These were some of the responses:

PFL4: *“Yes. Only if I am enjoying the topic. Because I get irritable if I do not understand in class. I mean you would also not enjoy it if you spent the whole hour listening to something you do not understand knowing very well that you will be required to write homework tasks based on it. And then you will struggle even more to write the homework, and then tomorrow another linking topic will come that builds on top of that question you did not understand. And then the cycle continues again and again”.*

The female learners showed that there exists a relationship between understanding in class and enjoyment. It was easy to understand the lived experiences of the participants as they were narrating in their own voices. They mentioned that if one understands, then one will enjoy. If one does not understand, one will not enjoy.

Sub-theme 2.4 An explanation that extra-classes tutors assist to boost performance of learners as opposed to daily ones and vice versa.

Sub-theme 2.4 indicates that extra-classes tutors assist to boost performance of learners as opposed to daily usual teachers, and that some extra classes do not assist to boost performance of learners.

When asked, do you need an additional teacher? The following was one of the responses:

PFL5: *“I think we need someone that we are not used to. Someone we don’t see every day. These ones, ah...we are already used to them. Even if they tell us to do something, we know that if we don’t do it, nothing is going to happen to us. They won’t do anything. We are just afraid of the female teacher because she acts if we did not do something she told us to do”.*’

When asked, Do you have other teachers? Except for your Physical Science teacher? Do you have extra classes on weekends or after school? The following were some of the responses.

PFL11: *"It's complicated. I used to go to her because she recommended going to her after I got level six in term 1. So, she was like you used to get 80s, so you dropped, so come to me. And then we will sort something out. But like nothing really changed. So, I still got level six in term 2. I don't attend anymore. It was my first time attending extra classes in general".*

PFL13: *"Yes, I do have. For Physical Science only. I do have a teacher that teaches here at school, Mr (surname). I feel like he is more patient, he gives every learner special attention and if you don't understand anything, he comes and explains. So, I take what the teacher taught me at school and when I get there I merge the information. Then if there is something I do not understand, I tell him, please explain this to me so that I can understand. If I missed something at school I go like, "whoo okay" at least I still have Mr (surname). It gives me hope".* The female learners indicated that they need someone that they are not entirely used to as an extra teacher. Some extra classes are beneficial, and others are not.

Sub-theme 2.5 Descriptions that self-activities/home-works given are done versus not done and reasons thereof.

Sub-theme 2.5 describes that self-activities/homework given are done versus not done and reasons are provided as to why such an occurrence occurs.

With the workload given to you when going home, are they okay or too much or would they prefer less? The following was the response:

PFL12: *"I feel like homework assignments are exaggerated here at school. Because they expect us to have studying time, we knock off at 5pm, when we get at home we must also rest, when you get at home, you need to recap on*

what was taught in class, that time you need to prepare for trials, at the end of the day, you are scared that a homework can land you in the principal's office. Your parents will be called. So, I feel like it adds unnecessary pressure. We should answer questions in class, we will come back and ask questions when we don't understand. It makes you feel overwhelmed unnecessarily so. And they expect you to have studied enough for the tests. And I am like, but where is the time?"

When asked, do you write all the homework tasks given to you in Physical Sciences? The following was one of the responses.

PFL4: *"No. I start with other easy subjects first, when I have time, I write maths and science homework tasks. If I don't have time, I don't write them. I will copy them from my friends in the morning. But sometimes if I don't have too much work, and I understand the work given, I will write all my Physics homework".*

Some learners write homework because they are afraid their parents can be called if they did not write. Showing that they write to comply because they are afraid of getting into trouble. While some learners choose not to write the Physical Sciences homework knowing that they will copy the work from their classmates that wrote already.

5.3.3 Explanation of support experienced at school and at home in relation to Physical Science subject.

Theme	Sub-themes
<p>3. Explanation of support experienced at school and at home in relation to Physical Science subject.</p>	<p>3.1 Support versus lack of support experienced from siblings, parents, community members, teachers and peers which leads to increased levels of performance and vice versa.</p> <p>3.2 Lack of siblings, parents, community members, teachers and peers' presence in assisting to solve learners' problems leads to emotional suffering on multiple levels in their lives.</p> <p>3.3 Lack of support by not providing feedback by educators problematic as it leads to non-performance as learners cannot self-correct.</p>

Theme 3: Explanation of support experienced at school and at home in relation to Physical Science subject.

Sub-theme 3.1: Support versus lack of support experienced from siblings, parents, community members, teachers and peers which leads to increased levels of performance and vice versa.

Sub-theme 3.1 explains support experienced from siblings, parents, community members, teachers and peers and also lack of support from siblings, parents, community members, teachers and peers which leads to increased levels of performance.

When asked a probing question, do you have chores at home? The following were responses given:

PFL12: *“For me I feel like sometimes maybe I can stop washing dishes and just write. But when I have a lot of work, my mom does help me (smiles). In as much as they can be a lot (schoolwork), I do get help when I need it”.*

PFL11: No. I only have chores on Saturday and Sunday.

When asked a probing question, do you have anyone that can assist you with Physical Sciences homework from your neighbours?

PFL2: *“No, I don’t have. My neighbours did geography and accounting meaning I don’t have help from anyone in terms of Physical Sciences as a subject”.*

When asked, what should your parents do to make sure that you have a pleasurable experience in class? The following were some of the responses:

PFL2: *“They should stop giving me too many chores and stop suffocating me. When I get home, they should stop telling me to wash the dishes and cook when I have too much schoolwork. My mom doesn’t do anything”.*

The female participants show that they would rather write homework than to do their home chores, this is also supported by Emmanuel (2015). There is also a feeling of support from their siblings, parents, teachers and community members in their lives and also some female learners feel like they do not get enough support from their siblings, parents, teachers and community members, especially from the view of doing chores at home.

Sub-theme 3.2 Lack of siblings, parents, community members, teachers and peers’ presence in assisting to solve learners’ problems leads to emotional suffering on multiple levels in their lives.

Sub-theme 3.2 shows the lack of some stakeholders in education's presence in assisting to solve Physical Sciences problems. This leads to different feelings that are not good.

When asked, what do you think your parents should do to assist you to have a more pleasurable experience in class? Some of the responses were as follows:

PFL2: *"They should stop giving me too many chores and stop suffocating me. It is not my duty to take care of the house chores. They should be at home and do those chores. They are not supposed to be my duty".*

PFL11: *"It breaks me when my parents fight and ignore me and my schoolwork. I feel like the attention they are giving to their silly fights should be directed to me and my siblings. So, they should just stop fighting, period".*

PFL1: *"When I go to write Physical Sciences, I get anxious. I am stressed because I don't understand. I just go write. Last term I just wanted to abscond while writing my exams, thinking what is the use? There is no use. But I eventually came. So, if my parents were around to help me, it would be better. Or maybe give me money for a tutor".*

There are different feelings experienced by female learners resulting from different occurrence, like parents fighting, writing the subject of Physical Sciences, and being given too many chores. The feelings range from that of suffocation, feeling anxious and feeling like they have reached a breaking point.

Sub-theme 3.3 Lack of support by not providing feedback by educators problematic as it leads to non-performance as learners cannot self-correct.

When asked, what do you think the teacher should do to help you enjoy yourself in class? The following was one of the responses:

PFL5: “They should give us corrections after the classwork and homework they give us. Then we will know if we have done the correct things or not. If not, then we will write corrections and correct our wrongs”.

The learner shows the importance of being given corrections.

Sub-theme 3.4 Support received from male learner peers as opposed to their female counterparts.

When asked, between boys and girls, who gives you more help with Physical Sciences?

PFL6: “I usually get assistance from boys. Those ones are not jealous, they help you with all their hearts. But girls, iyhooo! I would rather ask help from boys only”.

From observations, it was evident that boys and girls from the PFL6 class were seated together in class. However, due to the small number of boys in class, some girls were seated together. Showing that some girls preferred to sit with boys than with girls, as is supported by a study by Webb-Williams (2018).

5.3.4 Suggestions made by learners towards improvement of performance of Physical Science subject.

Theme	Sub-theme
4. Suggestions made by learners towards improvement of their performance of Physical Science .	4.1 Suggestion that correlation of theory into practice is important because only theory is taught. 4.2 Laboratory and more classes must be built which will result in promoting better learning as opposed to learning through videos

	<p>in congested classes.</p> <p>4.3 Government must provide more resources so as to promote better understanding of Physical Sciences.</p> <p>4.4 Learners must have self-motivation so that they can understand Physical Sciences and be encouraged to consult teachers.</p> <p>4.5 Parents, teachers, and siblings to provide support.</p>
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Theme 4: Suggestions made by learners towards improvement of performance of Physical Science subject.

Sub-theme 4.1 Suggestion that correlation of theory into practice is important because only theory is taught.

When asked, what do you think the government should do to help you enjoy yourself in class? The following was one of the responses:

PFL5: They should provide a lab for us. We need a lab so that we can see that when they say something happens because of something, we can see it. Because the teacher just comes and talks and says do you see it, and we just say yes. Even the change in colours, we don't see it, but we just say yes. So, I think if they give us a lab, we will pass better.

The student talks about the need of a laboratory to be able to take part in the practical classes.

Sub-theme 4.2 Laboratory and more classes must be built which will result in promoting better learning as opposed to learning through videos in congested

classes.

When asked, what do you think the school should do to ensure a more pleasurable experience for female learners? The following was the response:

PFL12: *“We should get a mini operating lab with all the required chemicals and apparatus. We should also get more experienced teachers”.*

During observation, it was noted that none of the four visited schools had a functioning science laboratory.

Sub-theme 4.3 Government has to provide more resources so as to promote better understanding of Physical Sciences.

Sub-theme 4.3 shows that the government should provide more resources to promote a better understanding of Physical Sciences.

PFL11: *“They should give us textbooks that actually do the job. Because I don’t use it, even our teacher doesn’t use it. It doesn’t have a lot of information, and it does not explain things well. They should give us textbooks that are user-friendly. They shouldn’t be too big too. Because they are not nice to use”.*

PFL12: *“We should get a mini operating lab with all the required chemicals and apparatus. We should also get more experienced teachers”.*

PFL13: *“They should give the school all the necessities they need for each subject. And everyone should be given an opportunity to voice out their opportunities”.*

PFL3: *“They should supply us with study guides. Sometimes our parents don’t have money for study guides. Also, their textbooks don’t have information.*

especially the one they gave us this year. Since they gave us, we don't even use them. Because they are not the same. He also told us that some do not go in line with the exam guideline".

PFL6: *"Our class should show that it is a science class. They should be side staff maybe on the walls just to show that this is a class for science students".*

Learners expressed their desire to have a laboratory and science accessories on the walls.

Sub-theme 4.4 Learners must have self-motivation so that they can understand Physical Sciences and encourage others to consult teachers.

Sub-theme 4.4 shows the importance of self motivation in learners.

When asked, what do you think you should do for you to have a pleasurable experience in your Physical Sciences class? The response was as follows:

PFL6: Participant I should start asking many questions so that I can start understanding more. The more I am shy to ask questions, the more it kills my studies. Because if I don't ask questions, other learners may also shy away from asking questions. I should start motivating myself to ask more questions".

The learner narrates how to self-motivate by asking questions in class. And perhaps, that may motivate other learners to also start asking questions.

Sub-theme 4.5 Parents, teachers, and siblings to provide support.

PFL2: They should stop giving me too many chores. My sister is also doing grade 12 but she is not given too many chores. My mother is at home full time, but she never helps me with my chores.

PFL3: My parents should not put me under pressure by deciding for me what to do in future. They tell me I can be a doctor if I work hard. While I do not want to be a doctor. Sometimes they give me a lot of chores, like doing laundry taking care of my sibling too.

5.3.5 Existing challenges that influence poor performance in Physical Science

Themes	Sub-themes
<p>5. Existing challenges that influence poor performance in Physical Science</p>	<p>5.1 Physical Science is viewed by some learners as difficult and others as a simple subject which causes suffering at multiple levels – stress, anxiety, panic, etc.</p> <p>5.2 Lack of laboratories, classes and all types of resources in learning Physical Sciences lead to lack of understanding of the subject.</p>

Sub-theme 5.1 Physical Science is viewed by some learners as difficult and others as a simple subject which causes suffering at multiple levels – stress, anxiety, panic, etc.

Sub-theme 5.1 illuminates the perception of Physical Sciences by some learners, as difficult. Which causes suffering at multiple levels.

When asked, are you able to concentrate in class? The following was one of the responses:

PFL7: *“Not really. I can’t concentrate on something that I do not understand. Maybe if I understood at least fifty percent of the things we do in class, maybe*

I would focus better. When I don't understand, I get bored and feel like sleeping."

Sub-theme 5.2 Lack of laboratories, classes, and all types of resources in learning Physical Science leads to lack of understanding of the subject.

Sub-theme 5.2 shows the effect of not having laboratories, classes, and other resources, which is lack of understanding the subject.

When asked what the government should do to ensure a more pleasurable experience in schools, this was the response:

PFL2: *"I think that the government should give education more money to pay our teachers so that they are not always complaining and that they build a laboratory in all schools in Limpopo Province"*

The learner shows the importance of the Limpopo government investing in education.

Sub-theme 5.3 Late coming to school by learners experienced and not acceptable which leads to stress and anxiety to learn the subject.

Sub-theme 5.3 shows the effects of late coming to school, which is stress and anxiety.

These were some of the extracts from learners.

PFL1: "And whenever I am late to extra classes, he makes me feel bad and that gives me stress. Sometimes I don't get late on purpose, but he will just say that I should wake up early".

PFL1: "Yes. It's a problem. When I go to write Physical Sciences, I get anxious. I am stressed because I don't understand. I just write. Last term I just wanted to

abscond while writing my exams, thinking that what is the use? There is no use. But I eventually came to write.

The above quotations shows that late coming does affect female learners' experience in class, especially the part where the learner mentions that "she feels bad and that gives her stress". Stress is not a feeling one should be getting in any class. This shows tardiness stemming from female learners is also affecting their experience negatively.

5.4 DATA PRESENTATION AND INTERPRETATION DERIVED FROM DOCUMENT ANALYSIS

The following themes and sub-themes were formulated from the research questions and subsequently adapted into the main theme of the study along with the themes and sub-themes developed from interviews and observations above. The main theme is that female learners in the Capricorn district of Limpopo experience their Grade 12 Physical Sciences theory classes negatively. A number of sub-themes then emerged from the main theme. The following analysis and discussions reflect the data derived from document analysis.

Themes and Sub-themes

Themes and sub-themes relating to the experiences of female learners in Grade 12 Physical Sciences classes in the selected rural and urban schools of the Capricorn District in Limpopo Province, South Africa, with the focus on improving theory and practical offerings.

5.4.1 Annual Teaching Plan (ATP)

Theme	Sub-theme
1. ATP followed/not followed	<p>1.1 The number of classwork/homework assignments correlates/does not correlate to those expected by the ATP.</p> <p>1.2 Informal practical not done as directed by the ATP.</p> <p>1.3 ATP topics covered/not covered.</p>

The ATP is a document that guides teachers as to when to teach which topic, for how long and how to assess that topic. It is a document that is provided by the National Department of Education and is amended as the national office sees fit. The following is the ATP for the year 2023/2024, covering the 2023 academic year. It was necessary in this study as the researcher needed to check if the experiences of female learners could be affected by teachers following the ATP, which would be seen from comparing learner books and the ATP. The informal work given in the learner book assists to check which topics or subtopics were taught by the teacher. Equally, the performance of learners in their test scripts supports the learner books.

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SBA GUIDELINES

Practical work:

- Learners do TWO experiments (ONE Chemistry, ONE Physics) for SBA. Choose these experiments from this ATP
- Term 1: Choose ONE experiment. Record in term one
- Term 2 OR term 3: Choose ONE experiment. Record the mark in term 3
- The suggested formal experiments NOT chosen for SBA, should become Informal experiments



TERM 1	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10-11	
CAPS TOPICS	MECHANICS: Momentum & impulse (2 hrs)	MECHANICS: Momentum & impulse (4 hrs)	MECHANICS: Momentum & impulse (4 hrs)	MECHANICS: Vertical projectile motion (4 hrs)	MECHANICS: Vertical projectile motion (4 hrs)	MATTER & MATERIALS: Organic molecules (4 hrs)	MATTER & MATERIALS: Organic molecules (4 hrs)	MATTER & MATERIALS: Organic molecules (4 hrs)	MATTER & MATERIALS: Organic molecules (4 hrs)	Consolidation of term 1 (2 hrs) CONTROL TEST (2 hrs) Discussion and remedial work on test (2hrs)	
TOPICS, CONCEPTS, SKILLS AND VALUES	<ul style="list-style-type: none"> • Define & calculate the momentum of a moving object: $p = mv$ • Describe the vector nature of momentum & draw vector diagrams • State Newton's second law in terms of momentum: $F_{net} = \frac{dp}{dt}$ • Calculate the change in momentum when a resultant force acts on an object 	<ul style="list-style-type: none"> • Define impulse • Use the impulse-momentum theorem ($F_{net} \Delta t = m \Delta v$) in calculations for a variety of situations (one dimension) • Impulse and safety considerations • State the principle of conservation of linear momentum • Explain what is meant by an isolated system, internal and external forces 	<ul style="list-style-type: none"> • Apply conservation of momentum to collisions of two objects (one dimension) • Distinguish between elastic and inelastic collisions by calculation 	<ul style="list-style-type: none"> • Explain what is meant by a projectile • Use equations of motion to determine the position, velocity, and displacement of a projectile at any given time • Sketch x vs t, v vs t and a vs t graphs for a free falling object, an object thrown vertically upwards & bouncing objects • Give equations for position versus time and velocity versus time for the graphs of 1D projectile motion 	<ul style="list-style-type: none"> • For given x vs t, v vs t or a vs t graphs, determine position, displacement and velocity or acceleration at any time • For given x vs t, v vs t or a vs t graphs, describe the motion of an object bouncing, thrown vertically upwards & thrown vertically downward and so on 	<ul style="list-style-type: none"> • Define organic molecules, functional group, hydrocarbon, homologous series, saturated, and structural isomer • Write condensed, structural & molecular formulae (max 8 C atoms, 1 functional group per molecule) for alkanes (no rings), alkenes (no rings), alkynes, alcohols, halo alkanes (no rings), carboxylic acids, aldehydes, ketones, esters • Write IUPAC names for structural, condensed structural formulae for compounds from above series 	<ul style="list-style-type: none"> • Write IUPAC names from structural or condensed structural formulae for compounds listed (one functional group per molecule, max two functional groups for haloalkanes) • Identify alkyl substituents (methyl- and ethyl-), max THREE alkyl substituents • Identify compounds that are saturated, unsaturated, structural isomers (chain, positional, functional) • Physical properties: boiling point, melting point, vapour pressure 	<ul style="list-style-type: none"> • Relationship between physical properties and strength of IMF, type of functional group, chain length and branching • Combustion of alkanes in excess oxygen and use as fuels • Equation & reaction conditions for the formation of an ester and IUPAC names for reactant and products • Classify reactions as elimination, addition, or substitution • Equations and reaction conditions for addition reactions of alkenes 	<ul style="list-style-type: none"> • Equations and reaction conditions for elimination reactions: dehydrohalogenation of haloalkanes, cracking of alkanes, dehydration of alcohols • Equations and reaction conditions for substitution reactions: hydrolysis of halo alkanes, halogenation of alkenes 	Revision (2 hours) ONE PAPER (100 marks - 2 hours) 50 marks – Physics • Newton's laws of motion • Momentum and impulse • Vertical projectile motion 50 marks – Chemistry • Organic molecules • Discussion and remedial work of control test	
REQUISITE PRE-KNOWLEDGE	Newton's laws of motion	Newton's laws of motion Equations of motion	Momentum Equations of motion	Equations of motion	Equations of motion	Chemical bonding Valency	Intermolecular forces	IUPAC naming, writing different formulae	IUPAC naming, writing different formulae		
RESOURCES (OTHER THAN TEXTBOOK) TO ENHANCE LEARNING	<ul style="list-style-type: none"> • Mind the Gap • Study guides • YouTube & Mindset videos • PHET simulations • Previous question papers 	<ul style="list-style-type: none"> • Mind the Gap • Study guides • YouTube & Mindset videos • PHET simulations • Previous question papers 	<ul style="list-style-type: none"> • Apparatus: Conservation of momentum • Mind the Gap • Study guides • YouTube & Mindset videos • PHET simulations • Previous question papers 	<ul style="list-style-type: none"> • Apparatus for experiment below • Mind the Gap • Study guides • YouTube & Mindset videos • PHET simulations • Previous question papers 	<ul style="list-style-type: none"> • Mind the Gap • Study guides • YouTube & Mindset videos • PHET simulations • Previous question papers 	<ul style="list-style-type: none"> • Mind the Gap • Study guides • YouTube & Mindset videos • Previous question papers 	<ul style="list-style-type: none"> • Mind the Gap • Study guides • YouTube & Mindset videos • Previous question papers 	<ul style="list-style-type: none"> • Mind the Gap • Study guides • YouTube & Mindset videos • Previous question papers 	<ul style="list-style-type: none"> • Apparatus: Chemicals and apparatus for experiment below • Mind the Gap • Study guides • YouTube & Mindset videos • Previous question papers 	<ul style="list-style-type: none"> • Mind the Gap • Study guides • YouTube & Mindset videos • Previous question papers 	<ul style="list-style-type: none"> • Mind the Gap • Study guides • YouTube & Mindset videos • Previous question papers

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TERM 1	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10-11	
ASSESSMENT	INFORMAL ASSESSMENT: REMEDIATION	• Homework	• Homework	• Homework • Informal test	• Homework	• Homework • Informal test	• Homework	• Homework • Informal test	• Homework	• Homework • Informal test	
	SBA (FORMAL) CHOOSE ONE EXPERIMENT	None	None	Formal practical (Physics) Conservation of linear momentum	Formal practical (Physics) Determine the acceleration due to gravity	None	None	None	Formal practical: (Chemistry) Preparation of three esters OR reactions of alkenes and alkenes with Br ₂	None	Control test

TERM 2	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11
CAPS TOPICS	MECHANICS: Work, energy, and power (2 hrs)	MECHANICS: Work, energy, and power (4 hrs)	MECHANICS: Work, energy, and power (3 hrs)	WAVES, SOUND & LIGHT: Doppler Effect (3 hrs)	WAVES, SOUND & LIGHT: Doppler Effect (2 hrs) CHEMICAL CHANGE: Rate and extent of reaction (2 hrs)	CHEMICAL CHANGE: Rate and extent of reaction (4 hrs)	CHEMICAL CHANGE: Chemical equilibrium (4 hrs)	CHEMICAL CHANGE: Chemical equilibrium (4 hrs)	CHEMICAL CHANGE: Acids and bases (4 hrs)	CHEMICAL CHANGE: Acids and bases (3 hrs)	June examination OR Control test (4 hrs)
TOPICS, CONCEPTS, SKILLS AND VALUES	<ul style="list-style-type: none"> Work Define the work done on an object Draw force diagram & free-body diagrams Calculate the net work done on an object Distinguish between positive work and negative net work done on the system 	<ul style="list-style-type: none"> State the work-energy theorem Apply the work-energy theorem on horizontal, vertical, and inclined planes Define conservative and non-conservative forces and give examples State the principle of conservation of mechanical energy Solve problems using the equation $W_{nc} = \Delta E_p + \Delta E_k$ Show that E_{mech} is conserved in the absence of non-conservative forces 	<ul style="list-style-type: none"> Define power and calculate the power involved when work is done Perform calculations using $P_{avg} = F_{avg} v_{avg}$ when an object moves at a constant speed along a rough horizontal surface or a rough inclined plane Calculate the minimum power required of an electric motor to pump water from a borehole of a particular depth at a particular rate using $W_{nc} = \Delta E_p + \Delta E_k$ 	<ul style="list-style-type: none"> State the Doppler Effect and explain the change in pitch observed when a source moves toward or away from a listener (sound and ultrasound) State applications of the Doppler Effect with/without waves in medicine, e.g. to measure the rate of blood flow or the heartbeat of a foetus in the womb Solve problems using $f_s = \frac{v \pm v_s}{v} f_r$ when EITHER source or listener moves 	<ul style="list-style-type: none"> Doppler Effect With light, explain 'red shifts' & use the Doppler Effect to explain why we conclude that the universe is expanding Rate of reaction Define reaction rate Calculate reaction rate from given data List the factors that affect the rate of chemical reactions 	<ul style="list-style-type: none"> Explain in terms of the collision theory how the various factors affect the rate of chemical reactions Answer questions and interpret data (tables or graphs) on different experimental techniques for measuring the rate of a given reaction Define the term positive catalyst to explain how a catalyst, temperature and concentration affect rate 	<ul style="list-style-type: none"> Explain Open & closed systems, reversible reactions, dynamic equilibrium List the factors which influence the position of an equilibrium State Le Chatelier's principle and use it to explain changes in equilibria Interpret simple graphs of equilibrium List the factors which influence the value of the equilibrium constant K_c 	<ul style="list-style-type: none"> Write an expression for the equilibrium constant from a given equation Perform calculations based on K_c values Explain the significance of high and low values of the equilibrium constant 	<ul style="list-style-type: none"> Define acids and bases according to Arrhenius and Lowry-Bronsted Distinguish between strong and weak acids/bases with examples Distinguish concentrated and dilute acid/bases Identify conjugate acid-base pairs for given compounds Perform calculations based on titration reactions & motivate the choice of an indicator 	<ul style="list-style-type: none"> Determine the approximate pH of salts in 'salt hydrolysis' Explain the pH scale and calculate pH values of strong acids and strong bases Define the concept of K_a and explain the auto-ionisation of water Compare the K_a and K_b values of strong and weak acids looking at pH Perform strong and weak acids by looking at pH, conductivity & reaction rate 	<ul style="list-style-type: none"> June examination TWO PAPERS Paper 1 – 150 marks, 3 hrs AND Paper 2 – 150 marks, 3 hrs OR CONTROL TEST (150 marks – 3 hours) 75 marks – Physics 75 marks – Chemistry
REQUISITE PRE-KNOWLEDGE	<ul style="list-style-type: none"> Gravitational potential and kinetic energy Equations of motion Force and free-body diagrams 	<ul style="list-style-type: none"> Gravitational potential and kinetic energy Equations of motion Newton's 2nd law of motion 	<ul style="list-style-type: none"> Gravitational potential and kinetic energy Equations of motion Newton's 2nd law of motion 	<ul style="list-style-type: none"> Wave properties: Frequency, wavelength, amplitude Graphical representation of waves 	<ul style="list-style-type: none"> Wave properties: Frequency, wavelength, amplitude Writing of formulae and balanced equations Energy in chemical reactions – Gr 11 	<ul style="list-style-type: none"> Writing of formulae and balanced equations Energy in chemical reactions – Gr 11 	<ul style="list-style-type: none"> Writing of formulae and balanced equations Stoichiometry 	<ul style="list-style-type: none"> Writing of formulae and balanced equations Stoichiometry 	<ul style="list-style-type: none"> Writing of formulae and balanced equations Stoichiometry 	<ul style="list-style-type: none"> Writing of formulae and balanced equations Stoichiometry 	<ul style="list-style-type: none"> Writing of formulae and balanced equations Stoichiometry
RESOURCES (OTHER THAN TEXTBOOK) TO ENHANCE LEARNING	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Apparatus for experiment below Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Apparatus: Chemicals and apparatus for experiment below Mind the Gap Study guides YouTube & Mindset videos Previous question papers 	<ul style="list-style-type: none"> Apparatus: Chemicals and apparatus for experiment below Mind the Gap Study guides YouTube & Mindset videos Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos Previous question papers 	<ul style="list-style-type: none"> Apparatus: Chemicals and apparatus for experiment below Mind the Gap Study guides YouTube & Mindset videos Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos Previous question papers

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TERM 2	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	
ASSESSMENT	INFORMAL ASSESSMENT: REMEDIATION	<ul style="list-style-type: none"> Homework 	Homework	<ul style="list-style-type: none"> Homework Informal test 	Homework	<ul style="list-style-type: none"> Homework Informal test 	<ul style="list-style-type: none"> Homework Informal test 	<ul style="list-style-type: none"> Homework Practical: Demonstrate factors that influence the equilibrium of CO_2 & H_2O or NO_2 & N_2O_4 (demo) 	Homework	<ul style="list-style-type: none"> Homework Informal test 	<ul style="list-style-type: none"> Homework Practical: Titration of a weak acid against a strong base to determine the concentration of the strong base Informal test 	<ul style="list-style-type: none"> Homework Informal test
	SBA (FORMAL)	None	None	Formal practical (Physics): Perform simple experiments to determine the work done and power expended in walking up (or running up) a flight of stairs	None	None	Formal practical (Chemistry): Determine the effect of temperature and concentration on the rate of reaction between Na_2SO_3 and HCl OR determine factors (any factor) affecting the rate of a reaction	None	None	None	Formal practical: (Chemistry) Determine the unknown concentration of an acid or base by titration against a standard solution	Control test or June examination

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TERM 3	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8-11
CAPS TOPICS	CONTROL TEST: Discussion, corrections, remedial work (1 hr) ELECTRICITY & MAGNETISM: Electric circuits (2 hrs)	ELECTRICITY & MAGNETISM: Electric circuits (4 hrs)	ELECTRICITY & MAGNETISM: Electrodynamics (4 hrs)	ELECTRICITY & MAGNETISM: Electrodynamics (1 hr) M & N: Optical phenomena and properties of materials (2 hrs)	MATTER & MATERIALS: Optical phenomena and properties of materials (4 hrs)	CHEMICAL CHANGE: Electrochemical reactions (4 hrs)	CHEMICAL CHANGE: Electrochemical reactions (4 hrs)	TRIAL EXAMINATION P1: 3 hrs P2: 3 hrs
TOPICS, CONCEPTS, SKILLS AND VALUES	<ul style="list-style-type: none"> Discussion, corrections, remedial work of June control test or exam Electric circuits Solve problems involving current, voltage and resistance for circuits containing arrangements of resistors in series and in parallel (maximum four resistors excluding internal resistance) 	<ul style="list-style-type: none"> Explain the term internal resistance Solve circuit problems using $\epsilon = IR_{int} + IR$ or $\epsilon = V_{int} + V_{resistor}$ Solve problems, with internal resistance, for circuits containing arrangements of resistors in series and in parallel (maximum four resistors) 	<ul style="list-style-type: none"> State the energy conversion in generators & use principle of electro-magnetic induction to explain how generators work Give examples of uses of AC & DC generators & functions of components State the energy conversion in motors & use motor effect to explain how motors work Explain the functions of components of meters and give examples of uses of meters State the advantages of alternating current over direct current Draw and interpret sketch graphs of voltage vs time and current vs time for an AC circuit 	<ul style="list-style-type: none"> Define the term rms for an alternating voltage or an alternating current Solve problems using $I_{rms} = \frac{I_m}{\sqrt{2}}$ $V_{rms} = \frac{V_m}{\sqrt{2}}$ $P_{avg} = I_{rms}^2 R$ $P_{avg} = \frac{V_{rms}^2}{R}$ $P_{avg} = V_{rms} I_{rms}$ $= \frac{1}{2} I_m V_m$ <p>(For purely resistive circuit)</p> <ul style="list-style-type: none"> Optical phenomena and properties of materials Describe the photoelectric effect and state its significance Define threshold frequency, f_0 Define work function, W_0 	<ul style="list-style-type: none"> Perform calculations using the photoelectric equation: $E = W_0 + K_{max}$, where $E = hf$ and $W_0 = hf_0$, and $K_{max} = \frac{1}{2} m v_{max}^2$ Explain the effect of intensity and frequency on the photoelectric effect Understand that the photo-electric effect demonstrates the particle nature of light Explain the formation of atomic spectra by referring to energy transition Explain the difference between atomic absorption spectra and atomic emission spectra 	<ul style="list-style-type: none"> Define oxidation & reduction in terms of electron transfer & oxidation numbers Define oxidising & reducing agents in terms of oxidation and reduction Define an anode and cathode in terms of oxidation and reduction Define an electrolyte Galvanic cells Define a galvanic cell State the function of salt bridge Predict the movement of ions and the direction of electron flow in external circuit Write half-reactions at each electrode & the overall cell reaction Predict in which half-cell oxidation/reduction takes place Use cell notation or diagrams to represent a galvanic cell Calculate emf for a galvanic cell Explain that V_{cell} decreases as [product ions] increases and [reactant ions] decreases and $V_{cell} = 0$ when equilibrium is reached, (the cell is 'flat') State the standard conditions under which standard electrode potentials are determined 	<ul style="list-style-type: none"> Describe the standard hydrogen electrode and explain its role as the reference electrode Explain how standard electrode potentials can be determined using the reference electrode, state the convention regarding positive and negative values Electrolytic cells Define an electrolytic cell Describe the movement of ions in the solution State the direction of electron flow in the external circuit Write equations for the half-reactions at the anode and cathode Write down the overall cell reaction Describe, using half-reactions and the equation for the overall cell reaction as well as the layout of the particular cell using a schematic diagram, the following electrolytic processes: <ul style="list-style-type: none"> The decomposition of copper(II) chloride Electroplating, e.g. the electroplating of an iron spoon with silver, nickel Refining of copper The electrolysis of a concentrated solution of sodium chloride 	<p>PAPER 1: 150 marks</p> <ul style="list-style-type: none"> Mechanics (85) Waves, sound, and light (15) Electricity and magnetism (55) <p>PAPER 2: 150 marks</p> <ul style="list-style-type: none"> Chemical change (92) Matter & materials (58) <p>The following Gr 10 and 11 topics will form part of the two papers:</p> <p>Paper 1:</p> <ul style="list-style-type: none"> Newton's laws (Gr 11) Electrostatics (Gr 11) Electric circuits (Gr 11) <p>Paper 2</p> <ul style="list-style-type: none"> Representing chemical change (Gr 10) Intermolecular forces (Gr 11) Energy and chemical change (Gr 11) Stoichiometry (application only) (Gr 11)
REQUISITE PRE-KNOWLEDGE	Electric circuits from Grade 11	Electric circuits from Grade 11	Electromagnetic induction Hand rules for direction of induced current	Electrical power	Wave properties: frequency, wavelength, amplitude Graphical representation of waves	Redox reactions	Redox reactions	

5

TERM 3	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8-11	
RESOURCES (OTHER THAN TEXTBOOK) TO ENHANCE LEARNING	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos pHET simulations YouTube & Mindset videos Previous question papers 	<ul style="list-style-type: none"> Apparatus for experiment below Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Apparatus: Chemicals and apparatus for experiment below Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	<ul style="list-style-type: none"> Mind the Gap Study guides YouTube & Mindset videos pHET simulations Previous question papers 	
ASSESSMENT	<ul style="list-style-type: none"> Informal Assessment: Remediation Corrections Homework 	<ul style="list-style-type: none"> Homework Informal test 	<ul style="list-style-type: none"> Homework Practical: Functioning of a simple electric motor (demonstration) 	<ul style="list-style-type: none"> Homework Informal test 	<ul style="list-style-type: none"> Homework Informal test 	<ul style="list-style-type: none"> Homework Informal test 	<ul style="list-style-type: none"> Homework 	<ul style="list-style-type: none"> Homework Informal test 	NA
SBA (FORMAL)	None	Formal practical (Physics): Internal resistance of a battery and equivalent resistance of resistors in series & parallel	None	None	None	None	Formal practical (Chemistry): Verify the reactions that take place in a galvanic cell and an electrolytic cell	Trial examination	

TERM 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5-10
CAPS TOPICS	TRIAL EXAM: Discussion (3 hrs)	TRIAL EXAM: Discussion (4 hrs)	CONSOLIDATION AND REVISION (4 hrs)	CONSOLIDATION AND REVISION (4 hrs)	FINAL EXAMINATION P1: 3 hrs P2: 3 hrs
TOPICS, CONCEPTS, SKILLS AND VALUES	Discussion, corrections, and remedial work of trial examination	Discussion, corrections, and remedial work of trial examination	All topics	All topics	PAPER 1: 150 marks <ul style="list-style-type: none"> • Mechanics (65) Momentum and impulse, vertical projectile motion, work, energy and power; Newton's laws (Gr 11) • Waves, sound, and light (15) Doppler Effect • Electricity and magnetism (55) Electric circuits, electrostatics, electrostatics (Gr 11), Electric circuits (Gr 11) • Matter & materials (15) Optical phenomena and properties of materials PAPER 2: 150 marks <ul style="list-style-type: none"> • Chemical change (82) Rate and extent of reaction, chemical equilibrium, acids and bases, representing chemical change (Gr 10), Energy and chemical change (Gr 11), stoichiometry (application only) (Gr 11) • Matter & materials (68) Organic molecules, intermolecular forces (Gr 11)
REQUISITE PRE-KNOWLEDGE	NA	NA	NA	NA	NA
RESOURCES (OTHER THAN TEXTBOOK) TO ENHANCE LEARNING	<ul style="list-style-type: none"> • Trial exam question papers 	<ul style="list-style-type: none"> • NA 	<ul style="list-style-type: none"> • Study guides • Previous question papers • Mindset & YouTube videos • Simulations 	<ul style="list-style-type: none"> • Study guides • Previous question papers • Mindset & YouTube videos • Simulations 	NA
ASSESSMENT	<ul style="list-style-type: none"> • Trial exam question papers 	<ul style="list-style-type: none"> • Trial exam question papers 	<ul style="list-style-type: none"> • Homework • Informal test 	<ul style="list-style-type: none"> • Homework • Informal test 	NA
SBA (FORMAL)	None	None	None	None	Final examination

The above ATP was sourced from the website of the Department of Education.

Theme 1: ATP followed/not followed.

Theme 1 shows that there is evidence that the ATP is followed in some instances and not followed in some.

In some cases, the ATP was followed and in other instances, it was not followed. This was examined by checking the day that specific topics were taught compared with the week number of the school calendar. For example, in week one, there should be evidence that the paper one topic was taught (momentum). In one school, learners were taught Paper two topics in week one (organic chemistry). This shows that the teacher reshuffled topics and did not follow the recommended sequence of teaching as stipulated in the ATP. This is evident in the field noted as attached.

Urban school A (ATP)-Evidence in the workbooks

PFL10-Book neatly covered. Handwriting visible and beautiful. Past question papers evident in the book. Feedback given for all work given. Teacher controlled all work given. P2 topics written at the start of term 1, whilst ATP directs P2 topic. Learner gets most of the answers correct. File for informal tests available, showing topics from the ATP. Some feedback given, they were not timely. Feedback given after 2 weeks of work given at some instances (especially on the worksheets).

PFL11 asked for her book not to be given to me. In case my parents see this even after assurance that her parents would not know if I took her book and wrote what was in it or not.

Rural Private school (ATP)-Evidence in the workbooks

PFL7-Book neatly covered. Handwriting visible and neat. Past question papers evident in the workbook. Feedback given to learners. Feedback somewhere is userfriendly, it aligns with the questions given, at some instances, it does not. Especially on the MCQ given. PFL8-Book neat. Handwriting visible. Feedback controlled by teacher and parent with an orange pen. Learner get most of the questions incorrect. PFL9-Book neatly covered. Handwriting visible. Did not write all activities given in class. Parent signature with an orange pen also visible in book.

Rural School A. (ATP) - evidence in the work books
Term 1 & 2 work audit.

PFL1 - work not categorised into classwork & homeworks.
work written as "activity". There is no distinction as to which work is done in class and which work is done at home. Past question papers pasted as questions, while some activities did not have questions which will not assist in revision.

More work is given, not all work is controlled and not all work is marked. One learner [PFL2] had less than 12 activities marked. There was no teacher's signature.

PFL3 had more activities than the other 2 participants. All topics from term 1 & 2 covered as per PFL3's Activity Book, as directed by the ATP

Rural School B (ATP) - evidence in the workbooks

PFL4 - work written well, dates clearly visible, good handwriting. All topics covered except for Cracking as a subtopic. Term 1 started with P1 topics and followed the ATP as it prescribed. Not all homeworks had feedback. 2 homeworks at the end of term 1 were not marked. PFL5 did not bring her work book (classwork and homework book).

PFL6 - work written well, dates clearly visible. teacher signed all work given, except for the 2 last works for term 2 as with PFL4.

The interpretation of the above paragraph is that, if a formal question paper with questions on momentum were to be sent to schools nationally, the learners who had not covered the topic would be disadvantaged, and this would increase their

chances of not performing well in the test. Additionally, if there are extra classes organised by the district on week four, they will follow the ATP and teach learners topics from week one to week four. This would disadvantage the learners from the above-mentioned school as other learners would have knowledge of the week one to week four topics.

Sub-theme 1.1 The number of classwork assignments correlates/does not correlate to those expected by the ATP.

In some schools, there was insufficient work output, while other schools had more than enough work output. This was seen through the number of classwork and homework assignments given in comparison with the number of days that learners were at school with a Physical Sciences period attended. For every one-hour period, there should be at least one informal assignment allocated. The urban public school, the rural private school and one rural public school had more than the required work output. Sadly, for one rural public school, there was evidence of insufficient work given to the learners in their informal classwork and homework book.

The interpretation of the above paragraph is that, in the three schools with sufficient informal work given, the teachers were teaching and allocating assessments as required. This assists in testing whether learners have understood what was on the lesson plan and whether the objectives of the lesson were reached or not. If the objectives were reached, then the next lesson would be taught. If not, the same lesson would be taught again with the same objectives but using a different approach. The repeated lesson would be taught in a different timeslot, either as an extra class or in the next available Physical Sciences period.

Sub-theme 1.2 Informal practical not done as directed by the ATP.

There is not one visited school that had a laboratory. All the schools relied on

external practical offerings such as the University of Limpopo to perform experiments/practicals. PhET (Physics Education Technology) simulations were used in the rural private school and the urban public school. You-Tube videos were used in the other two rural schools. All formal practicals were performed, according to the evidence provided. The learners had scripts of formal practical performed. There was no evidence of informal practicals in all the schools visited. Informal practicals are practicals that are recommended by the ATP but do not form part of the yearly marks accumulated by the learner, they do not form part of the SBA. The formal practicals that form part of the SBA (School Based Assessment), were all conducted on time.

Informal practicals assist learners to understand the theoretical aspects of Physical Sciences. If informal practicals are not done, even through the use of PhET simulations, learners are disadvantaged as their understanding of the theoretical aspects of Physical Sciences is hindered. Learners that find it difficult to understand Physical Sciences without practicals will be further disadvantaged.

Sub-theme 1.3 ATP topics covered.

All the classwork books reviewed had evidence of all topics as per the ATP, except one school which had all topics covered but not all subtopics. One subtopic (Cracking) was not evident in the schoolwork books of learners from the second rural public school. This is not something new to South African schools, as some teachers and Departmental Heads regards documents like ATP as a “tick-a-box” exercise (Mkhwanazi, Ndlovu, Ngema & Bansilal, 2021).

5.4.2 Female learners’ scripts

Theme	Sub-theme
2. Feedback not written on time/not written correctly	2.1 Feedback written on time
	2.2 Feedback not user-friendly to learners.

Feedback refers to the correction of incorrect answers in written work, with the hopes of enriching the learning of learners. There is evidence of feedback given to learners for some work outputs. However, the feedback is not given on time. Also, there are answers which need to be further explained by showing the steps used to reach them, so that learners can be able to do self-study when alone.

Learner scripts (June exam) [PHW] P. 42

Rural private school

PFL7 got level 2.

PFL8 got level 6.

PFL9 got level 7.

Scripts of other learners not participating in the study were not made available to me.

The teacher also requested that no pictures or videos be taken from the document I was provided with.

Urban public school

PFL10 got level 7

PFL11 got level 6

PFL12 got level 7

The teacher showed me learner scripts for the learners I had interviewed. They were level 6 and two level 7's.

Rural school A
PFL1 got level 1
PFL2 got level 1
PFL3 got level 2
The other girls that were not part of the study,
their marks ranged from level 1 to 4, feedback given
not satisfactory. MCA not explained.

Rural school B
PFL4 got level 3
PFL5 got level 6
PFL6 got level 3
The teacher mentioned that 2 of the interclass
teachers' scripts were still at the circuit in the SBA
file for moderation. Feedback given to learners
as evidence in their scripts.

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Theme 2: Feedback written and not written correctly.

Theme 2 elaborated on the feedback given/not given to learners.

Sub-theme 2.1 Feedback written.

Findings of this study reveal that teachers provide feedback to learners. There is evidence of feedback for every assignment given, and there is also evidence of controlled feedback. However, the feedback given is not timely. In the two rural schools, there were instances in which a teacher had given concurrent assignments on different dates, without feedback provided for the first assignment. The teacher would later give feedback of all the work that required feedback, in one day. This is not assisting learners, as they might have forgotten why they got some answers wrong in a previous assignment. It is recommended that after every assignment given, there should be feedback given during the same or the next lesson.

Sub-theme 2.2 Feedback not user-friendly

to learners.

Sub-theme 2.2 shows that the feedback given to learners is not user-friendly.

In a multiple-choice test, if a learner got an answer wrong, only the correct letter was written, with no explanation as to why that letter is correct. In this case, when there are 10 multiple choice questions given, all of them should have an explanation as to how the examiner arrived at that answer. This not only increases the content knowledge of learners but also equips them with skills on how to answer multiple-choice questions, hence, it is paramount to provide feedback after work given (Irons & Elkington, 2021).

5.4.3 Question paper (June examination)

Theme
1. June question paper standardised.

The June/ mid-year question paper is set by the Limpopo Provincial Department of Education, which prepares learners for the trial examination and final examination, which is set nationally. The paper 1 and paper 2 question papers were all standardised.

Theme 1: June question paper standardised.

Theme 1 shows that the trial (Limpopo, June 2023) question papers (Paper 1 and Paper 2) were standardised. Bloom's taxonomy was correctly utilised. Below is a copy of the June 2023 P1 and P2 question papers, which show which questions fall under which level in Bloom's taxonomy.



LIMPOPO

PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)
JUNE 2023

*Bloom's taxonomy checked
by Mphasha E.S*

MARKS: 150

TIME: 3 hours



MEPHSCP1

<i>Bloom's level</i>	<i>Marks</i>	<i>% actual</i>	<i>% expected</i>
1	25	16	15%
2	52	35	35
3	57	38	40
4	16	11	10

This question paper consists of 17 pages and 3-paged data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1 (Start on a new page)

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E. Each question has only ONE correct answer.

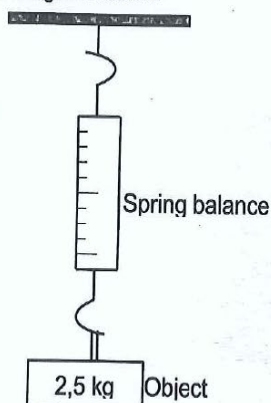
1.1 Which ONE of the following, regarding frictional force, is CORRECT?

- A It depends upon the area of contact
- B It depends upon the velocity of motion
- C It is proportional to the normal force
- D It is proportional to the applied force

(1)

(2)

1.2 An object of mass 2,5 kg hangs from the end of a spring balance which is graduated in newtons, as shown in the diagram below.



The reading on the spring balance is the SMALLEST when the system ...

- A is completely stationary.
- B is lifted up at $9,8 \text{ m/s}^2$.
- C is allowed to fall freely.
- D rises at constant velocity.

(1)

(2)

1.3 A person pulls on a wagon. Which one of the following is the force that makes him/her move in a forward direction?

- A The force of the person on the wagon
- B The force of the wagon on the person
- C The force of the ground on the person
- D The force of the person on the ground

(2)

1.4 A ball is dropped from a certain height above the floor. It bounces to a **quarter** of its original height. If air friction is ignored, which one of the following is the ratio of the speed of the ball immediately after impact with the ground to its speed immediately before impact?

- A 1 : 2
- B 2 : 1
- C 4 : 1
- D 1 : 4

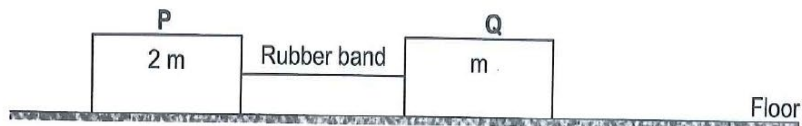
(2)

1.5 Starting from rest, ball X falls freely for 3 s and ball Y falls freely for 6 s. The distance travelled by ball Y, compared to the distance travelled by ball X is ...

- A half as far.
- B twice as far.
- C 3 times as far.
- D 4 times as far.

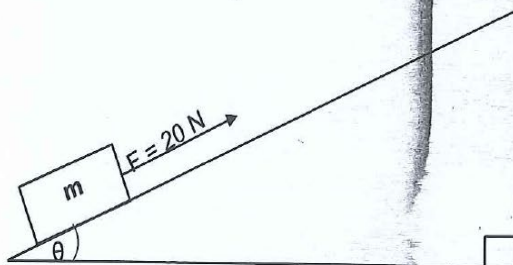
(2)

- 1.6 The sketch below shows two blocks that are connected by a rubber band. Block P has a mass TWICE that of block Q.



The blocks are pulled apart on a smooth, horizontal floor and released SIMULTANEOUSLY. When they are released, the blocks collide with each other, ...

- A and are brought to rest.
- B unite and move to the right. ②
- C unite and move to the left.
- D and move in opposite directions. (2)
- 1.7 A block with mass m is pulled up a ROUGH, inclined plane with a constant force of 20 N, as shown in the diagram below.



If the net work done on the block is equal to ZERO, then ... ②

- A the block is moving at a constant speed.
- B the block is accelerating up the incline.
- C a non-zero net force is acting on the block.
- D a 20 N frictional force is acting on the block. (2)

1.8 Which ONE of the following quantities would be equal to the work done in moving an object along a frictionless surface?

- A Change in momentum
- B Change in kinetic energy
- C Change in potential energy
- D Change in frictional force

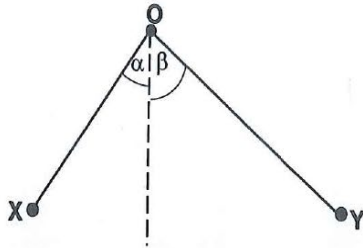
(2)

1.9 Which ONE of the following is the main *physics principle* applied in the flow meter which measures blood flow rate?

- A Redshift
- B Blueshift
- C Photoelectric effect
- D Doppler effect

(2)

- 1.10 Two small charged spheres, X and Y, of small masses are hung by IDENTICAL fine nylon threads from a fixed point O. In equilibrium, the angle α is LESS THAN the angle β , as shown in the diagram below.



Which ONE of the following statements is CORRECT?

- A The charge on X is greater than that on Y
- B The charge on X is smaller than that on Y
- C The mass of X is less than that of Y
- D The mass of X is greater than that of Y

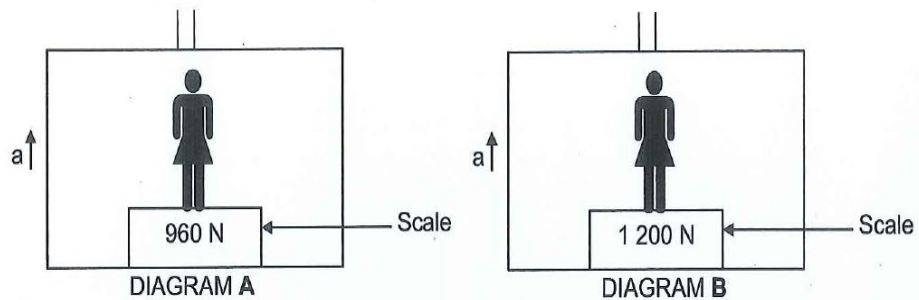
3

(2)
[20]

QUESTION 2 (Start on a new page)

A grade 12 physics learner is standing on a bathroom scale in an elevator (lift). The lift moves upwards with a constant acceleration. The scale reads 960 N. (see diagram A below).

When the learner carries a 20 kg box, the lift still accelerating upwards with the same constant acceleration, the scale reads 1 200 N (see diagram B below).



- 2.1 Describe the term *weight* in words. ① (2)
- 2.2 Calculate the learner's weight. ③ (6)
- [8]**

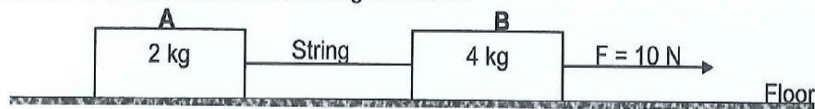
QUESTION 3 (Start on a new page)

3.1 An astronaut, whose mission is to go where no one has gone before, lands on a spherical planet in a distant galaxy. As he/she stands on the surface of the planet, he/she releases a small rock *from rest* and finds that it takes the rock 0,6 s to fall 1,9 m. Ignore the effects of air resistance.

3.1.1 State *Newton's Law of Universal Gravitation* in words. ① (2)

3.1.2 Calculate the mass of this planet if its radius is 9×10^7 m. ④ (5)

3.2 Two blocks, **A** and **B**, mass 2 kg and 4 kg respectively, are connected with a light, inelastic string and placed on a horizontal floor. The 4 kg block is pulled to the right with a force of 10 N, as shown in the diagram below.



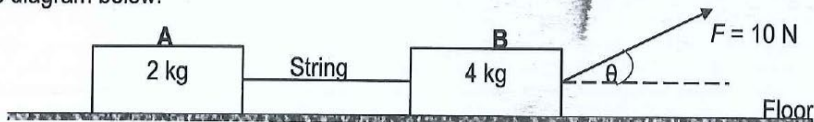
As the blocks are moving, the 2 kg block experiences a frictional force of 1,50 N and the 4 kg block a frictional force of 2,50 N.

3.2.1 State, in words, *Newton's Second Law of motion*, in terms of acceleration ① (2)

3.2.2 Draw a labelled free-body diagram for block **A**. ② (4)

3.2.3 Calculate the acceleration of block **B**. ② (5)

The force F of 10 N is now applied at an acute angle θ with respect to the horizontal, as shown in the diagram below.



State whether the magnitude of EACH of the following quantities INCREASES, DECREASES or REMAINS UNCHANGED:

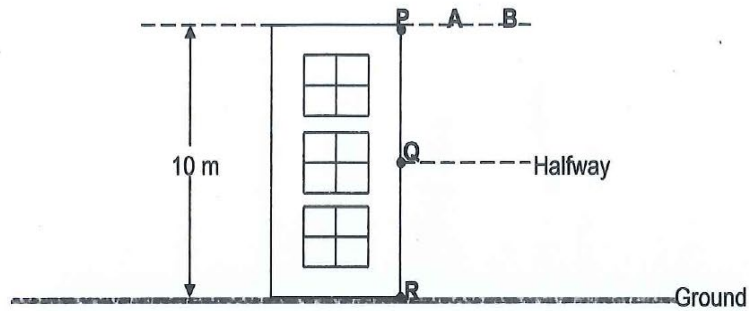
3.2.4 The acceleration of the block ③ (1)

3.2.5 The tension in the connecting string ③ (1)

[20]

QUESTION 4 (Start on a new page)

A building is 10 m tall. From the top of the building (at point P), a stone A is dropped from rest. When the stone A is **halfway** down, a second stone B is thrown straight down from the top of the building. The two stones strike the ground (at point R) **SIMULTANEOUSLY**.



Neglect the effect of air resistance.

- 4.1 Define the term *free-fall*. (1) (2)
- 4.2 Write down the magnitude of the acceleration of stone B when it passes point Q. (1) (1)
- 4.3 Draw a labelled free-body diagram for stone A when it passes point Q. (1) (1)
- 4.4 Calculate the:
- 4.4.1 Initial speed of the second stone B (3) (6)
- 4.4.2 Speed of stone A the instant it strikes the ground at point R (3) (3)
- 4.4.3 Speed of stone B just as it hits the ground (3) (3)

4.5 Draw velocity-versus-time sketch graphs for the entire motions of the two stones, A and B, on the same set of axes. Label the graphs A and B.

Clearly indicate the values of the following on the graphs:

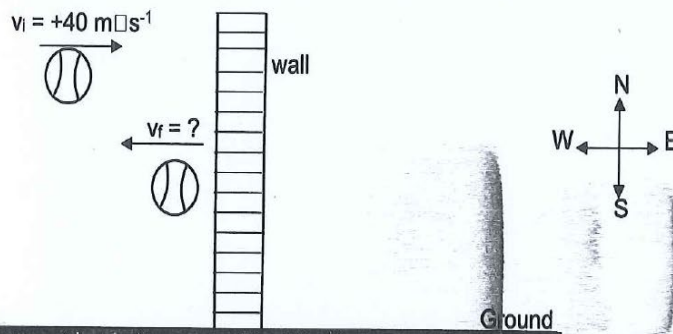
- The initial velocity of stone B
- Time at which the balls strike the ground
- Time at which stone B is projected
- Final velocity of stone A

3

(4)
[20]

QUESTION 5 (Start on a new page)

A tennis ball (with a mass of 0,06 kg) strikes a wall perpendicularly at 40 m s^{-1} and bounces back. The magnitude of its momentum change is $4,2 \text{ kg m s}^{-1}$.



Neglect the effects of air resistance and gravitational forces.

5.1 Define, in words, the term *impulse* as applied in physics. (1) (2)

5.2 Write down the magnitude of the impulse the wall exerted on the ball. (2) (1)

The wall and the ball are in contact for approximately 0,05 s.

5.3 Calculate the magnitude of the:

5.3.1 Average net force exerted on the ball (2) (4)

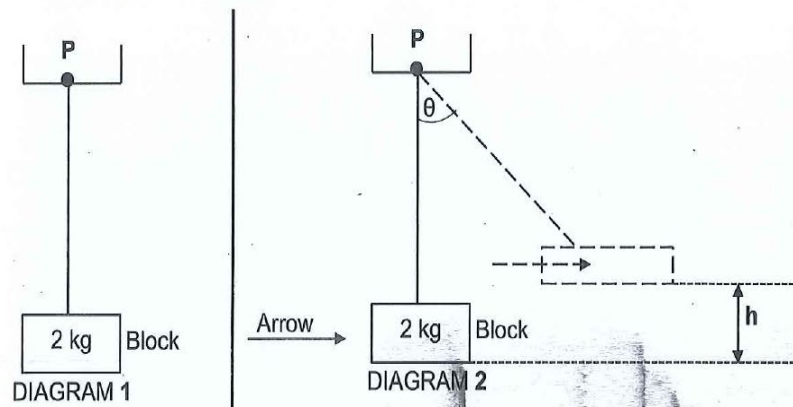
5.3.2 Final velocity of the ball (2) (4)

- 5.4 Draw labelled vector diagrams (not to scale) to illustrate the relationship among the initial momentum (p_i), the final momentum (p_f) and the change in momentum (Δp) for the tennis ball. (3)

[14]

QUESTION 6 (Start on a new page)

A wooden block of mass 2 kg (length 1,5 m) is suspended by a light, inextensible string which is fixed at point P (Diagram 1 below).



The arrow of mass 0,10 kg is now shot horizontally towards the wooden block and strikes it at 42 m s^{-1} . It penetrates and embeds into the block after hitting it. The block arrow system swings to a height h from the original position, as diagram 2 above illustrates.

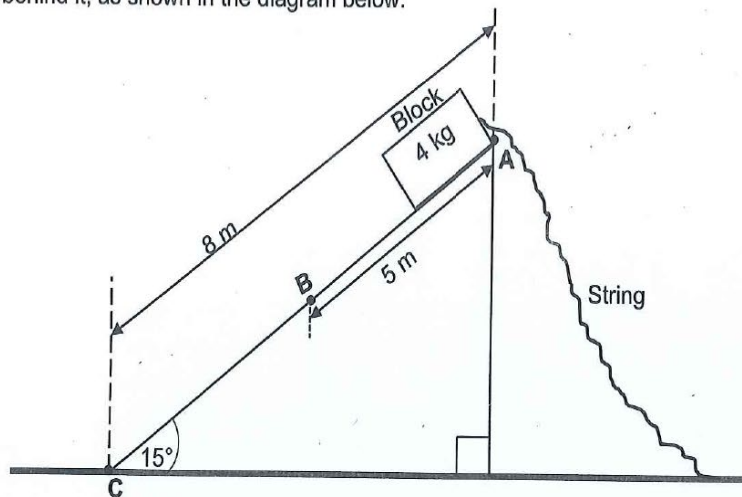
Neglect the effects of air resistance.

- 6.1 State, in words, the *principle of conservation of linear momentum*. (1) (2)
- 6.2 Calculate the:
- 6.2.1 Magnitude of the change in momentum that the arrow experiences (3) (5)
- 6.2.2 Vertical height h to which the block (and the arrow) swings (6) (4)
- 6.3 Hence, find the size of angle θ , shown in DIAGRAM 2 above. (3) (2)

[13]

QUESTION 7 (Start on a new page)

A 4 kg block is released from rest at the top of a frictionless plane of length 8 m that is inclined at angle of 15° to the horizontal. A light, inextensible string is attached to the block and trails along behind it, as shown in the diagram below.



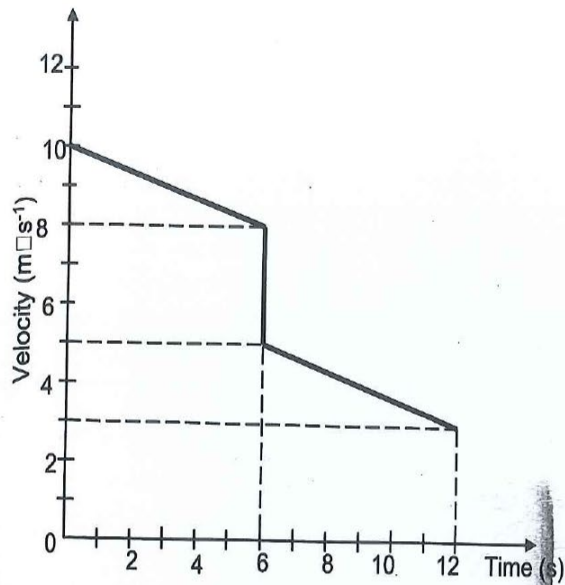
When the block reaches a point 5 m along the incline from the top, a physics educator grasps the string and exerts a constant tension parallel to the incline. The tension is such that the block just comes to rest when it reaches the bottom of the incline.

- 7.1 Classify *tension* as a CONSERVATIVE or NON-CONSERVATIVE force. (1)
- 7.2 Draw a labelled free-body diagram for the block whilst moving downhill after passing point B. (3)
- 7.3 Use energy principles ONLY to calculate the magnitude of the constant tension in the string. (5)
- [9]

QUESTION 8 (Start on a new page)

A trolley of mass 8 kg is moving at 10 m s^{-1} at time $t = 0 \text{ s}$. It rolls along a ROUGH floor. At time $t = 6 \text{ s}$, a lump of wet clay is dropped vertically onto the trolley.

The velocity-versus-time sketch graph for the motion of the trolley is shown below.

VELOCITY-VERSUS-TIME SKETCH GRAPH FOR THE MOTION OF THE TROLLEY

- 8.1 State the *work-energy theorem* in words. (1) (2)
- 8.2 Using the graph, calculate the work done by the frictional force in the FIRST 6 s. (3) (3)
- 8.3 Hence or otherwise, determine the mass of the clay dropped onto the trolley. (4) (3)
- [8]

QUESTION 9 (Start on a new page)

9.1 At an air show, a jet flies overhead in a straight line. It approaches the spectators on the ground at 220 m s^{-1} and produces a wave with a wavelength of $7 \times 10^{-2} \text{ m}$. The speed of sound at that place is 340 m s^{-1} .

9.1.1 Write down the *Doppler effect* in words. (1) (2)

9.1.2 Calculate the frequency with which the spectators hear the sound as the jet flies towards them. (5)

9.1.3 Write down the frequency with which the spectators hear the sound at the *instant* the jet passes *directly overhead*. Suggest a reason for the answer. (2)

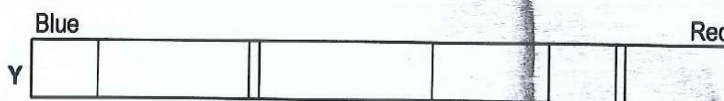
Draw three wave patterns that show what the spectators hear, clearly showing the differences as the jet: (Ensure that the spectators are on the right of the diagrams).

9.1.4 Approaches them (2) (2)

9.1.5 Flies overhead, and (2) (2)

9.1.6 Flies away from them (2) (2)

9.2 The diagrams below show the absorption spectrum of the same element, with X being observed in a laboratory on Earth, and Y being that of a distant star.



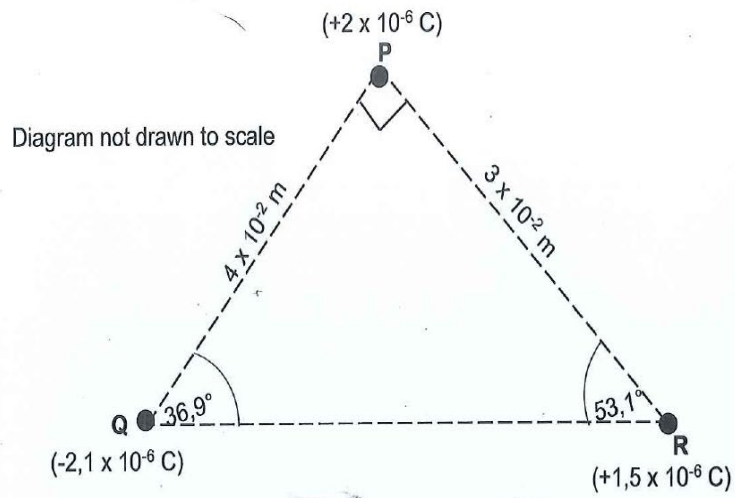
Is the star moving TOWARDS or AWAY FROM the Earth?

Explain the answer (2) (3)

[18]

QUESTION 10 (Start on a new page)

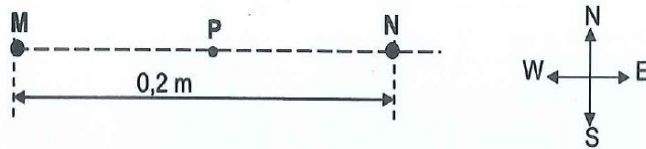
- 10.1 Three small charged metal spheres **P**, **Q** and **R** with charges $+2 \times 10^{-6} \text{ C}$, $-2,1 \times 10^{-6} \text{ C}$ and $+1,5 \times 10^{-6} \text{ C}$ respectively, are placed at the vertices of a right angled triangle, as shown in the diagram below. Sphere **P** is $0,04 \text{ m}$ from sphere **Q** and $0,03 \text{ m}$ from sphere **R**.



- 10.1.1 State *Coulomb's Law* in words. (1) (2)
- 10.1.2 Calculate the magnitude of the electrostatic force exerted on sphere **P** due to the presence of sphere **Q** and **R**. (3) (6)
- 10.2 Define, the term *electric field at a point* in words. (1) (2)
- 10.3 Describe the effect on the electric field at a point if:
- 10.3.1 The magnitude of the charge producing the field is *halved*. Briefly explain the answer. (2) (2)

- 10.3.2 The magnitude of the *test charge* in the field is *doubled* (state only NO EFFECT, HALVES or DOUBLES) (2) (1)

- 10.4 Two charged particles are placed 0,2 m apart at points M and N (as shown in the sketch below). P is a point *midway* between M and N: The magnitude of the charge at M is unknown while the magnitude of the charge at N is $+2 \times 10^{-9}$ C.



The net electric field at P due to the presence of BOTH charges is $5\,400 \text{ N}\cdot\text{C}^{-1}$ due WEST.

- 10.4.1 Write down the sign (POSITIVE or NEGATIVE) of the charge on the particle at point M. (1)
- 10.4.2 Calculate the magnitude of the charge on the particle at point M. (6)

GRAND TOTAL: [150]



LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

**NATIONAL SENIOR
CERTIFICATE**

GRADE 12

**PHYSICAL SCIENCES
PAPER 2 (CHEMISTRY)
JUNE 2023**

*Bloom's taxonomy checked
by Mphahla E.S*

MARKS: 150

TIME: 3 hours



MEPHSCP2

Bloom's levels	Marks	%actual	%expected
1	23	15	15
2	61	41	40
3	52	35	35
4	9	9	10

This question paper consists of 19 pages including DATA SHEETS

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Please turn over

INSTRUCTIONS AND INFORMATION

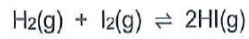
1. The question paper consists of seven questions. Answer ALL the questions.
2. Start EACH question on a NEW page.
3. Number your answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub-questions, e.g., between QUESTION 2.1 and QUESTION 2.2.
5. A non-programmable calculator may be used.
6. Appropriate mathematical instruments may be used.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. You are advised to use the attached data sheets.
11. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10), for example 1.10 E.

- 1.1 The number of structural isomers of the alcohol with the molecular formula C_3H_7OH is:
- A. 0
 - B. 1
 - C. 2
 - D. 3
- (2)
- 1.2 Which organic compound has the highest boiling point?
- A. hexane
 - B. butane
 - C. propane
 - D. ethane
- (2)
- 1.3 Alkenes:
- A. are a good example of a series of saturated hydrocarbons.
 - B. can undergo hydrogenation to form the corresponding alkynes.
 - C. react with bromine in addition reactions.
 - D. are not usually branched structures.
- (2)

1.4 Consider the following reaction:

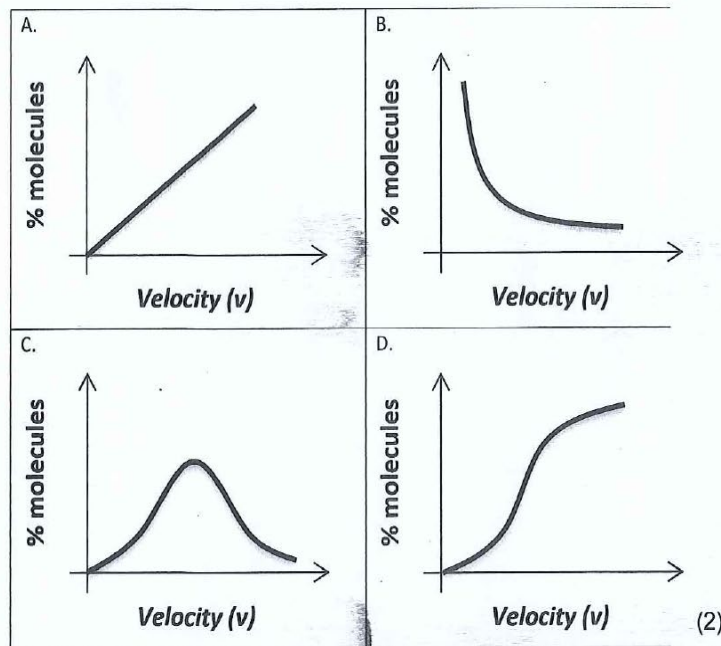


The activation energy for the forward reaction is 181,5 kJ and for the reverse reaction 192,8 kJ. What is the heat of formation of 2HI (g)?

- A. -374,3 kJ
- B. -11,3 kJ
- C. +11,3 kJ
- D. +374,3 kJ

(2)

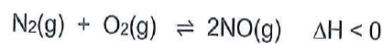
1.5 Which one of the following sketch graphs best represents the distribution of the velocities of the molecules in a sample of gas?



(2)

(2)

- 1.6 The RATE at which NO (g) is formed in the following reaction can be increased by:



- A. increasing the concentration of NO(g).
 B. increasing the volume of the container.
 C. decreasing the temperature. ②
 D. adding a catalyst.

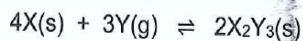
(2)

- 1.7 If a chemical system is in dynamic equilibrium, it implies that:

- A. the reactants and products always have the same masses.
 B. the reactants and products have the same concentrations.
 C. the equilibrium constant becomes zero. ②
 D. the forward and reverse reactions occur simultaneously at the same rate.

(2)

- 1.8 The equilibrium constants for the equilibrium reaction are 3×10^{-5} and 2×10^{-6} at temperatures of 313 K and 333 K respectively.



Choose the CORRECT statement.

A. For the forward reaction: $K_c = \frac{[\text{X}_2\text{Y}_3]^2}{[\text{X}]^4[\text{Y}_2]^3}$ ③

B. For the forward reaction: $K_c = \frac{[\text{X}]^4[\text{Y}_2]^3}{[\text{X}_2\text{Y}_3]^2}$

C. The forward reaction is exothermic.

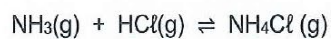
D. The forward reaction is endothermic.

(2)

1.9 Pure water is neutral because:

- A. $[H^+] = [OH^-]$
- B. it is very weakly ionized.
- C. $[H^+][OH^-] = 10^{-14}$ ②
- D. the equilibrium of the reaction $H_2O \rightleftharpoons H^+ + OH^-$ lies far to the left. (2)

1.10 The next reaction is a Lowry-Bronsted acid-base reaction.



The reason for the reaction to be classified as an acid-base reaction is that...

- A. NH_3 receives a proton.
- B. HCl receives a proton. ②
- C. NH_3 donate a proton.
- D. HCl donate an electron. (2)

[20]

QUESTION 2 (Start on a new page.)

Consider the organic compounds represented by the letters A to J in the table below.

A.	butane	B.	$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3 - \text{CH}_2 - \text{C} - \text{OH} \end{array}$
C.	CHCl_3	D.	butan-2-ol
E.	butan-1-ol	F.	$\begin{array}{c} \text{CH}_3 - \text{C} = \text{CH} - \text{CH}_3 \\ \\ \text{CH}_3 \end{array}$
G.	2-methylpropane	H.	$\text{CH} \equiv \text{CH}$
I.	$\begin{array}{ccccccc} & \text{H} & \text{H} & & \text{O} & & \\ & & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{O} & - \text{C} & - \text{H} \\ & & & & & & \\ & \text{H} & \text{H} & & & & \end{array}$	J.	$\text{C}_n\text{H}_{2n+2}$

- 2.1 Define a *hydrocarbon*. (1) (2)
- 2.2 Write down the letter(s) that represent(s) the following:
- 2.2.1 A Primary alcohol. (1) (1)
- 2.2.2 TWO compounds that are chain isomers. (2) (1)
- 2.2.3 A weak monoprotic acid. (1) (1)
- 2.2.4 The general formula of the homologous series to which butane belongs. (1) (1)
- 2.3 Write down:
- 2.3.1 The IUPAC-name of compound F. (2) (2)
- 2.3.2 The NAME of the homologous series to which compound C belongs. (1) (1)
- 2.3.3 The STRUCTURAL FORMULA of the functional group of H. (1) (1)

- 2.3.4 A balanced equation for the complete combustion of compound H using MOLECULAR FORMULAE. (3)
- 2.4 Compound I is the product of an esterification reaction. For Compound I, write down the:
- 2.4.1 IUPAC-name. (2)
- 2.4.2 STRUCTURAL FORMULA of the alcohol from which it is synthesised. (2)
- 2.4.3 IUPAC-name of the carboxylic acid from which it is synthesised. (1)
- 2.5 "Propanoic acid is a functional isomer of compound I." Explain this statement fully, using molecular and structural formulas for both isomers to indicate differences and similarities. (4)

[22]

QUESTION 3 (Start on a new page.)

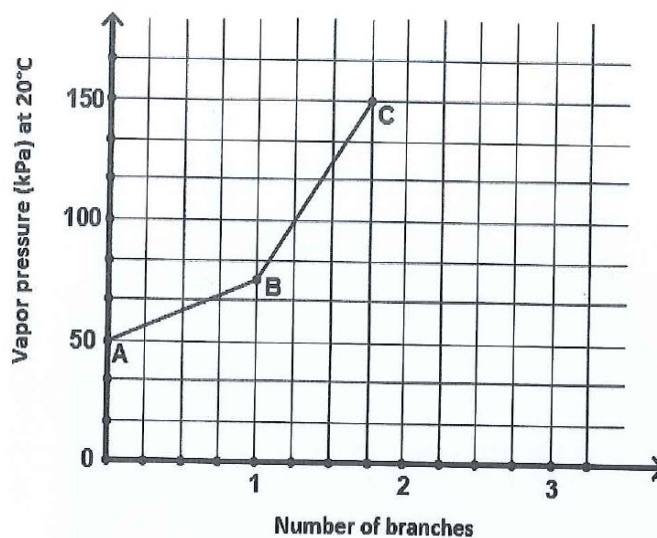
- 3.1 Alkanes are primarily used as fuels. Study the energy values of different compounds.

Fuel	Energy (kJ.mol ⁻¹)	Energy (kJ.g ⁻¹)
coal	394	33
octane	5 510	48
butane	2 636	45
methane	890	

- 3.1.1 Write a balanced equation for the complete combustion of butane using molecular formulas. (3)
- 3.1.2 Using a calculation, determine which fuel, BUTANE or METHANE, releases the most energy per mass (kJ.g⁻¹). (3)
- 3.1.3 Give one reason why many industries prefer to use coal as fuel, despite a low energy per mole ratio? (1)

- 3.2 The vapor pressure data of three chain isomers, **A**, **B**, and **C**, with the molecular formula, C_5H_{12} , are shown graphically.

Graph of vapor pressure versus number of branches.



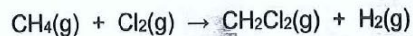
- 3.2.1 Define the term *chain isomer*. (1) (2)
- 3.2.2 Use the graph to estimate the vapor pressure of the straight chain isomer of C_5H_{12} at 20°C. (1) (3)
- 3.2.3 Write the STRUCTURAL FORMULA of compound **C**. (2) (2)
- 3.2.4 Explain the difference in vapor pressure of compound **A** and **B**. (3) (2)
Refer in your explanation to the STRUCTURE of the molecule, TYPE and STRENGTH of the INTERMOLECULAR FORCE(S).

- 3.3 The boiling points of three compounds, **D**, **E**, and **F**, are shown in the table.

Compound	Condensed structural formula	Boiling point (°C)
D	CH ₃ OH	78
E	CH ₃ CH ₂ CH ₂ OH	97
F	CH ₃ Cl ₂	39,6

- 3.3.1 Write down the NAME of the type of intermolecular force responsible for the difference in boiling points of compound **D** and **E**. (1) (2)
- 3.3.2 Explain the difference in boiling points of compound **D** and **F** by referring to the TYPE and STRENGTH of the intermolecular forces. (3)

Compound **F** is now prepared at standard conditions (STD) by the reaction between methane and chlorine as shown by the equation:

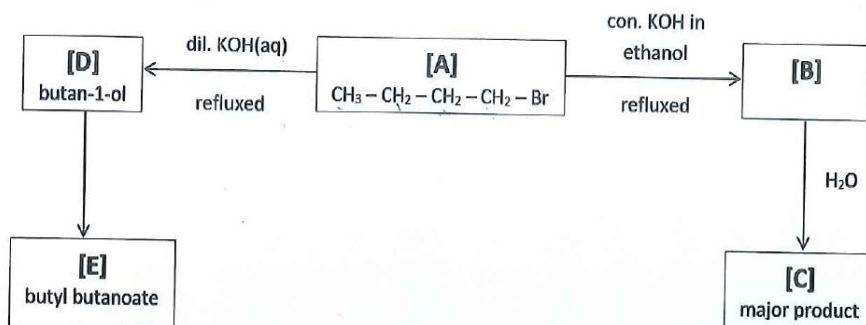


- 3.3.3 Write down the NAME of the type of reaction that leads to the formation of compound **F**. (1) (1)
- 3.3.4 During the reaction, 26,88 dm³ CH₄ produces about 0,043 kg CH₂Cl₂. Calculate the percentage yield after the course of the reaction. (3) (5)

[26]

QUESTION 4 (Start on a new page.)

Use the different reactions given in the diagram below to answer the questions that follow.



- 4.1 Define a *homologous series*. (1) (2)
- 4.2 Write down the homologous series to which compound [A] belongs. (1) (2)
- 4.3 Make use of condensed structural formulas and write a balanced equation for the conversion of compound [A] to compound(s) [B]. (4) (3)
- 4.4 Is the organic product [B] SATURATED or UNSATURATED? (1) (2)
- 4.5 Give a reason for your answer in QUESTION 4.4. (1) (2)
- 4.6 Compound [B] is allowed to react with water in the presence of H_2SO_4 to form compound [C].
- For compound [C], write the:
- 4.6.1 structural formula. (2) (3)
- 4.6.2 IUPAC name. (2) (3)
- 4.7 Name the type of reaction that takes place during the conversion of [A] to [D]. (1) (2)
- 4.8 Consider compound [E].
- 4.8.1 Name TWO reaction conditions during the reaction from [D] to [E]. (2) (2)
- 4.8.2 Write the structural formula of butyl butanoate. (2) (3)

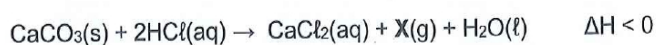
4.8.3 Give the IUPAC name of the carboxylic acid that reacted with [D] to give [E] as product. (1)

4.8.4 What inorganic product forms during this reaction? (1)
[20]

QUESTION 5 (Start on a new page.)

The reaction between calcium carbonate and hydrochloric acid is carried out to investigate one of the factors affecting reaction rate.

The reaction that takes place is represented by the following chemical reaction:



5.1 Identify gas X. (2)

5.2 Two experiments are performed.
The conditions for each experiment are given in the table below:

Exp.	Mass CaCO ₃ (s) (g)	State of division of CaCO ₃ (s)	Concentration of HCl (mol.dm ⁻³)	Temperature of HCl(aq) (°C)
1	4	pieces	0,2	40
2	4	pieces	0,4	40

5.2.1 Define, in words, the term reaction rate by referring to the concentration of hydrochloric acid. (2)

5.2.2 Give the independent variable, as derived from the above table (1)

5.2.3 Give a reason why the learners use the same equal masses and the same state of division of the CaCO₃(s). (1)

The reaction rate is HIGHER in **experiment 2** than in **experiment 1**.

5.2.4 Use the collision theory to explain this observation. (3)

5.2.5 Refer to **experiment 2** and calculate the volume of hydrochloric acid (in cm³) that reacts with the CaCO₃(s). (4)
Assume that the CaCO₃(s) is the limiting reagent.

5.3 Sketch a POTENTIAL ENERGY versus REACTION COORDINATE graph for this reaction.

Label the axes and show the following on the graph:

- Heat of reaction
- Activation energy
- Activated complex

3

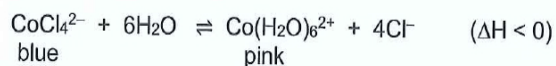
(4)

QUESTION 6 (Start on a new page.)

[17]

6.1 A solution of cobalt chloride in ethanol is blue owing to the formation of CoCl_4^{2-} ions.

If this solution is diluted sufficiently with water, it turns pink because of the formation of $\text{Co}(\text{H}_2\text{O})_6^{2+}$ ions according to the reversible reaction:



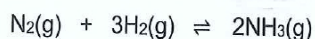
What will you OBSERVE in each case if:

6.1.1 the pink solution is heated strongly? 2 (2)

6.1.2 CONCENTRATED sulphuric acid is added to the blue solution? 3 (2)

6.1.3 CONCENTRATED hydrochloric acid is added to the pink solution? 3 (2)

6.2 A learner answered a question about the effect of pressure increase (at constant temperature) on the percentage yield during the preparation of ammonia:



"The effect of an increase in pressure is a decrease in volume. According to Le Chatelier's principle, the reaction which opposes the decrease in volume will be favoured. As the formation of ammonia is accompanied by a decrease in volume, this reaction will be opposed, and the percentage yield will be decreased."

6.2.1 Do you consider the above reasoning to be CORRECT or INCORRECT? 2 (1)

6.2.2 Explain your answer to QUESTION 6.2.1. 3 (4)

- 6.3 The following reaction reaches equilibrium in a closed container at a fixed temperature (T):



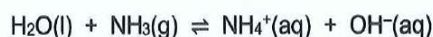
At equilibrium: $[\text{SO}_3] = 0,04 \text{ mol.dm}^{-3}$
 $[\text{SO}_2] = 0,5 \text{ mol.dm}^{-3}$
 mass $\text{O}_2 = 19,2 \text{ g}$
 $K_c = 31,25$

- 6.3.1 Define *chemical equilibrium*. (2)
- 6.3.2 Calculate the volume of the container. (8)

[21]

QUESTION 7 (Start on a new page.)

- 7.1 Consider the reaction below:

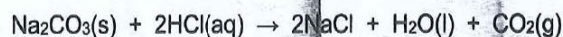


In this reaction, ammonia is a weak base.

- 7.1.1 Define the term *weak base*. (2)
- 7.1.2 Use the information in the equation and explain why ammonia is a Lowry-Bronsted base. (2)
- 7.1.3 Identify the conjugate acid of NH_3 in the reaction. (1)
- 7.1.4 Write down an equation for the hydrolysis of ammonium ions in the solution. (2)
- 7.2 Concentrated hydrochloric acid (HCl) is added to water. The sample of water is tested, and the pH is found to be 3,5.

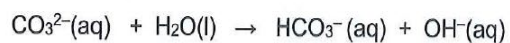
- 7.2.1 State which ions (OH^- or H_3O^+) were in excess in the sample. (1)
- 7.2.2 Calculate the concentration of the H_3O^+ - ions in the sample. (3)

Sodium carbonate is now added to the water sample to restore the pH of the water to a value close to 7.



- 7.2.3 Define the term *neutralization*. (2)

- 7.2.4 Calculate the mass of sodium carbonate needed to neutralize each 1 dm³ of the water sample. (6)
- 7.2.5 After neutralization, the water has a salty taste. Give a reason for the salty taste of the water. Refer to the comparison above. (2)
- 7.3 An aqueous solution of sodium carbonate was prepared by adding distilled water.



- 7.3.1 Is the solution ACIDIC, BASIC, or NEUTRAL? (1)
- 7.3.2 Use information from the equation to explain the answer to QUESTION 7.3.1. (2)

TOTAL 150

[24]

The above question papers show fairness in terms of the usage of Bloom's taxonomy, which gives female learners a fair chance at passing the subject (Allamsetty, Chandra, Madugula, & Nayak, 2023), which is welcomed by the Feminist Science Theory. The graph below shows how Bloom's taxonomy was applied to the Grade 12 Physical Sciences June examination question papers (P1 and P2).

A table showing Bloom's taxonomy for the June 2023 Paper 1 Physical Sciences examination for the Limpopo Province.

Bloom's levels	Marks	Actual percentage	Expected percentage
1	25	16	15
2	52	35	35
3	57	38	40
4	16	11	10

A table showing Bloom's taxonomy for the June 2023 Paper 2 Physical Sciences examination for the Limpopo Province.

Bloom's levels	Marks	Actual percentage	Expected percentage
1	23	15	15
2	61	41	40
3	52	35	35
4	14	9	10

Bloom's taxonomy was correctly applied to the June examination question papers as indicated in the two tables presented above.

5.5 SUMMARY

This chapter focused on data analysis and presentation. Data that was presented emerged from interviews, observations and document analysis which

was backed by existing literature. Themes and sub-themes were developed from the data. The next chapter will discuss the data presented in this chapter in greater detail.

CHAPTER SIX: DISCUSSION OF FINDINGS

6.1 INTRODUCTION

The preceding chapter provided data presentation and analysis. The background information of participants, being female learners. Data obtained from interviews, observation and document analysis was presented and interpreted. This chapter delves into the discussion of findings. The primary objective of the study was to investigate the experiences of Grade 12 female learners in Physical Sciences Classes in selected rural and urban schools within the District. The aim was to enhance both theoretical and practical offerings in the educational context. Findings are discussed using the Feminist Science Theory and they are confirmed/contrasted by literature. The chapter discusses the main finding, followed by discussion of findings according to subthemes from data derived from interviews and observations first. Lastly, follows discussion of findings according to subthemes from data derived from document analysis. Then, synthesis of the two discussions follows. The chapter is closed by a summary paragraph.

6.2 MAIN FINDING

The main finding that emerged from the study is that female learners are having a negative experience in their Physical Sciences classes. Which is against the FST, which advocates for an enabling environment for not only female learners, but for every learner in science classrooms. The negative experience experienced by female learners is attributed to several factors, which are not limited to lack of resources, lack of support from both parents, teachers and peers, lack of correlation of theory into practice, poor performance and unmanageable workload. A lack of resources was evident in the visited schools' lack of laboratories, which are needed for learners to be able to correlate theoretical work into practice. In every Physical Sciences provincial

and national question paper, a question that is based on the practical work is set. This puts learners that did not attain practical experience at a disadvantage. A lack of support from parents included parents who did not try to reduce the home-chores of female learners when asked to do so by both teachers and learners. A lack of support from teachers included learners not getting responses that are academically helpful when they ask questions on a topic they did not understand. One learner mentioned that when she asked her teacher questions, the teacher would be surprised that such a question could come from an academically gifted learner. Additionally, a lack of support from peers came in the form of peers refusing to assist some female learners or making it hard for them to ask questions. A lack of correlation of theory into practice was evident in the lack of laboratories in schools. Most topics in Physical Sciences such as; a collision in momentum topic need to be demonstrated practically to aid female learners in their understanding of the topic. Poor performance was evident when some female learners from rural schools mentioned that they got level one and two in Physical Sciences. Even though level two is considered a pass, the learners regarded it as poor performance. All learners interviewed complained of an excessive workload in Physical Sciences. They mentioned not having enough time in the afternoon to do their Physical Sciences work while balancing other subjects as well. The workload made them dread going to school the following day, as they anticipated that more work would be given to them. A negative association with class attendance is not a good indication for the subject, as there needs to be more female learners in STEM.

6.3 DISCUSSION OF FINDINGS ACCORDING TO SUBTHEMES FROM DATA DERIVED FROM INTERVIEWS AND OBSERVATIONS.

Theme 1. Paradoxical experiences of both female and male learners related to Physical Science as a subject

The theme explores contradictory experiences in studying Physical Science

among learners, suggesting unexpected or conflicting aspects in their perceptions or engagement with the subject. These paradoxical experiences are reflected in the following sub-themes:

Sub-theme 1.1: Paradoxical experiences resulting in various feelings to different learners about Physical Science (PS) subject outlined.

The study revealed that diverse and contradictory emotions were exhibited by learners in their Physical Sciences classes.

Physical Science, ranging from satisfaction and excitement to sadness, fear, and anxiety. Female learners also express uncertainty about their enjoyment of studying Physical Science. This delves into the complex emotional landscape experienced by female learners in the context of studying Physical Science (Avraamidou, 2020). This diversity suggests that learners engage with Physical Science in multifaceted ways, with each learner experiencing a unique set of feelings related to the subject (Bowden, Tickle, & Naumann, 2021). The unique feelings may be influenced by factors such as teaching styles, pacing, and the overall classroom environment. Additionally, issues such as the teacher's speed in delivering content and the perceived lack of responsiveness to learners' questions contribute to the paradoxical experiences reported by the learners (Phillips & Condy, 2020). The mixed feelings indicate that the experience is not universally positive or negative but varies among individuals (Zhao & Song, 2022). Female learners express uncertainty about their enjoyment of studying Physical Science, which is supported by the Feminist Science Theory (FST) (Bianchini, Cavazos, & Helms, 2000). This clearly shows that some female learners are enjoying themselves in Physical Sciences class, while others are not. Even though they are taught in the same class, and by the same teacher.

Sub-theme 1.2 Respect from teacher versus disrespect from learners experienced during classes.

In this study, it was found that teachers respect female learners and female

learners disrespects teachers. The coexistence of respect from teachers and disrespect from some learners resonate with existing literature on classroom dynamics and student-teacher relationships. However, Naicker, Myburgh, & Poggenpoel, (2014:6) mentions that teachers are disrespectful and aggressive to learners in some South African schools, especially in the Gauteng province. This is contradictory to the finding of this study. This may be because Limpopo (where this study is based) is largely a rural province where people still take the Ubuntu principles seriously, like the KwaZulu-Natal rural people (Mthiyane, 2023). The disrespect from female learners to teachers is not surprising as there are studies that confirmed this assertion. Studies by Segalo, & Rambuda, 2018: Motseke, 2020: and Botha, & Zwane, 2021: Ghasemi, 2022) confirms the lack of respect from learners to teachers in south African schools. Numerous studies have underscored the importance of a positive and respectful learning environment for effective education (Mitchell, & Wehby, 2022; Amaliana, Kabri, & Andanti, 2023). disrespect of learners to teachers, which is but not limited to, a negative learner-teacher relationship (Mostafaei Alaei, & Forough Ameri, 2021), which affects learner performance. FST is against the disrespect of female learners to teachers as this is not one of their principles. When there is disrespect from female learners to teachers, teachers will develop a coping mechanism, which may not be favourable to the female learners. Hence, female learners may not enjoy their experience in their Physical Sciences class because of their own actions.

Sub-theme 1.3 Respect experienced is not determined by gender either on teachers' or learners' side.

Sub-theme 1.3 indicates respect is an individual entity, it is not determined by being a girl or a boy. Respect may be towards teachers or fellow classmates of a different gender. From the study, it emerged that the experience of respect is not determined by gender, whether on the side of teachers or learners. Female learners described both her male and female teachers as strict. However, there is a notable difference in the way the learners perceive and interact with them.

The male teacher is reported to be disrespected by the students, especially girls, while the female teacher is referred to with respect as "boss lady." The learner acknowledges fear of the female teacher, attributing it to her ability to maintain a functional class environment. The female teacher is perceived as more focused and disciplined in her teaching approach, contrasting with the male teacher, who, despite teaching well, faces challenges in maintaining order and clarity in the classroom. Respect within the classroom, emphasising that it is not predetermined by gender. This perspective with existing literature that emphasises the multifaceted nature of respect, influenced by various factors such as individual characteristics, teaching styles, and interpersonal dynamics (Quaye, Harper, & Pendakur, 2018; Emmer, & Gerwels, 2013).

Research in educational psychology and sociology supports the idea that respect is a context-dependent concept. Teachers' and students' behaviours, attitudes, and communication styles play pivotal roles in shaping the perception of respect within the classroom (Blazar & Kraft, 2017). The observed difference in how the female learner perceives her male and female teachers resonates with studies on teacher-student relationships. These relationships have been shown to significantly impact students' academic performance, behavior, and overall well-being (Pastore, & Luder, 2021). The concept of a "boss lady" suggests a positive regard for the female teacher, possibly influenced by her ability to maintain order and create a functional learning environment. The challenges faced by the male teacher in maintaining order despite effective teaching align with the literature on classroom management. Effective classroom management is crucial for creating a conducive learning environment, and teachers who face difficulties in this area may experience challenges in gaining students' respect (Trpin, 2023; Egeberg, McConney & Price, 2021). The acknowledgment of occasional conflicts and a lack of teamwork among students as pointed in the study reflects the broader literature on classroom dynamics. Social interactions and relationships among students impact the overall classroom atmosphere and can influence the development of a respectful and cooperative learning environment (Hortigüela Alcalá et al.,

2019). Respect is indeed a personal attribute. It is a necessary thread in ensuring a conducive and healthy experience in a Physical Sciences class.

Sub-theme 1.4 Positive versus negative daily relationship experienced amongst female and male learners outlined.

The study discovered that there are dynamics of daily relationships among female and male learners, both in positive and negative contexts. The findings reveal varying experiences among participants. Some female learners describe positive relationships, while others express negative encounters with their male peers. This aligns with existing literature on social dynamics, gender interactions, and relationships within educational settings (Reychav, & McHaney, 2017; Solbes-Canales, Valverde-Montesino, & Herranz-Hernández, 2020). Research supports the idea that student relationships are complex and influenced by various factors (Reychav, & McHaney, 2017). Studies emphasise the variability in adolescents' social experiences within the school context (Cortina, Arel, & Smith-Darden, 2017; Fisher, Mowen & Boman, 2018). Different individuals may navigate social interactions differently, leading to a diverse range of relationships.

Existing research emphasises how conflicts can extend beyond the immediate parties involved, affecting broader social networks and dynamics within a group (Junge, 2020). The coexistence of positive relationships alongside negative aspects (exploitation by classmates) aligns with literature acknowledging the dual nature of peer relationships. Studies recognise that social dynamics among peers can encompass both positive and negative elements, reflecting the complexity of adolescent social development (Rubin, Bukowski, & Bowker, 2015; Branje et al., 2021). FST is a theory that encourages a healthy and positive relationship among all individuals and expects a high discipline and high morale from everyone (Longino, & Hammonds, 2015). When there is a positive relationship, it will be easier to communicate with peers about challenges experienced in the learning of Physical Sciences, however, a negative

relationship yields the opposite and probably contributes to a negative experience in class.

Sub-theme 1.5: Different types of bullying which are minimal versus no bullying at all experienced.

The results of the study revealed that there exists bullying within the Physical Sciences class, although it varies from minimal instances and the absence of bullying in some classes. The gathered insights reveal that learners acknowledge the presence of bullying, albeit at a minimal level. The participants also noted the prevalence of conflicts, particularly among girls. Conflicts among students often arise from gossip and rumours circulating among the students. Additionally, negative attitudes and a sense of superiority, particularly among older students, were identified as factors influencing interpersonal dynamics, leading to bullying. This understanding aligns with existing literature on bullying within educational settings, acknowledging that bullying can manifest in various forms and intensities (Izadi, & Hart, 2023). The study underscores that conflicts arising from gossip and rumours align with relational aggression, a type of bullying that is often covert and aimed at damaging social relationships (Juvonen, & Graham, 2014). The identification of distinct social groups and a lack of cohesive ties among classmates also echoes the social dynamics to understand bullying as highlighted by Espelage et al. (2009). There exists a strong reprimand from the FST on bullying in schools and in classes. As bullying increases the factors that contributed to the unpleasant experience in Physical Science classes.

Sub-theme 1.6 Positive versus negative relationship and treatment experienced between learners and various Physical Science teachers.

The study sheds light on the dynamics of relationships and treatment between learners and various Physical Science teachers, revealing a prevalent negative tone in these interactions. Participants highlighted becoming "invisible" to the

teacher to absorb content without interference suggests a preference for minimal interaction, highlighting a neutral or slightly negative stance towards the teacher. Favouritism of teachers towards male students was also highlighted. Learners further highlighted reluctance to ask questions or engage openly with the teacher. These findings align with existing literature on the significance of positive teacher-student relationships in fostering a conducive learning environment (Walker, & Graham, 2021). A positive and supportive teacher-student relationship is crucial for effective learning, and the identified negative aspects within this finding highlight potential areas for improvement in creating a more nurturing educational environment. Addressing these issues could contribute to a more positive and productive learning experience for the female learners in the Physical Sciences class.

Learners expressed desire to become "invisible" to the teacher, seeking minimal interaction, aligning with research highlighting the importance of a positive and supportive teacher-student relationship (Allen et al., 2021). Positive interactions with teachers contribute significantly to students' academic engagement, motivation, and overall well-being. Participants' emphasis on positive interactions as exceptions suggests a less-than-ideal learning environment, potentially hindering the development of a constructive teacher-learner relationship. The issue of favouritism, as reported in this study, corresponds with studies discussing the impact of differential treatment on students' perceptions of fairness and justice (Young et al., 2013; Aydogan, 2008). The participants' reluctance to ask questions or engage openly with the teacher, as highlighted in this study, aligns with research on the importance of a supportive and approachable teaching style (Keiler, 2018). A positive teacher-student relationship is characterised by open communication, trust, and a nurturing environment where students feel comfortable seeking clarification (Russell, Wentzel, & Donlan, 2016). The contrast in teaching approaches underscores the impact of the teacher's behavior on student engagement and learning outcomes.

Sub-theme 1.7 The content of physical science taught manageable (coping with workload) versus unmanageable by female learners resulting in the need for revision to grasp.

The study discovered an important aspect of the teaching and learning process in the context of Physical Sciences among female learners, specifically regarding the perceived manageability of the content. This aligns with existing literature that emphasises the significance of instructional strategies in enhancing students' comprehension and academic performance (Lajom et al., 2023). Optimal balance between intrinsic, extraneous, and germane cognitive load is crucial for effective learning (Kirschner, 2002). In the case of physical science, where complex concepts are often involved, managing cognitive load becomes particularly important. The participant's positive experience in grasping the content could be attributed to the instructor's ability to moderate the extraneous cognitive load, ensuring that the material is presented in a way that is digestible and understandable.

Sub-theme 1.8 Manageable versus unmanageable workload is given to learners leading to different reactions by each learner.

From the study, it emerged that there exists a paradox of manageable versus unmanageable workload that is given to learners. Learners' workload needs to be manageable, and they need to be given enough time to complete their work (Kyndt, Berghmans, Dochy, & Bulckens, 2014). Moreover, the participant's emphasis on the instructor's awareness of the learners' workload resonates with the literature on student-centered teaching approaches. Research suggests that adapting instruction to students' needs and considering their workload helps create a supportive and conducive learning environment (Baeten et al., 2016). This aligns with the idea that an educator who recognises the demands placed on students in terms of their overall academic workload can adjust the delivery of content to promote a more manageable and effective learning experience.

The participants' expression of selective approach to completing assignments, prioritising tasks they understand over those they find challenging. This strategy reflects elements of self-regulated learning, where students actively monitor, control, and regulate their cognition, motivation, and behavior to achieve academic goals. According to Zimmerman's theory of self-regulated learning (1989), students engage in cyclical processes of forethought, performance, and self-reflection when managing tasks. The participant's behavior aligns with the concept of task prioritisation as a self-regulatory strategy, allowing them to allocate resources effectively and cope with an overwhelming workload (Zimmerman & Schunk, 2011).

The study also highlights the issue of time constraints in completing assignments, expressing feelings of being overwhelmed by the volume of work given in a short duration. This concern resonates with research on workload management and academic stress among students. Studies have shown that high workload intensity and tight deadlines can negatively impact students' well-being and academic performance (Yangdon et al., 2020; Pascoe, Hetrick, & Parker, 2020). The teachers' experience underscores the importance of considering students' cognitive load and providing sufficient time for task completion to prevent stress and promote effective learning.

Theme 2. Explanation of performance of learners related to the subject Physical Science.

Sub-theme 2.1 Learners' performance differs resulting in uncertainty of exact ranking of performance levels.

The study found that within a particular context or group of learners, there is variation in performance levels. The findings align with existing literature that emphasises the variability in learner performance within educational settings. Educational research often recognises the influence of diverse factors on student outcomes, contributing to the observed differences in performance

levels. Research by Gardner (1987), on multiple intelligences and Howard on the theory of multiple intelligences suggest that learners possess different strengths and abilities. This inherent diversity among learners can lead to variations in performance. Understanding and acknowledging these individual differences is crucial for educators to tailor their teaching methods to accommodate diverse learning styles. Socioeconomic status has also been identified as a significant factor affecting academic performance. Students from different socioeconomic backgrounds may face varying challenges that impact their learning experiences (Munir et al., 2023). This is supported by the works of Coleman and other scholars who have explored the relationship between socioeconomic factors and educational achievement (Downey, & Condrón, 2016).

Bronfenbrenner's Ecological Systems Theory emphasises the impact of various environmental influences on an individual's development and learning. This theory suggests that learners are embedded in multiple systems (microsystem, mesosystem, exosystem, macrosystem) that can affect their performance (Perron, 2017). Understanding these contextual factors is vital for comprehending the variations in learners' performances. Female learners that were performing excellently all came from good family backgrounds, and those performing poorly came from poor family backgrounds. The background does affect performance according to this study.

Sub-theme 2.2 Required performance in various subjects including physical science outlined in relation to future career choice.

The study revealed that learners' motivation to study physical sciences is a pragmatic and strategic decision influenced by the career paths they aim to pursue. While some participants express genuine interest and enthusiasm, others view their engagement with Physical Sciences as a necessary step to meet the academic requirements of their chosen professions.

There exists a relationship between students' motivations, career aspirations,

and subject choices Arhin, (2018). The concept of career-related motivation aligns with the findings, emphasising that students often choose subjects based on their future career goals. Career development theories, such as Super's Career Development Theory, suggest that individuals go through stages of career development and make educational choices influenced by their career aspirations (Ireh, 1999). Also, the FST posits that students are motivated by their expectations of success and the perceived value of a task. The findings regarding female learners recognising the importance of physical sciences for their chosen careers reflect this theory. The participants' statements about feeling compelled to study Physical Sciences due to career requirements points to the development of academic and career identity. The researcher believes that students are more likely to engage in subjects they believe will contribute to their future success.

Sub-theme 2.3 Performance competition is gender-based where boys compete with girls.

The study found that there exists academic competition in the Physical Sciences subject, where boys compete with girls, propelling girls to compete back. The competition amongst learners highlighted in this study may increase and broaden the participation of gifted female learners (Ozturk & Debelak, 2008). However, FST is against academic competition between boys and girls as competition influences scientific practices and educational environments. This often leads to the reinforcement of traditional gender roles, where boys are encouraged to be competitive and assertive, while girls are encouraged from similar behaviours. The researcher is of the stance that teachers should discourage academic competition as it may increase the possibility of female learners having a negative experience.

Sub-theme 2.4 Good performance provides one with confidence as opposed to poor performance that causes embarrassment and suffering at all levels.

This study highlights the relationship between academic performance, emotional

experiences, and enjoyment in learning environments. Lack of comprehension leads to irritability, suggesting a negative emotional response to not understanding the material in class. Individuals' beliefs about their own capabilities to perform tasks influence their behavior, motivation, and emotional reactions (Artino, 2012). When students experience success and good performance, their confidence in their abilities increases, leading to positive emotional states such as pride and satisfaction. Conversely, poor performance can undermine self-efficacy and lead to negative emotions like embarrassment and frustration (Artino, 2012). The concept of Zone of Proximal Development (ZPD), developed by Lev Vygotsky, emphasises the importance of scaffolding and social interaction in learning. When students are provided with appropriate support and guidance, they can achieve tasks that they cannot accomplish alone. Good performance within the ZPD can boost students' confidence and motivation, whereas failure may indicate a need for additional support and guidance (Karimi-Aghdam, 2017).

On the other hand, emotion regulation strategies play a crucial role in shaping students' emotional experiences in learning environments. Students who are better able to regulate their emotions, such as by seeking support or reframing negative thoughts, may cope more effectively with academic challenges and maintain positive emotional well-being even in the face of setbacks (Thümmler, Engel & Bartz, 2022). The researcher believes that since good performance is directly proportional to confidence, only female learners that are performing and are confident enough, will have a positive experience in their Physical Sciences class. Consequently, low-achieving female learners will experience embarrassment and suffering in their Physical Sciences class as a result.

Sub-theme 2.5 Extra-classes tutors assist to boost performance of learners as opposed to daily ones and vice versa.

This study found that there is a perception among learners that extra-classes

tutors can help boost their academic performance, particularly in comparison to their daily teachers. This perception stems from various factors, including a desire for fresh perspectives and a belief that extra-classes tutors may provide more effective support and accountability. Additionally, extra classes tutors may add on to the knowledge base layered by everyday teachers. These findings align with existing literature on supplementary education and the role of external tutors in supporting students' academic performance. Research suggests that external tutors may provide additional resources, personalised attention, and alternative teaching methods that complement regular classroom instruction (Jang, Reeve, & Deci, 2010). However, the effectiveness of extra classes may vary depending on factors such as the quality of instruction, alignment with students' needs, and the level of engagement and motivation of the learners (Kauffman, 2015).

It was found that students' motivation and engagement in learning were influenced by the novelty and relevance of tasks (Wigfield, Cambria, & Eccles, 2012). Novelty can enhance motivation and engagement among learners by stimulating curiosity and providing new perspectives on familiar concepts (Oudeyer, Gottlieb, & Lopes, 2016). Additionally, the perception of increased accountability with external tutors aligns with studies showing that accountability mechanisms, such as clear expectations and consequences for performance, can positively influence student motivation and effort in learning (Finnigan, & Gross, 2007; Figlio, & Loeb, 2011).

Participants' experiences reflect a common scenario where learners turn to extra classes with high expectations of improving their grades. However, the lack of significant improvement to some learners despite attending recommended extra classes suggests that the perceived effectiveness of these classes may not always align with the actual outcomes. This resonates with literature on the effectiveness of supplementary education programs, which indicates that while such programs may offer additional resources and support, their impact on student achievement can be variable and dependent on various

factors, including instructional quality and student engagement (Santhi, 2011). A meta-analysis on the effectiveness of tutoring programs found that while tutoring interventions generally lead to positive academic outcomes, the effect sizes varied widely across studies (Kulik, & Fletcher, 2016). Factors such as tutor qualifications, instructional methods, and program duration were identified as critical determinants of effectiveness (Mji, & Makgato, 2006). The researcher believes that extra classes tutors do have a positive impact on the female learners' learning, and in turn, improves and increases the positive experience of female learners in their everyday Physical Sciences classes.

Sub-theme 2.6 Self-activities/home-works given are done versus not done.

This study shed light on the perceptions of female learners regarding the workload of self- activities and homework tasks assigned by their Physical Sciences teachers. The female learners feels that the amount of homework assigned by their teachers is excessive. They express concerns about the limited time available after school to rest, recap class material, prepare for assessments, and complete homework assignments. They also mentioned being scared that not completing homework could lead to consequences such as being sent to the principal's office and having their parents called, this in turn underscores the pressure students may feel to complete assignments.

The perceptions of female learners regarding the workload of self-activities and homework assigned by their teachers, indicate a significant concern among female learners about the volume of work expected of them outside of regular class hours. This finding resonates with existing literature that explores the effects of homework on students' well-being, academic performance, and overall educational experience. Secondary school learners often face competing demands from various activities, leaving them with insufficient time for sleep and relaxation, which are essential for their overall well-being and academic success (Shaikh et al., 2015). Research conducted by Cooper, Robinson, and Patall (2006) suggests that excessive homework can have

detrimental effects on students' academic achievement and psychological well-being, and hence, a negative experience in class. They argue that while homework can be beneficial in moderation, an overload of homework can lead to increased stress levels, decreased motivation, and a decline in academic performance. Feminists are against any form of activity that works towards a decline in performance of female learners in science, as this will result in fewer women in STEM. Homework has an important role to play in academic performance but should be regulated as per the ATP. The researcher believes that teachers should not bombard learners with too many homework tasks, as this will increase the factors that impede their enjoyment of their Physical Sciences classes.

Theme 3: Explanation of support experienced at school and at home in relation to Grade 12 Physical Sciences.

Sub-theme 3.1: Support versus lack of support experienced from siblings, parents, community members, teachers and peers which leads to increased levels of performance and vice versa.

This study highlights the kind of support offered and needed by female learners from siblings, parents, community members, teachers, and peers. Some female learners indicated that washing dishes at home took time away from their books and homework whilst their peers were continuing to study without interruption. Emmanuel (2015) states that when female learners have chores at home, this affects their studies negatively. Firstly, it takes time away from their studies, and it also makes them tired for when they have time to study. When there is a sibling at home that is not schooling, and a parent that is not employed and stays at home fulltime, they should be giving support by assisting with the chores assigned to the female learners.

Community members may give support to female learners through tutoring. For those that have passed Physical Sciences, and can still recall some concepts,

they may assist the female learners by giving them free tutoring where possible. Teachers may also offer support to female learners by demonstrating a term before introducing the theory of it in class (Shishigu, Hailu & Anibo 2017). For example, when talking about acceleration, the teacher may offer an illustration through the use of a toy car so that the female learners that do not understand what increase in speed looks like, can see it. Peers are helpful in improving the performance of their female counterparts through peer teaching (Imam, 2022). Peer teaching does not only benefit the female learner taught but benefits the peer-teacher. Peer education increases learners' confidence, independence and Physical Sciences skills (Rusli, Degeng, Setyosari & Sulton, 2021). If the siblings, parents, community members, teachers, and peers of female learners can be engaged and do their part, the researcher believes that this may increase female learners' performance. If support is not provided, the female learners' Physical Sciences performance may decline.

Sub-theme 3.2 "Lack of siblings, parents, community members, teachers and peers' presence in assisting to solve learners' problems lead to emotional suffering on multiple levels in their lives".

This study relieved crucial feelings resulting from lack of stakeholder's presence in assisting to solve learners' Physical Sciences academic problems. Some female learners feel suffocated and at times feels like they are at the verge of a breaking point. This highlights the significant impact of the absence of support from family, community members, teachers, and peers on learners' emotional well-being and academic performance (Suldo, Friedrich, White, Farmer, Minch, & Michalowski, 2009). The feelings of suffocation, emotional distress, and anxiety resulting from the lack of assistance in solving academic problems and coping with challenges lead to a negative experience in science classes (Jackson, & Finney, 2002). There exists the importance of social support in buffering against the negative effects of stress and promoting resilience in students. Research suggests that a lack of support from family, peers, and teachers can lead to increased emotional distress, academic disengagement,

and decreased well-being (Pietarinen, Soini, & Pyhältö, 2014). Moreover, the absence of support systems can contribute to feelings of isolation and hopelessness among learners, further exacerbating emotional suffering and negatively impacting overall academic performance (Stoliker, & Lafreniere, 2015).

It was found that prolonged exposure to stress without adequate support can lead to burnout and psychological breakdowns (de Souza & Feitosa, 2019). When learners feel overwhelmed and unsupported, they may experience a loss of motivation, decreased academic performance, and an increased risk of mental health issues.

According to Lazarus and Folkman's transactional model of stress and coping (1984), the perception of stress is influenced by individuals' appraisal of their resources for coping with stressors (Martin & Daniels, 2014). When learners lack access to supportive relationships and resources for managing academic challenges, they may experience heightened levels of anxiety and stress, which can impair their ability to perform academically. Additionally, this will affect their experience in a Physical Sciences classroom negatively.

Sub-theme 3.3 Lack of support by not providing feedback by educators problematic as it leads to non-performance as learners cannot self-correct.

This study found that some teachers do not give feedback consistently to learners in Physical Sciences class. It is expected that after every activity given to learners, timely and consistent feedback should be given as required by the ATP. Failure to give timely feedback affects students negatively (Ragupathi, & Lee, 2020). Lack of feedback wastes the learners' time as they would have written an activity, gotten it wrong, but was not corrected.

Sub-theme 3.4 Support received from male learner peers as opposed to their female counterparts and vice versa explained. This study found that female learners are receiving academic support from their male counterparts as

compared to their female counterparts. This may be because male learners have a high self-efficacy in science as compared to female learners (Namaziandost & Çakmak, 2020). It is important to note that male learners assisting female learners may not mean that female learners are generally underperformers, it may simply mean that female learners have less believe in their capacity to master Physical Sciences. Hence, they shy away from assisting other female learners. However, the less self-efficacy of female learners does contribute to them not enjoying themselves in their Physical Science class.

Theme 4: Suggestions made by learners towards improvement of performance of Physical Science subject.

In this study, female learners gave suggestions as to what should be done to improve performance in Physical Sciences, which will in turn improve their experience in class.

Sub-theme 4.1 Correlation of theory into practice is important because only theory is taught. In this study, it was found that only theory is taught in Physical Science classes. When experiments/practical slots are scheduled, they are taught the practical theoretically. Simply put, learners do attend practical classes, but because of reasons beyond the teacher's control, like the unavailability of laboratories in schools, teachers have no choice but to resort to teaching practical lessons theoretically. Instead of performing the practical and gaining scientific skills as required by the CAPS document and ATP, the teacher resorts to, out of desperation, explaining how the practical is performed, what the outcomes are and how to answer questions related to that practical. However, a study by Hirca, (2013) encourages teachers to use low-cost apparatus for practicals in schools if the government did not provide the necessary materials as expected. Principals of schools are often encouraged to use Norms and standards money allocated by the government to buy low-cost equipment that would enhance and enable practical performance in schools (Hunter, Chandran, Asmall, Tucker, Ravhengani, & Mokgalagadi, 2017). FST

encourages that institutions of learning permit the nurturing of female learners in all aspects, including the use of any equipment in the promotion of their education in science (Murphy, 2012: Jen, 2015). It is vital for female learners to perform practical tasks as this would make their experience in class a positive one. The lack of actual practical lessons is not assisting in retaining female learners in STEM subjects.

Sub-theme 4.2 Laboratory and more classes must be built which will result in promoting better learning as opposed to learning through videos in congested classes.

It was revealed in this study that none of the schools visited, or their neighbouring schools had a laboratory. Studies show that having a laboratory in school promotes fundamental educational targets, including but not limited to enhancing learners' understanding of scientific concepts (Lunetta, Hofstein, & Clough, 2013). However, Brinson, 2015 encourages the use of virtual laboratories like those found on You-tube, for the purpose of saving money for the school and the government. It is important to note that saving money is not more important than female learners having an experience in a lab, which may lessen the leaky pipeline that exists in sciences (Liu, Brown, & Sabat, 2019). FST encourages that females have an experience in a real laboratory, as this may assist in retaining them in science. The researcher believes that it is important that the Limpopo Department of Education mimics other departments, such as the Gauteng Department of Education, in the provision of laboratories in schools, as the findings of this study show that this will enhance the experience of female learners.

In this study, it was also found that in some schools, learners were congested in their Physical Sciences class. A study by Khan, & Iqbal, (2012) found that effective teaching of female learners was not possible in overcrowded classrooms and suggested that implementable measures be taken by the government in providing budget for school infrastructure to better education of

those female learners. Another study by Meier, & West, 2020 found that South African schools had a nature of overcrowded classrooms. Additionally, this nature exacerbates negative teacher attitude and lack of discipline in class. When a teacher has a negative attitude in class, this will result in the female learner having a negative experience in the Physical Sciences class.

Sub-theme 4.3 Government must provide more resources so as to promote better understanding of Physical Sciences. This study highlighted the perceived need for the government to allocate more resources towards improving the teaching and learning of Physical Sciences. There is an emphasis on the importance of textbooks that are comprehensive, user-friendly, and that contain sufficient information to support learning. The establishment of an operating lab equipped with the necessary chemicals and apparatus is supported by FST, which advocates for equal access to resources. This study also noted the need to provide study guides, especially for students whose families cannot afford to purchase them. It was found that textbooks shapes classroom instruction and student learning outcomes (Stein, Remillard, & Smith, 2007). Comprehensive textbooks that provide clear explanations and engaging content can support teachers in delivering effective lessons and help students develop a deeper understanding of Physical Sciences concepts (Gurung, Landrum, & Daniel, 2012). Research by Hofstein and Lunetta (2004) suggests that laboratory experiences play a crucial role in helping students develop scientific inquiry skills and conceptual understanding. Equipping schools with laboratory facilities and providing opportunities for hands-on experimentation can enhance students' engagement and mastery of Physical Sciences concepts. Studies have highlighted the link between resource adequacy and academic achievement, particularly for disadvantaged students (Waters et al., 2019; Gearin, Fien, & Nelson, 2018). Ensuring that all schools have access to adequate resources can help address disparities in educational outcomes and promote equitable opportunities for learning. When resources are adequate, the experience of female learners in the Physical Sciences class improves.

Sub-theme 4.4 Learners must have self-motivation so that they can understand Physical Sciences and encouraged to consult teachers.

This study highlights the importance of self-motivation and proactive engagement in understanding Physical Science. Learners must take initiative in their own learning process by actively seeking clarification and asking questions from teachers to enhance their understanding. Research in educational psychology emphasises the role of intrinsic motivation, wherein individuals engage in learning activities out of genuine interest and curiosity (Shroff, & Vogel, 2009). By expressing a desire to ask questions and understand more, learners demonstrate an intrinsic motivation to actively engage with the subject matter, which can lead to deeper learning and comprehension (Tofade, Elsner, & Haines, 2013). The need to ask questions and seek clarification from teachers reflects a proactive approach to learning. Studies by Zimmerman (2000) on self-regulated learning highlight the importance of learners actively monitoring and regulating their learning process (Spruce, & Bol, 2015). By seeking guidance and support from teachers, learners can address gaps in their understanding, clarify concepts, and deepen their knowledge of Physical Sciences. Moreover, there is an emphasis on the importance of consulting teachers that suggests the value of a supportive learning environment where learners feel comfortable seeking help and guidance. Literature emphasises the role of teachers in creating supportive classroom climates that foster students' sense of competence and autonomy (Alley, 2019). Encouraging students to ask questions and seek assistance can promote a culture of inquiry and collaborative learning in Physical Sciences classrooms, this will in turn promote female learner experience in class.

Sub-theme 4.5 Parents, teachers, and siblings to provide support.

This study revealed that some parents, teachers, and siblings did not support female learners in their Physical Sciences academic journey. Research by

Gunderson, Ramirez, Levine, & Beilock (2012) supports the idea that parents and teachers are having a gender-bias support against female learners in science related subjects. Studies have consistently shown that family involvement in education positively impacts students' academic achievement, motivation, and overall well-being (Reynolds et al., 2022; Castro et al., 2015). When a female learner feels supported by family members and teachers, this enhances their experience in their Physical Sciences class, and the opposite is true.

Theme 5: Challenges experienced in relation to Physical Sciences at schools.

Sub-theme 5.1 Physical Science is viewed by some learners as difficult and others as a simple subject which causes suffering at multiple levels – stress, anxiety, and panic.

This study found that some female learners viewed Physical Sciences as a subject that is extremely difficult to an extent that they started to panic, had stress and anxiety when faced with the subject. It is important to note that stress can lead to non-communicable diseases (Pascoe, Hetrick, & Parker, 2020) and should be always avoided. Stressful situations cause one to have an unpleasurable experience in science.

Sub-theme 5.2 Lack of laboratories, classes, and all types of resources in learning Physical Science leads to a lack of understanding of the subject.

This study found that the lack of resources leads to a lack of understanding of the Physical Sciences subject. Ceci, & Williams (2011) blames the lack of resources on women's lack of understanding of science subjects, and consequently, underrepresentation of women in science. When there is a lack of understanding of a subject, the experience will be negative in that subject. Hence, if female learners do not understand Physical Sciences, it is noted that they will not enjoy themselves in class.

Sub-theme 5.3 Late coming to school by learners experienced and not acceptable which leads to stress and anxiety to learn the subject.

Additionally, the notion of the need for revisions to enhance comprehension aligns with the literature on effective teaching strategies. Revision and reinforcement of learned material are widely recognised as essential components of the learning process (Darling-Hammond et al., 2020). The participant's acknowledgment of the instructor's efforts in ensuring understanding may reflect a pedagogical approach that incorporates periodic reviews and revisions, contributing to better retention and comprehension.

6.4 DISCUSSION OF FINDINGS ACCORDING TO SUBTHEMES FROM DATA DERIVED FROM DOCUMENT ANALYSIS

In this study, the findings from document analysis are divided into themes and subthemes.

The main finding of the study, which states that female learners are having a negative experience in their Physical Sciences classes, is also supported by the themes under document analysis.

Theme 1: ATP followed/not followed.

The ATP/Annual Teaching Plan is a document that guides teachers as to when to teach each topic, for how long and how to assess that topic. It is a document that is provided by the National Department of Education, and it is amended as the national office sees fit.

This study revealed that in one school, the ATP was not followed by the teacher. In three other schools, the ATP was followed. Failure to follow the ATP negatively affects female learners as it hinders their progress (Casnazuela Checa, Guanoluisa Arequipa & Valladares Oña, 2007). Since the ATP is used

to guide teaching, when there is no proper order in following it then female learners are put at risk of writing tests and exams focusing on content that they were not taught in class, ultimately contributing to their poor performance (Rammala, 2009). Poor performance in turn contributes to the negative experiences of female learners in school (Tshabalala & Ncube, 2012).

Sub-theme 1.1 The number of classwork assignments correlate/does not correlate to those expected by the ATP.

This study found that in some schools, there was insufficient work output, while some schools had more than enough work output. This was seen through the number of classwork and homework assignments given in comparison with the number of days that learners were at school and attended a Physical Sciences class. The challenge with learners not having enough work output is that they get robbed of the opportunity to find alternative ways of answering differently phrased questions. This leads to poor performance, which is not a good indicator for the experience of female learners. Additionally, when a teacher teaches the Doppler effect and only assesses it once, this limits the variety of questions that they can answer on that topic. However, if they are given enough questions on one topic, which will be evident in the amount of informal work given to the learners, their chance of performing well will increase.

Sub-theme 1.2 Informal practical not done as directed by the ATP.

This study found that none of the sampled schools performed informal practical work as advised. There is not one school visited that had a laboratory, which may have been one of the reasons why informal practicals were not performed. However, there is an option of using PhET simulations in place of performing real practicals. Even though PhET simulations are not real practical, where learners would feel and smell the apparatus and the products formed, they are still a better replacement for practical work, rather than not performing the practical at all. The importance of informal practicals is that

they allow learners to be able to remember how the practical was performed and what was in the products (Bhaw & Kriek, 2020) so that when a formal test or examination comes with a question that requires practical work knowledge, the learners would have covered the work. This is also supported by FST, which advocates for the provision of adequate resources.

Sub-theme 1.3 ATP topics covered.

This study found that teachers covered all topics, as indicated by the classwork assignments written. In one school, not all subtopics were taught. One subtopic (Cracking) was not evident in the schoolwork books of female learners reviewed. This is a cause for concern, as female learners would be assessed on the topic for the first time in a formal task which contributes to their yearly marks. Seeing a question on a certain topic for the first time in a formal assessment may cause the female learner to experience anxiety, which has a negative impact on them in the context of their Grade 12 Physical Sciences class.

Theme 2: Feedback written and not written correctly.

This study found that feedback was given to learners. However, the feedback was not given correctly. Feedback is the work done to firstly confirm whether what the learners wrote is correct or not and secondly, to give the correct alternative to the wrong answers written by learners (Adarkwah, 2021). It is a noble thing for teachers to do as this supports teaching and learning and improves the performance of learners in class (Hooda, Rana, Dahiya, Rizwan, & Hossain, 2022). As feedback improves performance, this contributes positively to the experience of female learners.

Sub-theme 2.1 Feedback written.

This study found that although feedback was given to learners, it was not given

on time. In this context this means that a teacher continued teaching and giving work on top of work that was not marked. There lies a danger in not giving feedback on time, which is that learners may acquire new information that relates to the prior classwork assignments, that were not corrected. The new information may build onto previously misunderstood concepts, and this may negatively affect female learners' experience of their Grade 12 Physical Sciences classes.

Sub-theme 2.2 Feedback not user-friendly to learners.

This study found that some feedback was not user-friendly to learners. This relates to multiple-choice questions (MCQs), which are questions where learners are usually given four possible answers to choose from, with only one option being the correct answer (Reich, 2015). The three incorrect answers are usually close to being correct. This study found that when a learner gets the MCQ incorrect, the feedback written by the teacher will be only the correct answer that the learner was supposed to write. Even if the teacher had explained how the answer was chosen, when the learner does not write the description on how the answer was arrived at, the feedback does not become user-friendly for the learner when they are revising away from the teacher. This leads to a negative experience for that learner.

5.4.3 Question paper (June examination)

This study found that the June 2023 Physical Sciences Paper 1 and Paper 2 question papers were all standardised. A standardised question paper for Physical Sciences contains the four levels of Bloom's taxonomy, distributed differently for the two different question papers. The June/mid-year question paper is set by the Limpopo Provincial Department of Education, which prepares learners for the trial examinations and final examinations which are set nationally.

Theme 1: June question paper standardised.

This study found that the Limpopo Department of Education managed to standardise the June/mid-year question paper. Bloom's taxonomy was correctly utilised and all four levels were represented accordingly. Bloom's taxonomy's four levels are as follows: level one is for Recall, level 2 is for Comprehension, level three is for Analysis and Application and level four is for Evaluation and Synthesis (Krathwohl, 2002). The four levels are spread out differently in the two question papers that form part of the Physical Sciences assessment. For Paper 1 (Physics), level one accounts for 15% of the questions, level two accounts for 35% of the questions, level three accounts for 40% of the questions while level four accounts for 10% of the questions. For Paper 2 (Chemistry), level one and level four are the same as in paper one, however, level two accounts for 40% of the questions while level three accounts for 35% of the questions. The June question paper had approximately the same percentages as those recommended by the Curriculum and Assessment Policy Statement (CAPS) document (Bhaw & Kriek, 2020). Using Bloom's taxonomy is useful in ensuring that female learners with different abilities can get an opportunity to pass Physical Sciences. A pass requirement for Physical Sciences is 30%, as recommended in the National Policy Pertaining to Programme Promotion Requirements (NPPPR) (Khembo, 2023). When female learners pass their Physical Sciences assessments, that improves their experience. Hence, the correct usage of Bloom's taxonomy contributes positively to the experience of female learners in their Grade 12 Physical Sciences class.

6.5 SYNTHESIS BETWEEN INTERVIEWS, OBSERVATIONS AND DOCUMENT ANALYSIS.

The experience of female learners, as the centre of this study has been explored using the three data collection methods. The interviews gave a clear picture of the female learners' experiences. While observations and document analysis augmented the voices of female learners in the interviews. Whilst discussion of

data from interviews and observations was done separately, discussion of document analysis is not giving a different result. The ATP clearly states that learners should perform practical in a laboratory, or employ the usage of PhET simulations, however, the female learners has reiterated that none of the two practical methods are being employed in their schools. Hence, creating a negative experience for the female learners. The document analysis has no linkage to the role parents play in the experiences of female learners in their Physical Sciences class. However, there is evidence of what the female learners were mentioning about the workload given to them in their workbooks (which is a lot according to them). Which is deemed as a positive thing by teachers and researchers as it assists learners to perform better (Fernández-Alonso, Suárez-Álvarez, & Muñiz, 2015), but it still gives female learners a negative experience in class. Lastly, the performance that was said to influence the experience of female learners was evident in the document analysis too. Some scripts of female learners had performed at level 7 whilst some performed at level 1 and 2. A high performance is associated with a positive experience in class while a low performance is associated with a negative experience in class (Hochschild Ovalle, Nussbaum, Claro, Espinosa & Alvares, 2024).

6.6 SUMMARY

The chapter presented and discussed the findings. The discussion was based on findings from the voices of female learners as they give explanations of their experiences in their Physical Sciences theory and practical classes. The discussion was based on data from individual interviews conducted with female learners, observations made in the four schools and from document analysis. The main finding was that female learners were having a negative experience in their Physical Sciences classrooms because of the numerous factors discussed above. In the next chapter, a summary of the study will be provided, followed by a conclusion of the study and lastly, recommendations for further research.

CHAPTER SEVEN: SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 INTRODUCTION

The previous chapter expounded the discussion and analysis of the study. This chapter will provide a recap of previous chapters with emphasis on the main ideas per chapter. The study's purpose will also be re-addressed. The study's contribution to knowledge will be provided. Followed by the effects of female learners having a negative experience in their Physical Sciences classroom.

7.2 RECAP OF CHAPTER ONE TO SIX

7.2.1 CHAPTER ONE (EXPERIENCE OF FEMALE LEARNERS)

In chapter one, there was a brief background of the study and the purpose of the study, which was to explore the experiences of Physical Sciences female learners in Grade 12 in the Capricorn District of the Limpopo Province in pursuit of improving theory and practical classes through a well-articulated recommendation to guide all stakeholders involved in a female learner's education. The research problem was also briefly highlighted. Additionally, three research questions were outlined, which are as follows: 1) What are the experiences of female learners in learning Physical Sciences in Grade 12 classrooms? 2) What role does gender play in the motivation and interest of female learners studying Physical Sciences? 3) Which recommendation can be brought in to enhance education to improve theory and practical offerings for female learners? Lastly, ethical considerations were outlined.

7.2.2 CHAPTER TWO (LITERATURE REVIEW)

In chapter two, key concepts that shape the research study were discussed. The historical background of female learners in schools will also be looked at.

This highlighted how female learners have been treated in Physical Sciences classes around the world, in Africa and eventually dived into the South African landscape. Chapter two also highlighted how the inclusion or exclusion of females evolved in recent years and how it affected their experience in Physical Sciences classes. In addition, there was a highlight of empirical studies that have looked at the experiences of female learners in Physical Sciences classes, how the experience has shaped female learners' performance, career choices, perception of science, and ultimately their life choices. Lastly, there was a glimpse into previous studies that have investigated the experiences of female learners in Physical Sciences classes in other parts of the world and in South Africa.

7.2.3 CHAPTER THREE (THEORETICAL FRAMEWORK)

In chapter three, an explanation of the theoretical framework underpinning this study was elucidated. Philosophers against the theory were mentioned with their reasons. Philosophers supporting the theory were also mentioned with their reasons. Other theories under the feminist umbrella were also be explained. The theoretical framework is a lens through which the whole study was gawped through.

7.2.4 CHAPTER FOUR (RESEARCH METHODOLOGY)

In chapter four, the focus was on the research methodology that was implemented to answer the research questions of this study. The primary goal of chapter four was to offer a thorough comprehension of the approach, design, data collection, data analysis, quality criteria and ethical considerations for the study. It sought to provide insights into the strategies used to address the research objectives as outlined in Chapter one.

7.2.5 CHAPTER FIVE (DATA ANALYSIS AND PRESENTATION OF FINDINGS)

Chapter five dove into the analysis and presentation of the results derived from the data collected during this research project as guided by the purpose of the study and the research questions. Analysis of data was from data collected from the primary participants of this study, which were female learners doing Physical Sciences. And also, from secondary participants of the study, which were male learners doing Physical Sciences and teachers offering Physical Sciences.

7.2.6 CHAPTER SIX (FINDINGS AND DISCUSSIONS)

Chapter 6 dove into the discussion of findings. The main finding was that female learners are having a negative experience in their Physical Sciences classes. A paradoxical approach to feelings experienced by female learners were also discussed.

7.3 RESEARCH PROBLEM

Existing research on female learners' experiences in Physical Sciences classrooms (Letsoalo, Masha & Maoto, 2019) proves that there are numerous factors affecting their success in the subject. These include socioeconomic factors (Letsoalo, 2017), natural phenomenon (Jochim, Cluver, & Meinck, 2021), the teaching strategies of educators, content knowledge, and motivation (Mji & Makgato, 2006). Despite these observations, information about the experiences of girls in science classes, as expressed through their own voices, is limited (Etzkowitz, Kemelgor, & Uzzi, 2000). More information is needed if we are to address the problem of poor performance in Grade 12 Physical Sciences, especially by female learners (Letsoalo, Masha, & Maoto, 2019). The researcher in the current study believes that the documentation of female learners' experiences in science classes could help policymakers and teachers to design programmes to support learners, especially in the Limpopo province.

The researcher's experience as a female teacher and a former Physical Sciences learner has shaped her research focus, which is the exploration of the experiences of female Physical Sciences learners currently in Grade 12, with the intention to offer theoretical and practical solutions.

7.4 SUMMARY OF THE FINDINGS

The main finding of this study is that: Female learners are having a negative experience in their Physical Sciences classes. The following are the findings based on the main question this study posed.

7.4.1 What are the experiences of female learners in learning Physical Sciences in Grade 12 classrooms?

Female learners are having a negative experience in their Physical Sciences class. The reason may be because of the lack of adequate facilities necessary in their schooling. Additionally, the lack of teachers' and parents' support is aiding in the negative experience. Female learners' lack of self-efficacy is also adding to the negative experience. As mentioned in the findings of this study, there also exists a paradoxical experience of female learners in Physical Sciences classes. From the learners' perspective, some of the top performers have a positive experience in class. Those performing poorly are having negative experiences in class. This does not mean that being a top performer is directly proportional to having a good experience in class. As this study proved that some of the top performing female learners are not having a good experience in class. Hence the main finding, which is that female learners are having a negative experience in their Physical Sciences classes.

7.5 RECOMMENDATION OF THE STUDY

The study has the following recommendations:

7.5.1 Workshops for parents

Parents should be given a short workshop organised by the school at the start of their female learners' grade 12 year. The workshop should include the reason why house chores should be limited for female learners, the benefits of reducing house chores for female learners and how to emotionally support their female learners doing Physical Sciences and other subjects. This recommendation will improve the experience of female learners in Physical Sciences theory and if possible, practical classes.

7.5.2 Courses for teachers

Teachers should attend online or face to face short courses on how to be inclusive holistically including in terms of gender when teaching. The government is organising free short online courses for teachers that are optional to attend, it is recommended that teachers attend those courses. This recommendation will improve the teachers' attitude towards female learners and support them holistically. This will in turn improve female learners' experience in their Physical Sciences theory and where possible, practical classes.

7.5.3 Laboratories for schools

The Limpopo Department of Education should dedicate twenty years to building laboratories in public schools, at least in the vicinity of ten secondary schools, one should have a laboratory that would be utilised by the ten schools for free. Not a small mobile laboratory as those are easily demolished, but a structure that will last for decades is recommended to be built as this will save the government money in the long run. After twenty years, a plan on how to provide a laboratory in every school should be developed. A manual on how to keep the laboratory intact should be developed and given to the teachers responsible for the laboratory. An accountability session should be held every two years to check if the laboratory is still intact or not. This will help in keeping

the laboratory functional for a longer period. The presence of a functional laboratory will give female learners an experience of performing practicals. Additionally, this may improve their experience in their Physical Sciences class.

7.5.4 Motivational talks for learners

Female learners need to be given a short motivation by female role models at least once in a year in the FET band that lets them know that part of their experience is because of their own attitude towards the subject. They should also work on the self-efficacy of female learners, as this will definitely improve their experience in the Physical Sciences class. As the female learners' experience improves, the theory and practical offerings will be improved too.

7.6 THE STUDY'S CONTRIBUTION TO KNOWLEDGE

The study was conducted in both the rural and urban areas and has found that female learners were having a negative experience in their Physical Sciences classes.

7.6.1 Empirical contribution

In the Limpopo Province of South Africa, with a specific focus on the Capricorn South district, there exists a paucity of research on the experiences of female learners, with a specific focus of their experience in the Physical Sciences class. This study aimed at contributing to the body of knowledge by examining how female learners experience their Physical Science classes, both in theory and practical classes. Kim and Meister (2023) argued that experience is a personal attribute that no one can express on behalf of the other. It therefore became important to centralise this study around female learners when they are in both the theory and practical classes. Therefore, the study contributes contextually on the lived experiences of both rural and urban school-going female learners due to factors including the availability of resources, the content of Physical Sciences

and stakeholders involved in their education, including teachers, parents and classmates.

The context of this study was in the Limpopo province, a highly patriarchal province (Malesa, 2022) in terms of limited Feminist Science scholarly research in the country and in the way that the majority lives. A few studies have been conducted in the Limpopo province of South Africa on the experiences of female learners. However, some of the studies are not focusing on female learners in Physical Sciences (Modiba, 2024). Those that focus on female learners in Physical Sciences (Kibirige & Modjadji, 2022; Mathibela & Masinire, 2024), do not have a specific focus on Grade 12 female learners but on Grade 10 female learners. Additionally, they are in the Mopani district (Kibirige & Modjadji, 2022) and Sekhukhune district (Mathibela & Masinire, 2024). In this study, the experiences of female learners based in the Capricorn district of Limpopo and studying Physical Sciences in Grade 12 the final year of secondary school education before tertiary education begins, are explored. Studies show that knowledge about the experience of learners in science subjects has a possibility of improving their performance and retaining them in STEM (Kusasi, Fahmi, Sanjaya, Riduan & Anjani, 2021), which is part of the Sustainable Development Goal 5, which stands for gender equality with a notion of “leave no one behind” (Colglazier, 2015).

As previously stated in this section, knowledge on the experiences of female learners in Physical Sciences within the Limpopo province is limited. This study sought to contribute to the body of knowledge by documenting the experiences of female learners as guided by the Feminist Science Theory. It was found that Grade 12 female learners are having a negative experience in their Physical Sciences theory and practical classes. None of the four schools visited, from quintile 2 and 5 (where quintile 5 is known to have enough resources) had a functional laboratory system, including the private school. The lack of laboratory facilities contributes to the negative experiences of female learners in Physical Sciences. It is imperative to acknowledge that the findings of this study are not unique to South Africa because this study offers insights that resonates with

international contexts. As South Africa is a developing country, female learners are needed to add to the pool of excellent minds working on alleviating social ills such as HIV and AIDS. A cure for HIV may be achieved faster if female learners have a positive experience in their Physical Sciences classrooms.

When female learners have positive experience in class, their motivation to study Physical Science increases. Schiefer, Stark, Gaspard, Wille, Trautwein, & Golle (2021) reiterate that motivating girls in class is important as it boosts their understanding of the work being taught.

7.6.2 Theoretical contribution

The Feminist Science Theory (FST) has been a good lens through which to conduct this study. It is advisable to use FST when dealing with a complex issue such as this one, where there are several aspects under consideration, namely female learners, experiences and Physical Sciences as a subject. The theory further clarified how female learners in different school settings (rural and urban), in different quintiles (2 and 5), and from both public and private schools, experienced their Physical Sciences classes. Additionally, the FST assisted in analysing what the experiences of female learners meant, what caused them and how they could be improved. The study's data analysis was simplified by the usage of FST. However, there exists a limitation to the usage of FST in a study, which is that the finding cannot be generalised.

However, this study was not meant to generate results that can be generalised. Rather, it was meant to explore the lived experiences of female learners in their Physical Sciences classes, which are shown to be overwhelmingly negative. The FST served as a guide in the study and its application was of great assistance in the exploration of the realities female learners face, as heard from their own voices.

7.7 LIMITATIONS OF THE STUDY

There were no laboratories in any of the schools visited by the researcher. The researcher could therefore not observe practical classes as intended in the planning of the study. However, the researcher could observe the planned practical classes that imitate the actual practical class, where PhET simulation was used. The experience of female learners in practical classes could not be penned as they were not in laboratories. On the days when some schools visited the University of Limpopo for practical lessons, the researcher was not invited due to the policies of the schools. Additionally, the private school and urban public schools did not allow for the learner scripts to be copied, as they mentioned that the scripts should not be copied as they are the official document of the department of education. At the other two rural and public schools, the researcher also took field notes when doing document analysis. Hence, only field notes were derived from the analysis of the learner scripts. Additionally, the ATP and June question papers were retrieved from the Department of Education's website.

7.8 IMPLICATIONS FOR FURTHER STUDY

This study focused mainly on female learners studying in Physical Sciences at the secondary school level. Other researchers may venture into the experiences of male learners as heard from their own voices. This study also focused on the Capricorn South district of the Limpopo province. The findings of the current cannot be generalised to cover the whole province, meaning that other researchers have an opportunity to conduct further studies documenting and reporting on the experiences of both female and male learners in science-related fields.

7.9 VISION OF THE STUDY

The vision of this study was to listen attentively to the voices of female

learners as they narrated their experiences in Physical Sciences classrooms. The study revealed that female learners are having negative experience in their Physical Sciences classes. Theory and practical classes are taught as needed by CAPS and the ATP, but practical lessons are not done justice due to a lack of laboratories, which affects female learners' experiences negatively. Other factors that affect female learners' experiences negatively are a lack of support from immediate family members, teachers, and the Limpopo Department of Education. It is recommended that female learners' experience be taken into consideration in all decisions, including the provision of knowledgeable teachers.

7.10 CONCLUSION OF THE STUDY

The study found that female learners are having a negative experience in their Physical Sciences classes. This is not a general conclusion, but it is a conclusion based on the study setting that included schools in rural and urban areas, private and public schools and Christian schools. The study also found that the Limpopo department of education does not provide adequate laboratories in both rural and urban schools. This negatively affects the female learner experience. The study concludes that the poor infrastructure in schools, the lack of parental and sibling support, the lack of teacher supports, the lack of female-on-female learner support, the presence of bullying, the lack of self-efficacy and motivation of female learners contributes to the negative experience of female learners in the Physical Sciences class. Giving female learners a voice assisted greatly in understanding their experience in the Physical Sciences class. The addition of male learners in the sample gave a great insight into how female learners relate with each other in class with the absence of a teacher. Moreover, the addition of teachers in the sample gave a great insight as to what other factors could be affecting the experience of female learners.

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APPENDIX A: INTERVIEW GUIDE AND SCHEDULE (English version)

Interview guide

For learners

Central question

1. May you please share with me your experience in a Physical Science class?

Probing questions

Female learner experience in Physical Sciences class. **a. Class ambiance**

2. How do you experience the Physical Sciences class ambiance?
3. Are you enjoying the tone in your class? Please elaborate.
4. Do you look forward to attending your Physical Sciences class? Please elaborate.
5. Are you enjoying your Physical Sciences class? Why did you choose that particular answer?
6. Are you able to concentrate in class?
7. Are you motivated to study Physical Sciences? If yes, what motivates you? If not, what do you think would motivate you to study Physical Sciences?

b. Classmates

8. How do you relate with your classmates in your Physical Sciences class?
9. Discuss with me your collaboration of other classmates by gender with you.
10. Think about a few female classmates, how do you relate with them?
11. Think about a few female classmates, how do they relate with you?
12. Think about a few male classmates, how do you relate with them?
13. Think about a few male classmates. How do they relate with you?

c. Teachers

14. How do you relate with your Physical Sciences teacher?
15. Do you have other teachers excluding your everyday schoolteacher that offers you Physical Sciences?
16. If the answer in 15 is yes, how many do you have, and kindly elaborate on how you relate with each of them?
17. Do you think you need an additional teacher? Why?
18. Do you think there is a difference in the treatment given by your teacher to female learners versus male learners? Give a reason for your answer.
19. Are you able to understand your teacher as they teach? Elaborate.
20. Do you think your teacher treats you female learners and male learners equally and equitably?

d. Workload

21. Are you able to cope with the Physical Science work?
22. Do you look forward to attending future classes? Why/ why not?
23. Are you prepared to make extra efforts to improve your experience in class?

Interview time	Interview place	Duration
Lunch time/ after school and sports days	Private school premises	+/- 35 minutes
N.B: One learner to be interviewed per day, without disrupting school periods and until data saturation is reached		

MAMETLETXO A: LENANEO LA DIPOLEDIXANO LE PEAKANYO

Lenaneo la dipoledixano

Bana ba sekolo

Potxixo-Kgolo

1. Ke kgopela o hlaloxe maitemogelo a gago ka phaphuxing ya

Saentshe.

Dipotxixo txa go latela

Maikutlo le boitemogelo bja makgarebe ka phaphoxing ya Saentshe

A. Tukologo ya ka phaphoxing

2. O kwa jwang tukologo yaka phaphoxing ya saentshe?
3. O kwa o iphina ka "tone" ya ka phaphoxing ya gago ya saentshe? Hlalosa ka botlalo.
4. Afa o fela o fela pelo ya gore oka ya go tsena le go rutwa ka phaphoxing ya Saentshe?

Hlalosa ka botlalo.

5. O kwa bose ge ole ka phaphoxing ya Saentshe? Naa o reng o kgethile Karabo yeo?
6. Naa o kgona go ithuta ka mogopolo ka moka?
7. Naa o hlohleletxegile go ithutela txa Saentshe? Ge karabo ya gago ele eya, o hlohleletxa ke eng? Ge Karabo ele aowa, o nagana gore oka hlohleletxwa ke eng go ithuta ka txa saentshe?

B. Baithutimmogo

8. Naa o swarana jwang le baithutimmogo le wena?
9. Nhlalasetxe perekixano-mmogo ya gago le baithuti-mmogo le wena ba baxemane le ba makgarebe.
10. Nagana ka makgarebe a mangwe ka phaphoxing, o phela le bona jwang?
11. Nagana ka makgarebe a mangwe ka phaphoxing, ba phela le wena jwang?
12. Nagana ka masogana a mangwe ka phaphoxing, o phela le bona jwang?
13. Nagana ka masogana a mangwe ka phaphoxing, ba phela le wena jwang?

C. Barutixi

14. O phedixana jwang le barutixi ba gago ba saentshe?
15. Ntle le morutixi wa gago yoo omo tlwaetxigo wa mehleng wa Saentshe, naa gona le omogwe mo sekolong yoo a go rutago Saentshe?
16. Ge eba karabo ya gago go 15 ke eya, ona le ba ba kae? Ke kgopela o nhlalasetxe gore bona o phedixana le bona jwang.
17. Naa o nagana gore o hloka morutixi yo mongwe wa Saentshe?

18. Naa o nagana gore go na le phapano go tshwaro ya barutixi go ba rutwana ba makgarebe le ba masogana? Efa lebaka la Karabo ya gago.

19. Naa o kwexixa morutixi wa gago ge a ruta? Hlalosa.

20. O nagana gore morutixi wa gago o swara makgarebe le masogana ka go lekana le ka go swana?

D. Moxomo wa sekolo.

21. Naa o kgona go kgotlelela lego kgona go dira mexomo ka moka ya saentshe?

22. Naa o ipona o duma go rutwa ka phapuxing ya Saentshe?

23. Naa o ikemixeditxe go oketxa maatla go re o atlege go txa Saentshe?

Nako ya dipotxixo	Lefelo la dipotxixo	Nako
Nako ya go ja/ge sekolo se txwele/ka txatxi la dipapadi	Ka diphaphuxing txa sekolo	+/- 35 ya metsotso
N.B: Moithuti yo tee o tla fiwa dipotxixo ka letxatxi. Gore nako ya sekolo eseke ya senywa.		

APPENDIX B: REQUEST FOR APPROVAL FROM THE DEPARTMENT OF EDUCATION LIMPOPO PROVINCE

Greetings.

My name is Mphasha Elisa Sebina, a researcher interested in the experiences of female learners in Grade 12 Physical Sciences classes in the selected rural and urban schools of the Capricorn district in Limpopo Province, South Africa, with the focus on improving theory and practical offerings.

I am requesting permission to conduct the study in Limpopo, Capricorn District's schools.

I saw the need to embark on this research because of the high impact it is anticipated to have in advancing women's interests in science.

The world is moving towards sustainability in all fashions, including human capital. Advancement of women in science would come in handy in that fashion.

Name: Mphasha E.S Program: PhD University of Limpopo

Contact number: 081 752 9153

Email address: sebinachuene@yahoo.com

MAMETLETXO B: KGOPELO YA TUMELELO GO TXWA GO BA LEFAPHA LA THUTO GOLA PROFENSE YA LIMPOPO.

Thobela.

Ke nna Mphasha Elisa Sebina, monyakixixi wa go ba le kgahlego mo maitemogelong a bana ba makgarebe go la mphato wa lesomo-pedi ka phaphoxing ya Saentshe ya thuto le ya go ithuta ka go dira Profenseng ya Limpopo, Sedukothutong sa Capricorn.

Ke kgopela tumelelo ya go tla go phetha dinyakixixo dikolong txa profense ya Limpopo, Sedukothutong sa Capricorn.

Ke boni bohlokwa ba go txwa lesolo ka go nyakixixa ditabeng txe txa makgarebe le Saentshe ka ge ke boni protxeke ye ena le kgonagalo e kgolo ya gore e ka txwetxa pele dikgahlego txa makgarebe gola thuto ya Saentshe.

Lefase le sepelela go la go godixa batho ba goba le tsebo yeo e tlo kgotlelelago lebaka lele telele. Thekgo ya basadi gola dithuto txa Saentshe eka thuxa go oketxa palo ya basadi bao ba nago le tsebo ya Saentshe bao batlo kgotlelelago nako e telele.

Lebitxo: Mphasha E.S Lenaneo: PhD Yunibesithi ya Limpopo

Nomoro ya mogala: 081 752 9153

APPENDIX C: LETTER TO PRINCIPALS

Greetings.

My name is Mphasha Elisa Sebina, a researcher interested in the experiences of female learners in Grade 12 Physical Sciences classes in the selected rural and urban schools of the Capricorn district in Limpopo Province, South Africa, with the focus on improving theory and practical offerings.

I am requesting permission to conduct the study in (name of school) school.

I saw the need to embark on this research because of the high impact it is anticipated to have in advancing women's interests in science.

The world is moving towards sustainability in all fashions, including human capital. Advancement of women in science would come in handy in that fashion.

Name: Mphasha E.S Program: PhD University of Limpopo

Contact number: 081 752 9153

Email address: sebinachuene@yahoo.com

**MAMETLETXO C: Lengwalo la
Hlogo ya sekolo**

Thobela

Ke nna Mphasha Elisa Sebina, monyakixixi wa go ba le kgahlego mo maitemogelong a bana ba makgarebe go la mphato wa lesomo-pedi ka phaphoxing ya Saentshe ya thuto le ya go ithuta ka go dira Profenseng ya Limpopo, Sedukothutong sa Capricorn.

Ke kgopela tumelelo ya go tla go phetha dinyakixixo mo sekolong seo se phagamego sa

Ke boni bohlokwa ba go txwa lesolo ka go nyakixixa ditabeng txe txa makgarebe le Saentshe ka ge ke boni protxeke ye ena le kgonagalo e kgolo ya gore e ka txwetxa pele dikgahlego txa makgarebe gola thuto ya Saentshe.

Lefase le sepelela go la go godixa batho ba goba le tsebo yeo e tlo kgotlelelago lebaka lele telele. Thekgo ya basadi gola dithuto txa Saentshe eka thuxa go oketxa palo ya basadi bao ba nago le tsebo ya Saentshe bao batlo kgotlelelago nako e telele.

Lebitxo: Mphasha E.S Lenaneo: PhD Yunibesithi ya Limpopo

Nomoro ya mogala: 081 752 9153

Imeile: sebinachuene@yahoo.com

APPENDIX D: PARENTAL CONSENT FORM

Greetings

My name is Mphasha Elisa Sebina, a researcher interested in the experiences of female learners in Grade 12 Physical Sciences classes in the selected rural and urban schools of the Capricorn District in Limpopo Province, South Africa, with a focus on improving theory and practical offerings.

I(Full names), parent/legal guardian of
.....

Hereby give consent for my child to participate in the above-mentioned study. I understand that it has no effect on her grades, I understand that the study will take place at the school premises. No harm will be brought upon my child.

I understand that there will not be any payments made because of his/her participation.

Name:.....

.....

Signature:.....

.....

Date:.....

.....

Mametletxo D: SEBOPEGO SA LENGWALO LA TUMELELO

Thobela

Ke nna Mphasha Elisa Sebina, monyakixixi wa go ba le kgahlego mo maitemogelong a bana ba banenyana go la mphato wa lesomo-pedi ka phaphoxing ya Saentshe ya thuto le ya go ithuta ka go dira.

Nna (Mabitxo ka botlalo),
motswadi/mohlokamedi wa(lebitxo la ngwana)

Ke fa tumelelo gore ngwana wa ka aka txea karolo mo protxekeng ye e hlahositxwego. Kea kwexixa gore ekase oketxi goba go fokotxa dimaraka txa gagwe txa sekolo. Kea kwexixa gore protxeke ye etlo swarwiwa ka moagong wa sekolo feela. Ngwana otlo dula a bolokegile ka dinako ka moka.

Kea kwexixa gore go ka sebe le di patela mo protxekeng ye.

Name.....

.....

Mosaeno.....

.....

Letxatxikwedi...

.....

APPENDIX E: LEARNER ASSENT FORM

Title of Study: Experiences of Female Learners in Grade 12 Physical Sciences classes in the selected rural and urban schools of the Capricorn District in Limpopo Province, South Africa: Improving theory and practical offerings.

I(full names) understand that I have been asked to participate in a study titled “Experiences of female learners in Grade 12 Physical Sciences classes in the selected rural and urban schools of the Capricorn District in Limpopo Province, South Africa: Improving theory and practical offerings ”

I will be asked questions concerning my learning of Physical Sciences inside and outside of the classroom setting. I understand that I do not have to take part in the study. Once I have agreed to participate, I can pull out whenever I feel like I no longer want to be part anymore.

My teachers and parents will not be told of what I say in the study. I understand I will remain anonymous when the study is reported.

In signing this form, it shows that I understand everything in this form and that I have read and understood everything in it.

Name.....

Surname.....

Signature.....

Date..... Contact Details: 081 752

MAMETLETXO E: SEBOPEGO SA TUMELELO YA NGWANA WA SEKOLO

Thaetlele: maitemogelong a bana ba makgarebe go la mphato wa lesomo-pedi ka phaphoxing ya thuto leya go ithuta ka go dira txa mahlale profenseng ya Limpopo, sedukothutong sa Capricorn.

Nna(mabitxo ka botlalo) ke kwexixa gore ke kgopetxwe go txea karolo protxekeng ya go bitxwa “maitemogelong a bana ba banenyana go la mphato wa lesomo-pedi ka phaphoxing ya thuto leya go ithuta ka go dira txa mahlale profenseng ya Limpopo, sedukothutong sa Capricorn”.

Ke tlo botxixwa dipotxixo mabapi le goithuta ka txa Saentshe ka gare le ka ntle ga phaphuxi ya thuto. Kea kwexixa gore ga ke gapeletxegi go txea karolo. Le ge nka dumela go txea karolo, ke na le malokelo a go ikgogela morago nako yengwe le yengwe.

Barutixi le batswadi baka ba ka se tsebe gore ke boletxi jwang. Kea kwexixa gore lebitxo laka le ka se tsebegi.

Go saeneng gaka ga foromo ye, go itaetxa gore ke kwexixa dilo ka moka mo foromong ye. Ebile ke badile le go kwexixa mangwalo ka moka ao a lego mo lephepheng le.

Lebitxo.....

Sefane.....

.....

Mosaeno.....

Letxatxikgwedi.....

.....

Dinomoro txa mogala:
081 752 9153

APPENDIX F: LANGUAGE EDITING CONFIRMATION LETTER



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19/06/2025

CONFIRMATION OF EDITING AND PROOFREADING SERVICES

This letter serves as confirmation that the PhD thesis titled 'Experiences of female learners in Grade 12 Physical Sciences classes in selected rural and urban schools of Capricorn District: Improving theory and practical offerings', submitted by Elisa Sebina Mphasha, was professionally edited and proofread by Nkateko Masinga and her team at Nsuku Publishing Consultancy.

Best regards,

Nkateko Priscilla Masinga
Founder and Managing Director,
NSUKU Publishing Consultancy