Girls' access, participation, and achievement in Grade 10 Physical Science subject in a selected rural school in Limpopo: Sekhukhune district, South Africa.

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A Research Report

By

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A research report submitted to the Faculty of Humanities, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Education

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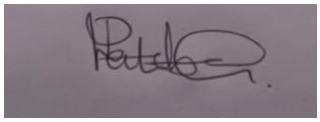
DECLARATION

I confirm that this research report is solely my work. I am submitting it for the Master of Education degree at the University of the Witwatersrand, Johannesburg. This report has not been submitted previously for any other degree, partial degree, or examination at this university or any other institution.

Signed by: **Date:** 15 March 2024



Phumzile Mathibela (researcher)

DEDICATION

This research is dedicated to girls and women in South Africa who continue to bear the disproportionate weight of gender-based violence, discrimination, and the devastating effects of high unemployment. It is for those who remain under-represented in science-related fields, not because of a lack of talent or ambition, but because of the systemic barriers that limit their opportunities. It is also for the women who serve as the backbone of their households, nurturing, providing, and leading with strength and resilience. This work honours their unrecognised labour and quiet sacrifices. It is also a tribute to those who dreamed of continuing their education and creating a better future for themselves and their families, but their hopes were held back by the ongoing inequalities in the education system, job market, and society. Finally, it is dedicated to every woman whose role has been confined by societal expectations, and whose contributions have too often gone unseen. May this work stand as a small step in amplifying their voices and championing their right to be seen, heard, and empowered.

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ABSTRACT

Research on girls in the learning of science has focused on issues of access and involvement extending beyond high school and undergraduate studies in the science domain. This study focuses on the construction of girls in a grade 10 Physical Science class in a rural school in Limpopo, South Africa This study seeks to understand the pedagogical practices employed by teachers in rural schools that either facilitate or hinder the participation of girl in a Physical Science classroom and how processes and practices of gender construction manifest within the Physical Science classroom. This study employed a qualitative research design using a case study methodology and was situated in the interpretive paradigm. 13 participants were selected using purposive sampling to determine the sample from which participants were selected. The research data was collected using semi-structured interviews. The study findings revealed that processes and practices of gender construction manifest within the Physical Science classroom through the interactions between teachers and learners, shaping perceptions of abilities and interests associated with specific genders. Furthermore, the study findings revealed that gender construction processes occur in Physical Science classrooms through teacher-learner interactions, influencing perceptions of gender-specific abilities and interests. Gender gaps persist in Physical Science due to factors like gendered aspirations in science, modeling of science roles, pedagogical practices, and the persistence of inequalities in sciences, hindering girls' access and participation. Consequently, the study argues that classroom processes and teachers' pedagogical practices whether consciously or unconsciously play a significant role in shaping girls' perceptions of Physical Sciences. Therefore, the study recommends that interventions for gender equality in education should also focus on helping teachers in devising pedagogical approaches and practices that are gender sensitive and appropriate. Such interventions look into mentorship and professional development designed to give teachers the tools and support they need to understand and handle gender dynamics in the classroom. This means carefully assessing how well current programs are working and coming up with new ideas to promote teaching methods that include and empower girl and boys to work and learn collaboratively and for the common good.

Keywords: *Physical Science, gender construction, rural education, gender inequalities, South Africa*

LIST OF ABBREVIATIONS

DBE	DEPARTMENT OF BASIC EDUCATION
PED	PROVINCIAL EDUCATION DEPARTMENT
UNICEF	THE UNITED NATIONS INTERNATIONAL CHILDREN'S EMERGENCY FUND
SET	SCIENCE ENGINEERING AND TECHNOLOGY
DHET	DEPARTMENT OF HIGHER EDUCATION AND TRAINING
HEI	HIGHER EDUCATION INSTITUTIONS
UN	UNITED NATIONS
WHO	WORLD HEALTH ORGANISATION

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CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

This study investigates ways in which girls are constructed in Physical Science classrooms in South African rural schools. The study is focused on understanding how girls as learners are perceived, treated, and represented in Physical Science classrooms in South African rural schools. The emphasis is on exploring how their gender may influence their experiences, participation, and opportunities in science education. By focusing on this rural context, the study aims to identify potential gender-related barriers or biases that may uniquely impact girls' experiences and opportunities in science education within rural settings. The study draws on a feminist critique of science to explore how gender influences girls' engagement with Physical Sciences in rural school classrooms. It examines how classroom experiences, shaped by broader societal views on gender, affect the academic streams and career paths that girls pursue after high school. By adopting this lens, the study offers a more comprehensive understanding of the structural, cultural, and pedagogical factors that impact girls' participation in Physical Sciences.

1.2 Background

When President Thabo Mbeki was elected as the president of South Africa in 2004, he stated that "no government in South Africa could ever claim to represent the will of the people if it failed to address the central task of emancipation of women in all spheres of life, and that includes the government we are privileged to lead" (Mbeki, 2004). The former president emphasized the importance of gender equity and women's empowerment in the development and progress of South Africa as a whole. Mbeki recognized the need for women's full participation and inclusion in society as essential for the country's progress and success. Mkumbwa (2018) asserts that the economic growth and development of the country depend on the usage of the resources and the capabilities of its citizens. Therefore, the development of the country's resources and the development of its citizens are both critical for economic growth and combat poverty. Many governments and organizations around the world have recognized

that investing in women's education is an effective way to eliminate worldwide poverty (Johansson, 2009). Thus, educating and empowering women can result in significant positive changes for the world.

The Constitution of the Republic of South Africa of 1996 protects the rights of women and girl while the South African Schools Act of 1996 aims to provide equal education and respect for all learners. Gender equality is a human right and is essential to the achievement of peaceful societies with full human potential and sustainable development (Fredman & Women, 2015). It is therefore vital that women have full access and participate in the science department, particularly in Physical Sciences. Moloi and Chetty (2010) found that despite significant progress in maintaining gender balance in education, South Africa still faces gender inequalities in school management, girl participation, and learner achievements. Despite the South African Department of Basic Education (DBE) and Provincial Education Departments (PED) have introduced policies to promote gender parity across education levels, gender equity in Physical Science remains below expectations (Engelbrecht, 2022). Although Several policies have been enacted to facilitate gender equality and equity in education, these policies have led to gender parity in enrolment and increased participation of both boys and girls in school, key among these is the National Education Policy Act of 1996, which provided the legal framework for ensuring equality and access for all students, regardless of gender, and the South African Schools Act of 1996, which aimed to make schooling compulsory for children aged 7 to 15, thereby promoting equal access to education for both boys and girls. Additionally, the Gender Equity in Education Policy of 2001 specifically targeted gender disparities in education, with the goal of eliminating barriers that girls faced in accessing and participating in education. These policies have significantly provided a framework for achieving gender parity in school enrolment and have increased the participation of both boys and girls in education.

The education system in South Africa seems to provide equal opportunities to both genders, but equality in numbers does not necessarily mean equality in education outcomes. Farrel (2021) asserts that although girls have equal access to schools, their education and prospects are significantly impacted by the patriarchal society in which they operate. In South Africa, despite 45% of researchers being girls in 2016, a significant gender gap persists at the STEM leadership level, with only 17% of university chancellors or vice-chancellors and 19% of heads of science councils and national science facilities being women (UNICEF, 2019, p.1). Similarly, Kgabi (2005) states that there are notably fewer women than men, worldwide, in

Physical Science and engineering. In Africa particularly, women are underrepresented in the science fields globally and within African countries (Chuene, 2021). Science education in Africa frequently faces challenges of limited and uneven accessibility, leading to the production of scientists and engineers who may lack the necessary skills to contribute to the continent's development (Hassan, 2011). Consequently, Africa often relies on importing engineers and scientists to address this capacity gap.

Although the government has endeavoured to foster equal access to Physical Science education for all students, a gender gap persists, wherein girls remain underrepresented in science fields compared to boys (Master, 2021). This, therefore, indicates a problem of access and participation for girls in Physical Science, especially since this field is generally viewed as male dominated. In rural South Africa, the challenges of poor educational quality are even more severe, affecting both boys and girls in different ways. Mdolo (2017) notes that education in these areas often suffers from a lack of resources, poorly trained teachers, and inadequate facilities, all of which contribute to the overall low quality of learning. These issues are made worse by cultural norms that reinforce traditional gender roles. For example, there is a strong link between masculinity and science, which leads to the belief that science is a subject and career path meant for boys. As Makarova (2019) points out, this perception causes many girls in rural areas to see science as a field reserved for boys. The combination of poor educational quality and deep-rooted gender stereotypes limits girls' chances to engage with and succeed in science, reinforcing gender inequality in education and future career opportunities in these communities.

South Africa is an interesting case study for this analysis, particularly in rural areas. Francis & Webster (2019) state that women in South Africa generally face discrimination and encounter greater obstacles in carrying out their responsibilities compared to men. This implies that women encounter obstacles and challenges that are not faced by men, which can negatively affect their ability to achieve success and equality in various aspects of their lives such as employment and social status. In rural areas, gender stereotypes are powerful due to cultural practices. These cultural practices in rural areas often assign specific roles and responsibilities to individuals based on their gender. Factors related to cultural norms, traditional beliefs, and practices can have a strong influence on girls' enrolment, persistence, and performance in school (Colclough & Tembon, 2000). As a result, girls are often expected to prioritize domestic chores, and caregiving responsibilities, and conform to societal expectations of femininity. These expectations can limit their access to educational opportunities and hinder their pursuit

of subjects such as Physical Science, which may be perceived as more aligned with masculine domains. This study, therefore, focuses on how girls are portrayed and perceived within the classroom setting, with an emphasis on encouraging them to participate in Physical science classes and explore ways to increase the number of girl scientists, and Physical science teachers to promote science teaching as a viable career option for girls.

A recent study by Zuze and Beku (2019) indicates that gender differences in academic performance vary across school types, with girls outperforming boys in government schools and rural settings. However, the above does not mean that all is well with the girls, especially in science learning in rural schools in South Africa. Some studies have revealed that even though girls excel in academic performance during school and college examinations, they are not closing the gap with boys when it comes to attaining high grades in science subjects, resulting in a low representation of women in science careers (Moss et al., 2018; Olaitan & Mavuso, 2022). Although graduation rates in South Africa reveal that the number of girl graduates has increased over the years, however, attaining gender equality remains a challenge. In 2020, the total enrolment in public Higher Education Institutions was 1,068,046, and 1,094,808 in 2021 marking a 2.4% decrease from 2020. Notably, in 2020, the Science Engineering, and Technology (SET) department reported a total enrolment of 319,902 students, approximately 48.89% (156,343) were girl and 51.11% (163,534) were boys (DHET, 2021). However, moving to 2021, the number of girl students decreased to 155,794, while the number of boys students increased to 157,932 (DHET, 2021). In terms of graduates from public Higher Education Institutions (HEIs), there were 233,257 in 2021, representing a 1.9% (4,625) decrease compared to 2020. Notably, in 2021, there were 64,474 more girl graduates than boys graduates (DHET, 2021). The interesting aspect, however, is that even though gender-based segregation in fields of study is decreasing in South Africa, women still face underrepresentation in the field of science. Hence, the persistent underrepresentation of girls in science is worrisome, as it impacts both the future workforce and the efforts to reduce inequalities in the labor market (Mosomi, 2021).

Furthermore, gender disparities are extensively documented across various aspects of women's participation in the scientific workforce, including their advancement into senior and leadership roles, acquisition of grants and awards, publication and citation rates, and the duration of their research careers (Cowley et al., 2020). Research indicates that women in the scientific field often face challenges such as being under-cited, under-paid, under-promoted, and lacking professional recognition compared to their male counterparts (Huang et al. 2020; Leslie et al.

2015; Bonawitz, 2009). Despite an increasing number of women pursuing medical studies and entering academic careers, a noteworthy proportion fails to reach senior positions in science (Wagner, 2019). This occurs because girl employees consistently secure positions in industries and occupations with lower wages in South Africa (Roberts & Schöer, 2021). Thus, gender inequalities persist even in the face of various national-level policy initiatives and instruments designed to address these issues.

Despite notable progress in reducing gender disparities in science achievement, persistent gaps in early science engagement and confidence likely contribute to the continued underrepresentation of women in science careers (Stevenson et al., 2021). This is because girls in Higher Education still face a lack of representation in certain academic disciplines, including Engineering, Computer and Information Science, Physical Science, and Chemistry (Casale et al., 2021). Current research has also highlighted a notable issue concerning the insufficient presence of women in undergraduate Physics courses (Radulović et al., 2022, Casale et al., 2021). This, therefore, emphasizes the need to explore the factors influencing women's motivation to engage with Physical Science during their secondary education and post-high school.

The issue of gender disparities in science is related to principles of fairness, social equality, and optimizing social and individual investment in human capital, talent, socio-economic development, and competitiveness (Vázquez-Cupeiro, 2015). Thus, factors that influence women's access, participation, and progress in science careers are a complex problem. Therefore, by studying classroom settings and interactions in high school, we can identify teacher-learner and learner-learner practices or pedagogic relations in science learning which create barriers and challenges that affect girls' participation and achievement in Physical Sciences. Understanding these dynamics helps in devising targeted interventions to promote healthy gender relations and ensure that girls have equal opportunities to excel in the Physical Sciences. Thus, this means there is an immediate concern to develop pedagogically girl-friendly learning classroom environments that will allow girls to participate freely and succeed. Once that is achieved, then there can be more girls pursuing Science-related courses in post-secondary and tertiary education and encouraged to teach Physical Sciences.

1.3 Problem statement and rationale.

This study is driven by a fundamental concern for achieving equity and addressing the insufficient focus on capacity building within the field of science, especially for women in rural

areas. The first problem the study seeks to address is the prevalent issue of gender underrepresentation, particularly the scarcity of women in prominent science positions in rural South Africa. This is because South Africa has emerged relatively from a deeply racist history that favored whites and men's access to public resources such as education and ensured job reservation in the professional well-paid Science, Engineering, and Technology (SET) sector (Salo et al., 2014). To date, women's realities in South Africa are still determined by race, class, and gender-based access to resources and opportunities. As a result, African rural women, in particular, are the poorest of the poor, they experience poverty and inequality differently from men, and socioeconomic changes impact differently on them (Kehler, 2001). African rural women's lack of access to resources and basic services is combined with unequal rights in family structures, as well as unequal access to family resources and positions in higher sectors (Helman & Ratele 2016; Khuzwayo et al., 2019). The effects of this legacy continue to echo in the contemporary period making it important to focus the study on rural girls in South Africa.

Although I acknowledge that the Departments of Higher Education and Science and Technology have made concerted efforts since 1994 to encourage women to follow academic and professional careers in SET. However, the number of women in this sector has increased steadily, this has been off a very low base (Modjadji, 2021). Furthermore, when considering race, white women continue to represent the majority of women in SET, whereas the representation of black women in SET remains limited, albeit with a gradual increase in numbers (Salo et al., 2014). This highlights the need for continuous and focused efforts to not just keep up but speed up the progress in making SET more diverse and inclusive. It is important to specifically address the specific challenges that women from various racial backgrounds may encounter in this field, especially the marginalized groups in rural areas. As such, girls in South Africa, like their counterparts globally, face a multitude of challenges and opportunities shaped by the socio-cultural, economic, and educational landscape of the country. This significantly impacts their experiences, participation, and access to various fields, including the sciences.

While numerous studies have explored the factors influencing girls' reluctance to enrol in science subjects, and equality in science classrooms in the past (Kahle & Lakes 1983; Mtambo 2005; Hazari et al. 2013; Spearman & Watt 2013). However, this study takes an approach by exploring learners' interactions and behaviours within the teaching and learning environment in Physical Science in the classroom today, following a feminist decolonial perspective. It seeks to challenge traditional notions of gender and explore how social norms shape and perpetuate

power relations, including gender inequality in Physical Science classrooms in rural schools. Thus, exploring how gender is constructed at the classroom level of practice affords us an entry point concerning intervention. Gender construction and deconstruction will be possible pedagogically at the classroom level. It also allows us to think of gender as not necessarily given biologically through nature but as an active process that happens in real life.

A significant challenge in examining literature concerning girls or women in the field of science lies in the accessibility and involvement of girls, extending beyond high school and undergraduate studies in the science domain. Extensive research and initiatives addressing gender issues in science education have highlighted how gender influences learners' engagement in the classroom (Kibirige & Modjadji, 2022; Chauke, 2022). These studies reveal that factors such as societal expectations, classroom dynamics, and limited role models continue to discourage girls from pursuing science, particularly in rural areas. However, there remains a gap in research specifically focused on how girls are constructed within science classrooms in rural South African contexts and how these constructions influence their subject and career choices. Although gender disparities in science education are widely acknowledged, there remains a need for deeper exploration of how girls are positioned and experience science in rural classrooms, and how this affects their long-term academic and professional paths. These challenges manifest as both direct and indirect forms of marginalization and discrimination experienced by girl students in rural schools. By looking into these issues, the study aspires to contribute insights that can inform strategies for promoting inclusivity, dismantling gender biases, and fostering a more equitable and diverse science landscape. Thus, understanding the factors that shape girls' engagement in a Physical Science classroom during this critical grade can help develop targeted interventions and policies that support their continued interest, persistence, and success in science-related disciplines.

1.4 Purpose and Objectives of the Study

The purpose of this research is to explore how gender is constructed in practice in rural schools in Physical Science and to find ways to encourage more female learners to get involved. It seeks to explore and identify ways in which the Physical Science classroom can be transformed into a safe and inclusive space for girls. Thus, the objective of this study is to bridge the gaps in participation and access that exist for girls in the field of Physical Science. This study will make noteworthy contributions to the curriculum field by actively challenging gender

stereotypes that are perpetuated by social constructs in rural areas consequently affecting pedagogical practices which may hinder girls' participation in Physical Sciences. This is because there is a need for more women in science to meet South Africa's demand for skills and to improve women's economic prospects. Women make up a large percentage of the poor in rural areas hence they must be assisted to contribute to the transformation of the economy (Mokoena & Alexander, 2021).

The study is anchored on the following objectives:

a) To identify and describe teachers' pedagogical practices in Physical Science that promote or hinder the participation of girls in Physical Science in rural science classrooms.
b) Analyze the processes and practices of gender construction within the science classroom.

1.5 Research questions

a) What are the pedagogical practices employed by educators in rural schools that either facilitate or hinder the participation of girls in a Physical Science classroom?
b) How do processes and practices of gender construction manifest within the Physical Science classroom?

1.6 Significance of the study

There is an African proverb that says "If you educate a boy, you educate a man. If you educate a girl, you educate a family." This proverb speaks about basic education, but when looked at through the lens of science education for the informed citizen, it takes on a different meaning. In an increasingly technological world where individual members of society are called upon to engage with socio-scientific issues, it has become increasingly important to focus on science education (Kolstø, 2000). Therefore, through the lens of this proverb, it becomes even more important to focus on the science education of girls.

As a science educator, this study holds significance because there have been situations where the enrolment of girls in Physical Science at certain rural schools has been low, and this trend persists. Furthermore, the absence of female Physical Science teachers in these schools is

concerning and highlights the need for intervention. Effective gender awareness and teaching in rural high schools, particularly in Physical Sciences, is necessary; thus, further research is required to address this issue. This study particularly focuses on grade 10 because it is a significant point where learners begin to make decisions about their subject choices for the final years of their schooling. The subjects chosen in grade 10 can significantly shape their future educational and career and as a result, by studying how girls are constructed in the Physical Science classroom specifically in grade 10, the researcher can gain insights into the underlying factors that influence girls' decision to engage or disengage from science-related fields in the future. Understanding these influences can help identify barriers and opportunities for girls' participation in Physical Science and inform interventions to promote their sustained interest and involvement.

Furthermore, women are the majority in rural areas, and they are not empowered both educationally and economically. According to Dlodlo (2013), women constitute most of the population in rural areas, yet they face significant challenges in terms of educational and economic empowerment. As a result, women in rural areas are dependent on men to survive because they are not aware of the existence of national organizations to support and protect them, that is because awareness campaigns do not seem to reach them. Women in rural areas are particularly affected by these inequalities due to a lack of access and the perception that science is predominantly male dominated. According to Nel (2018), women in Africa were historically denied social and economic benefits that men enjoyed. Aguele and Agwagah (2007) further state that this deprivation of economic benefits has impacted the status of girls and women, potentially altering their mental capacity in ways that may remain incompletely understood. In a study conducted by Cherney and Campbell (2011), it indicated that young women and men approached planning future careers in different ways where women tended to consider the responsibilities of having a family in addition to their aspirations. This, therefore, reinforces the societal norms that inhibit meaningful participation in Physical Science in women.

Despite ongoing global and South African initiatives to promote gender equality, a significant education gap persists between men, women, boys, and girls globally. Notably, one of the most alarming areas of gender inequality is observed in the field of science (Charamba, 2021). As a result, this study explores how through classroom practices girls are constructed in ways that hinder their participation and achievement and consequently limit their chances in science-related after-school programs and careers. As such, Grade 10 is a critical period for the

development of learners' self-efficacy and confidence in their abilities. Research has shown that girls, in particular, may experience a decline in self-confidence and self-perception of their scientific capabilities during this age (Heilman 1998; Quatman & Watson 2001; Simmons et al.,1979). Therefore, by focusing on grade 10, the researchers can explore the factors that influence girls' self-perception in the Physical Science classroom and identify strategies to enhance their confidence and belief in their scientific abilities. Such interventions can help mitigate the impact of gendered stereotypes and foster girls' long-term engagement in science-related fields.

1.7 Conclusion

In Chapter 1, several issues related to the context or background of the study were highlighted in the discussions. The importance of developing an understanding of the South African context became very clear even though the meaningful participation of girls in science education is a global issue. Chapter 2 critically examines relevant literature as well as anchoring the problem in a relevant theoretical framework to develop a clearer understanding of the identified problem, providing a more detailed justification to carry out the study as well as shedding clarity on the identified problems. Chapter 3 outlines the methodology of this study; the research paradigm, research design, methods of sample collection, and the method employed for data collection. Chapter 4 outlines the analysis of data by presenting the results of the study as well as the themes that emerged. Chapter 5 discusses the findings in relation to the literature. Lastly, chapter 6 is the concluding chapter which presents the limitations of the study and recommendations for future research.

CHAPTER 2: LITERATURE REVIEW

2. 1 Introduction

This chapter presents a review of the relevant literature on the construction of girls in Physical Science classes which may hinder their access, participation, and achievement in the discipline, focusing on schooling in rural areas. The purpose is to situate the study of the interplay of gender and schooling in South Africa in rural schools, particularly in Physical Sciences. Much research has focused on the under-representation of girls in science, specifically the participation of girls in Physical Science to explain reasons behind the potential lack of motivation or excellence in the domain of science. Although this extensive literature covers a wide variety of factors influencing girls' underrepresentation in science, this review will focus on five major themes that will highlight the factors influencing girls' access and participation and how they are constructed in Physical science classrooms. First, the literature will give various conceptions of gender on an international framework. Then the themes that will be discussed include an analysis of gender construction within the Physical Science class, gender as a social or biological construct, girls' participation in Physical Sciences, and gender representation in textbooks. This thorough analysis of existing literature lays the groundwork for a more profound understanding of the challenges and possibilities involved in shaping the role of girls in Physical Science classes.

2.2 The international framework of gender

The concept of gender varies significantly across the globe, with diverse definitions and frameworks shaping its understanding. Connell and Pearse (2014) state that gender has been theorized in different ways, ranging from associating personality traits and behaviors specifically with women or men. Similarly, Richardson & Robinson (2020) point out that gender is thought of as the existence of two different social groups, women and men, which are the product of unequal relationships. In a UN report released in March 2001, the UN Women defined gender as the socially constructed roles, behaviors activities, and attributes that a given society considers appropriate for men and women. Consequently, the World Health Organisation (WHO) describes gender as the characteristics of women, men, girls, and boys that are socially constructed. However, Connell (2009) argues that gender is defined by social

relations within which individuals or groups operate and is not dichotomous, thus, cannot be solely divided into two distinct groups consisting solely of women and men. Considering these definitions of gender, it can be argued that above all, gender is a social practice. From a social constructionist perspective, men and boys are not mere recipients of a socially dictated role, nor are they merely conditioned or socialized by their cultures (Courtenay, 2000). Instead, men and boys play an active role as agents in the construction and reconstruction of prevailing norms of masculinity (Manwell, 2007).

The international picture of gender provides a global understanding of the roles and expectations associated with masculinity and femininity. Grant and Sleeter (1986) argue that gender is a complex and multifaceted concept that is shaped by social, cultural, political, and economic factors at both the local and global levels. Therefore gender policies are affected by cultural beliefs and practices related to gender and legal and social structures that support or limit gender equality (Kjeldstad, 2001). According to the United Nations (UN), Gender equality is a human right, and is essential to the achievement of peaceful societies with full human potential and sustainable development. The WHO advocates for promoting gender equality and empowering women and girls. As a result, to achieve gender equality the feminist theory comes in as a tool for women to fight for their rights to freedom in the world of politics, social, and economic issues (Arizah, 2019). However, Ferguson (2019) argues that feminism is more than just making things equal between men and women. She further argues that is not only about women based on biology either, but brings a strong political aspect to women's rights, considering the difficulties faced by all of humanity in the face of serious challenges (Ferguson,2019). Although these remarks hold significance, it is crucial to emphasize that the goal of empowering women and advocating for their equal opportunities in prominent science roles does not imply neglecting or marginalizing men and male in the process. Therefore, gender equality in science education aims to contribute to improving the situation of women and reducing the STEM gender gap in education and research (Arizah, 2019).

In the field of education, promoting gender equality means creating an environment where all children, regardless of gender, have equal opportunities to learn, participate, and succeed (Tiedeu et al., 2019). This includes ensuring equal access to education, providing gender-sensitive and inclusive curricula and teaching practices, and promoting equal participation of both boys and girls in all levels of education (Chisamya et al., 2012). Thus gender equality in Physical Science would mean giving women equal access to the privileges that still favour

men. Beyond simply acknowledging women's participation, true gender equality would involve dismantling systemic barriers and biases that may hinder women's progress in science.

2.3 Gender as a biological and social construct

Various literature has looked into how society creates ideas about gender and how this can result in inequality. According to Risman (2018), gender is like a system deeply ingrained in all aspects of daily life and social structures. Similarly, Lorber (2000) argues that the distinctions between genders are mainly used to explain why there are differences in how people are treated based on their gender. Ridgeway (2011) demonstrated that the assumptions about people's status based on gender and race apply in various situations, and as a result, these expectations play a role in maintaining inequality situations where there is no reason for male privilege to exist. Therefore, gender is widespread because without acknowledging differences, it becomes difficult to justify inequality, particularly in the science field which is predominantly dominated by men.

A dominant conception of gender has often ascribed gender differences to biological sex differences. According to the literature, some argue that it is inherent for girls to prefer reading and writing, and to enjoy working quietly, while boys are naturally more active and require more effort from teachers to engage them in schoolwork (Darling-Hammond et al. 2019; Riley 2014; Gurian 2010). For instance, Buchman et al. (2008) assert that findings from numerous national and international large-scale assessments suggest that boys tend to achieve higher test scores in science, whereas girls tend to achieve higher scores in reading. However, the idea that "boys are more active or better at math and science than girls is a social construct, rather than a biological fact" (Leaper, 2014, p.710). Therefore, it would be inaccurate to assert that the limited participation and access of girls in Physical Science fields can be solely attributed to their biological innate.

A different perspective considers gender as not a fixed and inherent characteristic of individuals, but rather a product of social construction, expectations, and norms. Much literature shows that gender scholars are more commonly thinking of gender as a social construct instead of seeing it as a fixed or unchanging identity, they view it as something that is created and acted out through social interactions (Berkowitz 2010; Hemsing & Greaves, 2020). For example, Richardson (2008) argues that gender is a hierarchy that exists in society,

wherein one group of people, men, has power and privilege over women. The understanding of gender as a hierarchy highlights the existence of gender inequality and the structural imbalances that contribute to it. Within the gender hierarchy, power is wielded by those who hold dominant positions within society, typically men, and it is exerted over those who occupy subordinate positions, typically women (Owen & Renn, 2020). Therefore, this power dynamic manifests through various institutions, such as the family, education, media, and government, which enforce and reinforce societal expectations, roles, and norms associated with gender (Gjergji et al., 2023).

Additionally, Foucault's (1980) analysis highlights that power relations are not solely oppressive but also productive. Similarly, Hearn (2017) argues that power produces knowledge and shapes discourses that define what is considered normal or deviant in terms of gender identities and behaviors. These norms and discourses are internalized by individuals, leading them to self-regulate their behaviors and conform to societal expectations. Drawing from the gender interactionist theories concept, they focus on the idea that gender is produced through everyday social interactions, and as a result, these theories emphasize the role of daily behaviors and communication in shaping gender roles and identities (Cahill, 1980). However, structural theorists criticize gender scholars who adopt an interactionist perspective for downplaying the influence of institutional arrangements in constructing gender relations arguing that interactionist theories often neglect the broader societal structures that contribute to the shaping of gender roles (Burt, 1982).

Feminist theorists further the above argument by stating that gender is best conceptualized as a social system that apportions resources, roles, power, and entitlements according to whether a person or practice is perceived as boy or girl, masculine or feminine (Ridgeway & Connell 2004). Nonetheless, it can be argued that the construction of gender within a social context is influenced by both interpersonal interactions and institutional structures. In this view, gender is not solely shaped through individual behaviour and relationships but is also significantly impacted by the broader frameworks and systems present in society. Therefore, theories about the social construction of gender involve considering the combined influence of identities, interactions, and institutions in shaping how power, privilege, and resources are distributed between and among women and men (Collins 2000; Lorber 1994; Risman 2004). The gender order is characterized by a hierarchical structure, where, on the whole, men hold dominance over women in terms of power and privilege (Berkowitz, 2010). In the context of the Physical

Science discipline, it can be argued that there is a recognized hierarchical structure in gender relations, with men generally holding more power and privilege than women.

The underrepresentation of women in science-related fields persists as a significant issue of occupational segregation and gender inequality. Extensive psychological literature highlights average differences in occupational interests between men and women (Konrad et al. 2000; Morris (2016). Su et al. (2009) conducted a pivotal meta-analysis, focusing on occupation-relevant interests and preferences for specific STEM careers, revealing substantial sex differences that potentially contribute to observed STEM gender gaps. Similarly, Irwing and Lynn 2018 conducted a meta-analysis of 22 papers examining sex differences in university students and found higher average IQ scores for men in science students compared to women and art students. However, the unequal participation of women in science was explored through a biological lens, but this perspective was gradually discarded due to the absence of evidence supporting biological differences in capacities (Blickenstaff 2005; Hyde 2016). Therefore, the controversy of biological difference being the focal point in the underrepresentation of women in science is absurd.

2.4 Girls' access, participation and opportunities in Physical Science

The issue of unequal access to education between girls and boys is particularly pronounced in rural South Africa, where socio-economic and cultural barriers severely limit girls' opportunities to pursue education, especially in science fields like Physical Science. In these rural areas, traditional gender roles, economic constraints, and a lack of resources create an environment where girls are often discouraged from enrolling in or excelling in science subjects (REF). This gender disparity is not merely a reflection of personal choices but is deeply rooted in societal norms and structural inequalities that favor boys education (Shabaya et al., 2004). Although there has been some progress in increasing girl enrollment in Physical Science, as indicated by rising National Senior Certificate (NSC) statistics, the challenges specific to rural schools remain significant (Chakawodza 2018; Schwendeman, 2014).

These challenges include pervasive stereotypes that deem science too difficult or inappropriate for girls, along with inadequate school resources such as laboratories and qualified teachers (Brickhouse & Potter 2001; Chetcuti, 2009). Such factors heavily influence how girls in rural areas perceive and engage with science, often reinforcing traditional gender roles that limit

their participation and success in Physical Science (Schwendeman, 2014). Efforts to address these disparities have included initiatives to improve school facilities and resources, but these alone are insufficient. Therefore, a more comprehensive approach is needed, one that challenges cultural stereotypes and provides continuous support to girls, ensuring that increased enrollment in Physical Science translates into meaningful educational and career opportunities (Schwendeman, 2014).

Furthermore, several lines of evidence suggest that women earn approximately half of all bachelor's degrees in science (Baker 2013; Krajcik, & Czerniak, 2018). However, Wieselmann et al. (2020) note that there is a noticeable absence of women in specific subfields such as engineering, computer science, and physics. Thus, despite progress in women earning overall science bachelor's degrees, they continue to face challenges in achieving gender balance. According to Hazari et al (2013), girls' lack of participation in these fields can be attributed to several factors, such as unsupportive classroom environments and the perception that the Physical Science is a predominantly male-dominated field. Similarly, Ekine (2013) argues that cultural biases, perpetuating the belief that science is primarily for boys, deeming it less important for girls' future lives, and questioning girls' capabilities in science, are significant factors contributing to the gender gap in science. These biases are evident in science curricula, instruction, and assessment, influencing the attitudes of both girls and boys, as well as parents and teachers (Akhigbe & Adeyemi, 2020). These biases may create barriers that may either hinder or limit girls' access and participation, as well as their interest in pursuing studies and careers in Physical Sciences.

Nurturing an interest in science among girls from an early age is crucial, emphasizing that science is equally for them as it is for boys. Current research on girls' involvement in the sciences suggests that disparities in participation and interest tend to widen as learners progress to higher education levels (Ekine 2013; Barton & Brick 2006; Watt, 2016). Ekine (2013) contends that in numerous African countries, fewer girls transition to secondary school compared to men and enroll in fewer science classes. A study by Spaull and Makaluza (2019) found that at higher levels of achievement, boys outperform girls but only in Physical Science. An interesting trend in African countries is that "fewer girls choose science subjects as they progress through the education system, and they are outperformed by boys" (Chetcuti & Kioko, 2012, p.1573). However, a recent analysis by Zuze and Beku (2019) examining gender and learning outcomes in South Africa, using comprehensive representative data, offers a valuable summary indicating that girls excel over boys at the primary and lower secondary levels in

Physical Sciences. This analysis cannot, however, be generalized to how girls are performing without recognizing the diversity of educational landscapes globally. Further research and cross-cultural comparisons would be essential to gain a more comprehensive understanding of the complex interplay between gender and learning outcomes in Physical Sciences.

Teachers' attitudes and perceptions about science play a role in gender disparities and influence girls' participation in Physical science. While teachers are commonly seen as agents of change and policy implementers in schools, existing literature suggests that their attitudes significantly influence girls' choices and participation in Physical Sciences. According to Kabeer (2010), teachers often hold different expectations and attitudes towards boys and girls in the classroom. Woolfolk (2013) supports this notion, highlighting that teachers tend to engage more with boys during classroom interactions. As a result, the research conducted by Mutekwe and Modiba (2012) regarding the prevalence of patriarchy and gender role ideology in co-educational schools revealed that teachers often perceive boys as more knowledgeable than girls, and as a result of this stereotype they ask more questions to boys than girls during teaching and learning, ultimately causing feelings of isolation and discouragement among girl learners. Similarly, a study by Nsuntsha (2016) indicated that boys learners were given more opportunities than girls to study Physical Science in Kwazulu Natal, where teachers frequently discriminated against girls in the classroom based on gender. Emerging from this body of literature it can be argued that behaviors and perceptions about gender may have an impact on girls' participation in Physical Sciences. However, there is a lack of evidence regarding how specific pedagogical methods affect the participation of girls, making it necessary to find out in this study.

Learner performance is influenced by their interest in the subject, as mentioned earlier. A study conducted by Nickens (2005) in the United States revealed a widespread lack of interest in Physical Science among American students, with girls demonstrating higher dropout rates than boys at every academic level. Similarly, a study by Miller et al. (2007) linked poor learner performance to a lack of interest. However, this observation may not directly translate to the South African context, where more girls than boys participate in Physical Science matric examinations as indicated by the Department of Education in 2022. In South Africa, girls seem to demonstrate an interest in Physical Sciences, surpassing boys in NSC examinations. Therefore, this prompts the question of whether curriculum delivery practices impact initial interest, potentially leading to poor performance of girls who choose Physical Sciences.

Miller et al. (2007) introduce another crucial factor that could impact the involvement of girls in science education, focusing on the representation of girl role models among science teachers. According to Baird (1997), male teachers tend to attribute the underrepresentation of girls in physics to societal and cultural factors, lack of girl role models, and differences in ability or aptitude. On the other hand, girl teachers tend to attribute it to the lack of interest among girls, which is caused by male-oriented instruction and the focus of physics applications on topics that are more relevant to boys.

The argument posits that an increased presence of girl scientists and educators could enhance girls' interest in science. This implies that, for this positive influence to take place, girl teachers should serve as role models for girls. Consequently, it suggests that teachers are expected to be more understanding of the challenges faced by girls studying science, while also motivating and supporting them. Emerging from these views, it is worth noting that it is indeed the role of female teachers as inspirational figures for girls to shape curriculum delivery practices in a way that also benefits girls, consequently leading to enhanced academic performance.

2.5 Construction of girls in science classrooms

Some factors within the schools may demotivate girls from participating in sciences. Based on research conducted by Haambokoma (2000), multiple factors within the school environment impact girls' perceptions of science; these include gender-biased classroom interactions that often favor boys, negative attitudes from teachers towards girls, and the unfavorable attitudes of boys towards their girl peers. Additionally, Duschl and Osborne (2002) suggest that the teacher, rather than the student, remains central to educational practices, often initiating most classroom discourse. Therefore, teachers, through their actions, choices of discourse, and pedagogical methods, have the potential to impact the construction of girls' identities, participation, and experiences within the Physical Science class. Nevertheless, it is important to highlight that there is a limited amount of literature discussing the influence of teachers' pedagogical methods on the construction of girls in Physical science classrooms. According to Eschar et al. (2013), earlier studies have identified inconsistencies between teachers' attitudes and beliefs, and their actual pedagogical practices in science classes.

However, how the teacher questions and leads interactions in class may influence how girls are constructed in the classroom. Chin (2007) argues that teacher questioning plays a significant

role in classroom discourse, typically used to assess students' understanding in traditional lessons, however, in classrooms emphasizing true dialogue, questioning may serve multiple purposes beyond evaluation. Similarly, Eliasson et al. (2017) note that most questions in science class require the recall of factual knowledge, and there is a noted gender disparity, with boys dominating classroom interaction more than girls. During these interactions, it is observed that boys still have greater access to the space for interaction in science classrooms (Eliasson et al., 2017). Mtambo (2007) however, brings an interesting aspect forward that boys tend to intimidate, mock, and use insulting language to girls, and as a result, this lowers the girls' self-esteem, confidence, and ability to express themselves in front of boys, especially knowing that they will not be defended by their teachers. For example, in a study by Williams (1996) on mixed-sex science classrooms, girls participated infrequently in whole-class discussions due to intimidation by boys, predominantly engaging by asking questions; in small groups, girls felt more at ease participating in same-sex groups, and the presence of even one boys often resulted in their silence. This, therefore, may demotivate girls from fully expressing themselves and participating freely in the science classroom.

Horn (2011) states that since science is generally considered a masculine discipline, the stereotype of girls interested in science is that they are less feminine. This is because science is generally considered a "masculine, competitive, objective, impersonal qualities that are at odds with our images of what girls are. The more masculine the branch of science (e.g., physics), the less likely it is that girls will like it or do well" (Brickhouse et al., 2000, p.441). However, a study conducted by Breakwell et al. (2003) found that girls interested in science did not consider themselves to be less feminine; in fact, they found the opposite of the stereotype to be true for both boys and girls. Therefore, it can be argued that the concept that associates boys with masculinity and girls with femininity requires additional investigation due to a scarcity of recent literature offering contemporary insights on this topic. It is crucial to be provided with relevant insights that shed light on the degree to which the type of science question that boys and girls teachers pose in science classrooms influence how boys and girls participate in teacher-student inter- actions. This emphasizes the necessity for more up-to-date research to explore how current perceptions of femininity and the perceived masculinity of scientific fields may influence girls' identity constructions in science today.

2.6 Gender representation in science textbooks

Research into gender representation in textbooks has a long history and researchers have analyzed textbooks across various disciplines to assess their fairness and accuracy in covering specific topics or social groups, reflecting the importance attached to the messages conveyed by these materials. Similarly, Joshi (1994) identified a distinct gender bias, emphasizing the role textbooks play in shaping sex roles in the context of primary-level textbooks in Nepal. Potter and Rosser (1992) investigated life science textbooks for factors impacting girls' interest in science and asserted that textbooks, as significant influencers in science education, play a crucial role in either attracting or deterring girls from studying science.

The large volume of research dedicated to textbook analysis indicates the potential influence attributed to the messages they impart (Elgar, 2007; Vojíř & Rusek, 2019). A study by Pillay and Maistry (2018) on four Business Studies textbooks selected from countries in the Southern African Development Community (SADC) region to theorize about their representation, found that fitness existed in all four business textbooks where men are prioritized before women. For example, the ordering of men and women such as ‘Mr and Mrs’, ‘brother and sister’, and ‘husband and wife’, were prevalent in all four textbooks, suggesting that the masculine word should come first (Pillay & Maistry, 2018). As a result, this pattern reinforces the stereotypical notion that womanhood has a second-place status and therefore, that girls are not as important as boys .

Many cultures expect women to be subservient to men, and the idea that a woman's place is in the kitchen is still prevalent. This is reflected in the way that textbooks depict men and their roles, with Physical Science textbooks tending to feature predominantly boys’ images of men pushing, driving, or lifting. According to Vurayai (2021), gender inequalities are evident in science textbooks using discriminatory language and images that depict gender stereotypes where women are often shown in traditionally feminine roles such as nurses, vendors, typists, and receptionists, while men are portrayed in traditionally masculine roles like builders, Scientists, mechanics, and doctors. Thus, this is evident that the portrayal of gender in textbooks can have a significant impact on students' perceptions, attitudes, and beliefs about gender. Elgar (2007) argues that textbooks contribute to the sex role socialization of children, and sex bias in science textbooks may be instrumental in ‘encouraging the view that science is a boy subject more than a girls subject.

Mdolo (2017) argues that the gender biases in the curriculum depict girls as passive and portray boys as strong and ambitious. These images already separate girls from boys and give a

perception that Science is exclusively for men. Moletsane and Reddy (2011) contend that the science curriculum in South Africa is unfavorable towards girls, as it fails to recognize them. In essence, the science curriculum is not designed to be inclusive of girls, and the content is not tailored to accommodate them. For example, only a few topics in Physical Science center around feminine activities.

2. 7 Empirical reviews of girls' access, participation, and achievement in the Physical Science subject.

A study by Masinire (2011) investigated the interplay of masculinity and schooling in Zimbabwe and used ethnographic methods which included observation and unstructured interviews to collect data. The methodology used in the study is based on Connell's (1995) concept of multiple gender identities which recognizes that gender is influenced by various factors such as culture, social context, and individual agency. Similarly, this study is complemented by Masinire (2011) study because it looks at the complex interactions between teachers, girls, and boys in a Physical Science classroom. The study by Masinire (2011) uses ethnographic methods to provide a holistic understanding of the classroom context. However, this study does not use ethnography because "they are used by researchers to study an intact cultural group in a natural setting over a prolonged period by collecting, primarily observational data" (Cresswell, 2003, p.14). Given the time frame of this study, the ethnographic research design was not feasible. As a result, this study used observation as a means of collecting data and semi-structured interviews to collect data.

Pillay and Maistry (2018) follow a feminist poststructuralist perspective in their study. The focus of interest in feminist poststructuralism in their article is language as a way of constructing and contesting social meanings. Feminist poststructuralist scholars argue that power relations are rooted in language, discourse, and social structures and that these power relations perpetuate gender inequalities (Pillay & Maistry, 2018). The feminist structuralist approach "aims to provide multiple voices and accounts to provide space in discourse analysis for the coexistence of distinctively different voices and accounts, such as those of the research participants, other researchers on the project, and possibly even people who review and comment on the research" (Baxter, 2008, p.3). In as much as the feminist poststructuralist perspective allows the researcher to critically examine power relations, especially on gender diversity and equality, this study however adopted a feminist decolonial perspective as an

alternative theoretical framework because it focuses on the power dynamics, and cultural aspects, and religious factors that perpetuates gender inequalities in marginalized communities. Women form part of the marginalized community due to historical and ongoing systemic factors that contribute to their disadvantaged position in society.

On the other hand, Naidoo (2009) conducted a case study to explore how gender is constructed by investigating the power relations among boys and girls in a grade 10 Physical Science classroom. The findings of the study are that contexts are critical in shaping the performances of masculinities and femininities, which in turn define the constructions of gender. Naidoo's (2009) study was located in a grade 10 Physical Science classroom in a school from the Umlazi Township, in Durban following a post-structural feminist theory. There is a commonality in the category of intersection, however, what distinguishes feminist post-structural theory from feminist decolonial theory is the context of the history of colonialism/ and rurality. Therefore, the Feminist decolonial theory used in the study questions and deconstructs the dominant narratives and knowledge systems that perpetuate gender inequality and marginalization by challenging the Eurocentric and patriarchal perspectives that have shaped societal norms, policies, and institutions, and highlighting the need for diverse voices and experiences to be recognized and valued.

Furthermore, similar to Naidoo's study, my study also uses a case study method to gain a deeper understanding of how girls are constructed in grade 10 Physical Sciences, however, the contexts in which this study is taking place differ from that of Naidoo because my study is researching the construction of girls in a rural context. Specifically, rural contexts are of particular significance in this study because they are spaces where social norms and inequalities persist, often perpetuating traditional power structures. For instance, in comparison to township settings, rural areas are often governed by traditional chiefs, who hold significant influence and authority over the community.

The governance of rural areas rests with traditional leadership in South Africa because "this governance is determined by the fact that land is in the custodian of this traditional leadership" (Mazibuko, 2014, p.1). The association of leadership with men has implications for girls' self-esteem, confidence, and willingness to pursue leadership roles or assert themselves in various domains. This perception reinforces traditional gender norms and perpetuates gender inequalities within the community, limiting girls' agency and opportunities for leadership and self-efficacy. A study by Kongolo and Bamgose (2002) focused on the influence of government

development policy, education, and cultural values on rural women. The findings suggest that a significant number of women in rural areas are illiterate and lack initiatives, innovations, and self-reliance attitudes. It also indicates that women in rural areas experience isolation, confinement, and marginalization due to non-interactive government policies regarding rural areas. In as much as efforts are being made to ensure that decisions related to land governance consider the interests and perspectives of all community members, including women and marginalized groups (Rangan & Gilmartin 2002; Ainslie & Kepe, 2016). However, it can be argued that the progress towards gender equality in rural areas is a complex and ongoing process, influenced by various factors such as cultural norms, legal frameworks, and socio-economic conditions. Cultural norms and beliefs play a significant role in shaping gender roles and expectations within rural communities. Therefore, this study will examine how traditional gender roles and patriarchal norms create barriers to women's access and participation in a field such as Physical Science where men are dominating specifically in a rural context. These social norms hinder girls' access and participation in rural schools. The focus of this study is on unequal gender norms that are constructed in science classrooms. This is because traditional gender roles and patriarchal norms create barriers to girls. However, the key focus is on how gender normalization is recreated and reinforced in the classroom setting.

Cervonia and Ivinson (2011) investigated how girls in primary school science classrooms adopt gender norms through their behaviour, body language, and communication to accomplish certain goals. The research involved detailed observations and interviews conducted in grade 3 science classrooms of four primary schools in the United Kingdom and the United States with participants of children aged 7 and 8 years. Similarly, my study focuses on the behaviour, engagements, and interactions of girls with their teachers and male peers while teaching and learning Physical Science in grade 10. Furthermore, the study will also use observations and interviews to collect data. However, the context differentiates. Cervonia and Ivinsion (2011) from my study. Specifically, differences in the cultural landscapes mean that gender identities are not constructed the same. Western countries have more liberal attitudes, so their practices differ from those in South African culture, particularly in rural areas. Thus, the social construction of girls in a classroom setting in the UK differs from how girls in rural contexts in South Africa are constructed, primarily due to their cultural differences. These cultural differences play a significant role in shaping the social dynamics, norms, and expectations surrounding girls' roles and behaviour within their respective educational environments.

2.8 Theoretical framework

"a vibrant and compelling framework for feminism in our times." Judith Butler

This research is grounded in a decolonial feminist theoretical framework. The study aligns with the perspectives of Latin American decolonial feminist activist and scholar Miñoso (2009), who advocates against the coloniality of knowledge and gender. Miñoso (2009) seeks to dismantle the system of dominance imposed upon indigenous, black, and marginalized women, striving for a collective goal of decolonization and depatriarchalization. According to Miñoso (2017), decolonial feminist theory serves as a crucial instrument in deconstructing the racist/sexist coloniality/modernity project and is to decolonize and break free from patriarchal systems. It implies a new path that is not an imposition or prescription, but a worldview, a way of seeing and doing and understanding gender that emanates from marginalized women in the Global South (Manning, 2021). According to Lugones (2008), many Global South women live in an in-between world full of ambiguities and are often marginalized. The feminist decolonial perspective, therefore, highlights how historical colonial legacies, such as the unequal distribution of resources and opportunities, continue to impact the lives of girls in rural areas. Therefore, this study uses a decolonial feminist framework to explore how girls are constructed in spaces that are predominantly reserved for men and understand the complexities of their experiences hindering their access and participation in Physical Sciences.

A decolonial feminist theoretical framework is a critical, reflexive tool that, when applied to how girls are constructed in the Physical Science classroom in South African rural schools (because rural areas are still marked by social and cultural beliefs which may be of disadvantage to women) can serve as a point of understanding and dismantling the embedded social and cultural beliefs prevalent in rural areas. Manning (2021) explains that decolonial feminist theory is a crucial aspect of an ongoing movement to reclaim and reinterpret scientific and philosophical narratives, challenging the Eurocentric worldview. This theory actively challenges the Western patriarchal economic ideology that has historically marginalized women, Black people, Indigenous people, and individuals from Asia and Africa, positioning them as inferior beings (Vergès et al., 2021). For example, the apartheid system in South Africa enforced a racially segregated education system that entrenched social inequalities (Hoadley,

2010). In as much as the current curriculum in South African schools seeks to promote equality and redress historical injustices, remnants of the previous system and its effects continue to linger. Apartheid upheld patriarchal norms and reinforced traditional gender roles and expectations by assigning women to domestic and caregiving roles, while men were positioned as the breadwinners and heads of households (Mudau, 2017).

Furthermore, these gender roles were entrenched in various apartheid laws and policies creating significant barriers to girls' access to quality education, and perpetuating gender inequalities in knowledge acquisition, skills development, and future opportunities (Mshweshwe, 2020). Chisholm (2012) furthers this argument by stating the legacies of apartheid education left to a democratic government were immense, spanning everything from inequality across all spheres to the persistence of racism (and sexism) despite a negotiated solution and national reconciliation policies. Similarly, Unterhalter (1990) noted that black women faced significant limitations and restrictions in terms of opportunities. The particular race-class hierarchy of privilege constructed through apartheid and Bantustan education was underpinned by gender inequality (Chislom, 2012). Thus, the feminist decolonial theory combines feminist perspectives with decolonial thought to understand the challenges and address how colonialism and patriarchy persistently intersect and perpetuate systems of oppression, particularly in the science domain.

Feminist perspectives with decolonial thought speak to the integration of feminist theories and decolonial frameworks in analyzing and addressing issues related to gender, power, and colonialism (Manning, 2021). It acknowledges that both feminism and decolonization share the goal of challenging and transforming oppressive systems, and recognizes the intersections between gender-based oppression and the legacies of colonialism. Thus, the use of feminist decolonial theory to identify the importance of understanding and dismantling power structures that have been shaped by colonialism, while also centering the experiences and knowledge of marginalized women in the decolonial struggle is crucial. This approach challenges and aims to dismantle dominant narratives, power structures, and Eurocentric standards while promoting inclusivity, intersectionality, and social justice within rural areas, especially in South African rural schools where social stereotypes may marginalize women. This interdisciplinary approach can serve as a tool to create space for the diverse experiences and knowledge of girls from different cultural, racial, and ethnic backgrounds, and to promote transformative change at individual, collective, and systemic levels in the science field.

2.9 Conclusion of the review

The literature reviewed was aimed at a deeper understanding of the theories behind girls' participation in physical sciences. The literature helped to define the problem and largely informed the research methodology. For example, it became evident that this study must focus on the pedagogical practices of educators in rural classrooms which may hinder girls' access to and participation in Physical Sciences. This is because no research evidence describes and informs teachers about pedagogical practices and processes and how they impact girls' participation and access to Physical Science classes in South Africa, therefore, the need to carry out this investigation cannot be overemphasized. Additionally, one of the teachers' primary resources is the textbook, and teachers would probably find it easier to present a science free of gender bias if textbooks themselves were gender fair.

Furthermore, it seems clear from the literature that whatever biological differences there are between men and women, there is very little difference in scientific ability, and certainly not enough to explain the under-representation of women in the science field. This implies that biological dissimilarities cannot sufficiently account for the under-representation of women in the science field. Therefore, continually stressing biological differences may lead to the misconception that no action is necessary to address gender disparities in science.

CHAPTER 3: METHODOLOGY

3.1 Introduction

A research methodology is a crucial component of the research process. It involves the procedures and strategies employed by the researcher to gather information on a specific phenomenon (Kothari, 2004). The purpose of this section is to describe and provide a justification for the methodological approaches chosen for the study by outlining the; research approach, paradigm, methods for collecting and analysing data, sampling techniques, considerations for ensuring the reliability and validity of the findings, ethical considerations, as well as the limitations of the study. This chapter explains how the research will be carried out. It also gives an overview of the participants and the site from which the sample of respondents was drawn. The research design used to collect data is also described. It examines the qualitative approach, research paradigm, research site and methods, data collection, and information about the data analysis procedures and triangulation issues that were implemented.

3.2 Research approach.

The research uses a qualitative approach to explore how girls are constructed in a grade 10 Physical Science classroom in a rural context in South Africa. According to Cresswell (2009), qualitative research emphasizes the exploration and understanding of social phenomena through an in-depth investigation of individuals' perspectives, experiences, and meanings. Thus, this study uses a qualitative approach to explore how traditional gender norms are constructed in a science classroom resulting in limiting girls' access and participation in Physical Science in a rural school. Badenhorst (2008) notes that a key element of the qualitative research approach is the study of participants' understanding and interpretation within the natural context of the participants to capture the complexity of the problem. The qualities of this form of research approach are useful for the study of how girls are constructed in a Physical Science classroom in a rural school. Specifically, qualitative research allows for a deep exploration of the experiences, perspectives, and social interactions of girls in the Physical Science classroom. This approach provided the researcher with a comprehensive understanding of how girls are constructed and shaped by the classroom environment (teacher's influence and

peer interactions), and the social dynamics at play in a rural school which ultimately hinder girls' access, participation, and experiences in Physical Sciences.

3.3 Research design

This study uses a case study of a grade 10 physical science class in a selected rural school in the Sekhukhune district in South Africa. According to Cresswell (2009), case studies are a strategy of inquiry in which the researcher, explores in depth a program, event, activity, or one or more individuals. Cases are bounded by time and activity, and the researcher collects detailed information using a variety of data collection procedures over a sustained period (Creswell, 2009). This method helps researchers understand the unique challenges and learning environments in rural schools.

Research in rural schools in South African highlights the complex factors influencing science education, particularly the challenges in effectively teaching Physical Science. For example, Zenda (2017) identified that hands-on, student-centered learning activities are crucial in improving academic achievement in rural settings, yet these methods are often underutilized due to resource constraints. Additionally, studies like Ramokgopa (2013) emphasize the importance of adapting teaching methods to the specific needs of rural learners, suggesting that case studies are vital for understanding and addressing these unique educational challenges.

This study was conducted in Sekhukhune particularly because it is located in the Limpopo province, the northernmost part of South Africa, and is the smallest in the province with most of which is rural. Sekhukhune has both limited economic infrastructure opportunities and services of a reasonable doubt. Intersectionality plays a significant role in shaping individuals' experiences and opportunities. In Sekhukhune, girls may face challenges due to intersecting factors such as gender, socio-economic status, and geographic location. Therefore, it became an area of interest for study because by focusing on Sekhukhune, the researcher can gain insights into the intersection of rural dynamics and gender disparities in science education, and careers for girls. Thus, a case study allowed me to observe how boys interacted with girls in a classroom setting and the behaviour of both teachers and learners during the teaching and learning process.

3.4 Research paradigm

This study is positioned in the interpretive paradigm. The interpretive paradigm holds the position that the understanding of reality is socially constructed and, therefore, subjective (Chowdurry, 2014). Creswell (2003) asserts that an interpretive paradigm is best suited for qualitative research. A key element of this paradigm is that it engages participants' subjective understanding, which means that the data collected is subjective and is informed by the participants' interpretation. The relevance of the interpretive paradigm for this study is that it acknowledges participants' perspectives as their version of social reality (Cresswell, 2003).

The interpretivist paradigm is rooted in the belief that reality is socially constructed and can vary across different contexts. As highlighted by Guba and Lincoln (1994), this paradigm acknowledges that researchers bring their own interpretations to the study, which are shaped by their own backgrounds and experiences. The researcher's role, therefore, is to engage with participants in a way that facilitates a deep understanding of their lived experiences. This engagement often involves methods such as in-depth interviews, participant observation, and thematic analysis, which allow researchers to capture the nuances of human behavior and social interactions (Creswell & Poth, 2018).

Furthermore, the interpretivist paradigm encourages reflexivity, where researchers continuously reflect on their own biases and assumptions throughout the research process. This reflexivity is critical in ensuring that the research findings authentically represent the perspectives of the participants, rather than being influenced by the researcher's preconceptions (Berger, 2015). Therefore, interpretive paradigm is relevant to study the construction of girls in a rural school because it acknowledges the significance of participants' perspectives as their version of social reality. Furthermore, this paradigm recognizes that girls have their interpretations, beliefs, and understandings of how they are constructed within the classroom setting. Thus, by valuing these subjective meanings, the researcher gained insights into the girls' lived experiences and how they perceive their roles, identities, and interactions in a Physical Science classroom.

3.5 Research site

The purpose of this study was to investigate the construction of girls in a Physical Science classroom at a rural school. The school is attended by learners from both the Ndebele and Pedi communities, adding cultural diversity to the picture. Situated in the Sekhukhune region, where economic opportunities are limited, this setting reflects the challenges often faced by rural communities. Therefore, by focusing on this specific context, the researcher aimed to understand the various factors, such as gender, socio-economic status, and cultural norms, that shape girls' experiences in science education. The goal was to find insights that could help create opportunities for girls in science within rural areas.

3.6 Entering the research site

The selection of Zama Zama Secondary Rural High School as the research site was influenced, to a certain extent, by practical considerations. Although not entirely representative of all rural high schools in Sekhukhune, the school's central location within a rural community and its proximity to major roads connecting to towns like Groblersdal and Middleburg played a pivotal role in the decision. Essentially, Zama Zama High School stood at the crossroads of African traditionalism and Western modernity, presenting a unique intersection where new understandings and practices of gender among students could emerge.

Having prior knowledge of the Zama Zama secondary school from my experiences as a learner and as the Learner Representative Council (LRC) president in the school, I was confident that the principal would grant me easy access to my research. My familiarity with him from his roles as both my Physical Science teacher and the principal contributed to this expectation. However, despite my initial confidence, gaining access proved to be more complex than anticipated. The principal requested a letter of permission from the Department of Education in Limpopo, even though I had provided him with ethical clearance from Wits University. Consequently, I had to wait until I obtained official permission from the department before proceeding with the research.

Once permission was granted, I proceeded with collecting data explained the purpose of my research to each participant, and distributed participation forms and consent forms. These documents were taken home by the participants to be signed and brought back the following

day. Assent forms for minors were also provided to confirm their participation agreement. Upon securing access, the principal assigned the Head of Department for Maths and Science to guide me around the school and provide the necessary resources for the duration of my stay. An office space was allocated for interviews and to serve as a workspace for writing notes during moments when I was not actively interacting with learners and teachers. While conducting the research, I chose to spend much of my time in the staff room with teachers or inside and outside the classrooms with Grade 12 learners. This decision was intentional, allowing me to immerse myself in the school's environment and better understand the dynamics of gender construction in the context of rural South African education.

3.7 Methods of data collection

This study used observations and semi-structured interviews to collect data. The advantage of using observations is that the researcher has first-hand experience with participants and can record information as it is revealed (Cresswell, 2003). Thus, observations during teaching and learning in a Physical Science classroom allowed me to observe the physical environment, the teacher's behavior, peer interactions, and other contextual factors that influence the relations between girls and boys. From these observations, I was able to explore first-hand how gender identities are constructed in experience. Observations allowed the researcher to capture the real-time interactions and environment in the Physical Science classroom, noting how gender identities are expressed and negotiated. These observations then informed the semi-structured interviews, guiding the questions to explore specific behaviors and patterns observed in the classroom. This iterative process helped validate the data and provided a more nuanced understanding of how gender roles are constructed in educational settings (Creswell, 2003). According to Gill et al. (2008), semi-structured interviews are particularly effective when informed by observational data, as they allow for deeper exploration of the themes that emerge during observation, enhancing the overall reliability of the study.

Furthermore, the use of semi-structured interviews enabled both open and closed questions to explore further responses of participants about this study. According to Brinkmann (2014), in semi-structured interviews, the interviewer holds the authority to guide the conversation toward topics that are considered important to the research project. Similarly, Barrbiball and While (1994) state that semi-structured interviews are well suited for the exploration of the perceptions and opinions of participants regarding complex and sometimes sensitive issues and enable probing for more information and clarification of responses in line with the research

project. Thus, semi-structured interviews allowed the interviewer to have the discretion to direct the interview toward specific areas or issues that were deemed relevant and significant for this study.

3.8 Sampling

Purposive sampling was used to determine the sample from which participants were selected. Wagner et. al., (2008) state that purposive sampling includes the researchers' decision in selecting participants who are representative of the general population based on a specified selection criterion. In addition, purposeful sampling allows researchers to focus on individuals who are most likely to provide relevant and rich data for understanding the phenomena being studied (Palinkas et al., 2015). The research questions of this study directly influenced the selection of participants for interviews by targeting individuals who could provide insights into both the pedagogical practices in rural schools and the construction of gender roles in Physical Science classrooms. For the first question, teachers were selected to discuss how their teaching methods either support or limit girls' participation. The second question required input from both teachers and learners to explore how gender roles are formed and maintained in the classroom, making them ideal participants for examining these dynamics. During observation, I identified about 5 boys and 5 girls who seemed to show portraits of interesting insights that were being active in the construction of gender. Furthermore, I selected girls who were displaying feminine characters and boys portraying masculine characters for interviewing. This deliberate selection aimed to see how these individuals actively contributed to the construction of gender roles within the societal context. The identification of specific gendered characteristics and behaviors served as the basis for further exploration and understanding of the underlying processes shaping gender identity.

Table 1: The selection criteria for the participants

Selection Criterion	Justification for the study
Grade 10 learners	I chose to interview grade 10 learners because this is a significant grade where they start doing Physical Science as a major. Perceptions of gender roles and stereotypes can shape girls' beliefs about their abilities

	and interests and therefore. I therefore, chose to explore grade 10 learners' views on the suitability of different genders for Science, to gain insights into the societal and cultural factors that contribute to gender imbalances in Physical Sciences.
5 Boys and 5 girl learners in grade 10	Understanding the perspectives of both girls and boys in a grade 10 Physical Science classroom was necessary to shed light on how boys perceive girls and the perspectives of girls regarding their roles and identities within a Physical Science classroom. 5 girls who were displaying feminine characters and 5 boys portraying masculine behaviour were selected during observation.
Grade 10,11,12 Science teachers and Head of departments in Science subjects.	The behaviour and participation of girls in a Grade 10 Science class may be influenced by the teachers. Exploring the viewpoints of these teachers regarding students provided insight into the understanding of gender dynamics and roles within a Physical Science classroom.
Rural school	Rural areas are known for perpetuating traditional and cultural norms which hinder girls' access and participation because every gender is assigned roles. Consequently, examining and engaging with students and educators at a rural school provided valuable insights into the impact of cultural and traditional norms on girls. I wanted to see how gender is constructed in a classroom setting, this was because boys, girls and

	teachers come to school with traditional roles from the communities and as a result, they act out these roles in the classroom to consolidate the norms.

3.9 Data collection and analysis

During interviews, the researcher has the opportunity to uncover information that may not have been apparent initially. According to Scott and Morrison (2006), interviews offer a more nuanced way of acquiring knowledge compared to what a questionnaire might provide, especially when addressing specific research questions. Consequently, Lofland and Lofland (1995) emphasize that interviews yield data that differs significantly from observations and questionnaires. Cohen et al. (2000) propose that interviews can serve as the primary method for gathering information directly related to the research objectives. However, Patton (2001) highlights certain drawbacks associated with interviews, considering them expensive and time-consuming. The flexibility inherent in interviews may lead to inconsistencies across different interview sessions. Moreover, there is a risk of participants distorting their perceptions or expressing a desire to please the interviewer. To conduct effective interviews, the researcher must remain aware of these potential issues and take proactive measures to address them. Being aware of these challenges is crucial for ensuring the reliability and validity of the information gathered through interviews.

According to Slavin (2006), the researcher develops a set of questions organized into a schedule for an interview-based study. In this particular study, four distinct schedules were employed: one for the Science Head of Department (HOD), one for Physical Science teachers, one for girl Physical Science learners, and one for boys Physical Science learners. Gillham (2005) notes that interviews involve one person interacting with another, relying on interpersonal sensitivity. Furthermore, as stated by Lofland and Lofland (1995), an in-depth interview is essentially a dialogue between an interviewer and an interviewee. Its primary objective is to extract rich, detailed material for subsequent analysis. In-depth interviews are characterized by thorough probing and the use of semi-structured questions.

The researcher created various interview schedules and guides containing a list of questions to be addressed. The questions were semi-structured, allowing both teachers and learners to freely

express their perspectives on gender perceptions that might impact girls' access and participation in Physical Sciences. These interview questions were derived from the literature review, which looked into the factors influencing how girls are perceived in the Physical Science classroom. The purpose of the interviews was to delve into the thoughts of the participants, gathering information and exploring the perceptions of teachers and learners that may impact girls' access and achievement in Physical Sciences. All interviews were conducted in a face-to-face format.

Table 2: semi-structured interviews and observation guide.

Girl learners	To: • Describe their feelings in a Physical science class and elaborate on their experiences. • Share any instances where they may have felt humiliated as girls in the Physical Science classroom, whether by teachers or fellow learners (girls or boys). • Discuss positive experiences in the physical science class where they felt supported, either by teachers or other girls and boys. • Describe their perceptions of the presence of boys in the Physical Science class and whether they feel equal when participating in science-related activities. • Reflect on the situations in which they typically interact with boys in the classroom. • Provide insights into the dynamics of their relationships with boys in the context of the Physical Science classroom. • Share their preferences regarding working with either girls or boys during class activities, projects, and experiments in Physical Sciences, and the reasons behind their choice. Observation of learners and learner-teacher interactions focusing on discipline, social relations and attitude.

Boy learners	To: • Share their perceptions of the presence of girls in the Physical Science class. • Describe the situations in which they typically interact with girls in the classroom. • Express their opinions on whether they believe girls are equally capable in Physical Science and provide the reasons behind their views. • Share their feelings about collaborating with girls in projects or experiments related to Physical Sciences. • Discuss their preferences regarding working with either girls or boys during class activities, projects, and experiments in Physical Science and provide the reasons for their preference. • Offer their thoughts on girls pursuing careers in Science and share any perspectives they may have on this matter. Observation of learners and learner-teacher interactions focusing on discipline, social relations and attitude.
Teachers and Head of Department (HOD)	To: • Describe whether there are specific stereotypes or biases observed or heard regarding girls in Grade 10 Physical Science classes. • Request descriptions of one or two experiences of girl gender discrimination or bias that have been observed in science classes. • Reflect on your typical approach to dealing with stereotypes and biases in your role as a teacher. • Investigate any noticed differences in the way girls and boys approach and engage with Science topics.

	• Examine the impact of boys' attitudes and behaviours towards girls in Science classes on the girls' learning experiences. • Share opinions on what you, as a teacher, can do to encourage more girls to actively participate and excel in science subjects, particularly in Physical Sciences.

To gather the information based on the research questions, I immersed myself in Zama Zama secondary school within the villages of Sekhukhune. This involved positioning myself within the lives of the students and their unique experiences. By embedding myself in the school environment, I was able to closely observe the dynamics of the Grade 10 Physical Science class, paying specific attention to discipline, social relations, and attitudes. This immersive approach allowed me to gain a deeper understanding of the cultural context, including the impact of initiation practices on the students' experiences and perspectives within the educational setting. Through this engagement, I aimed to capture authentic insights into how gender identities are constructed in the context of a rural South African school with distinctive cultural traditions.

While the initial focus was on the initiation practices specific to boys, I did not overlook other cultural nuances and diversity within the school that could have influenced the construction of gender identities. I also considered the agency of students in shaping their own gender identities. Understanding their active role in this process was vital for a comprehensive analysis. In addition, I looked at how intersecting factors such as socioeconomic status and community dynamics interact with cultural practices to influence the construction of gender identities.

3. 10 Data analysis

Bazeley (2009) notes that meaningful analysis begins with the reading and interpretation of gathered data. Patton (2001) explains that data analysis in qualitative work is to generate impressions based on initial digital recordings and to move quickly to write summaries that blur the distinction between what was heard in the raw data and the patterns and themes that an investigator has discerned which can often best be termed an interpretation of the data. To

achieve this, the researcher needs explicit processes for tracking and managing raw qualitative data for coding the data using phrases in ways that permit data to be looked at both in its textual context and outside of it for checking on the dependability of coding by using multiple coders for recognizing and articulating emergent ideas about patterns, themes, and explanations (Braun & Clarke, 2006). Watling and James, (2007) describe data analysis in the qualitative paradigm as research for understanding, interpretations, and meaning rather than conveying facts and measuring information. Data analysis in this research aims to give appropriate meaning to the views of teachers and learners on what may hinder girls' access to participation in Physical Sciences.

This research used Thematic Analysis to examine the collected data. Thematic analysis involves the identification of patterns or themes within qualitative data. Braun and Clarke (2006) highlight that Thematic Analysis serves as a foundational qualitative method, providing essential skills applicable to various types of analysis. They further allude that it is recommended as the first method to be learned due to its versatility and broad applicability (Braun & Clarke, 2006). Notably, one key advantage, particularly in the context of learning and teaching, is that Thematic Analysis provides accessible and systematic procedures for generating codes and themes from qualitative data. Codes are the smallest unit of analysis that capture interesting features of the data potentially relevant to the research question (Clarke & Braun, 2015). This means that codes are the building blocks for themes, larger patterns of meaning, underpinned by a central organizing concept; a shared core idea. Themes provide a framework for organizing and reporting the researcher's analytic observations. The aim of TA is not simply to summarise the data content, but to identify, and interpret, key, but not necessarily all, features of the data, guided by the research question (Clarke & Braun, 2015).

The semi-structured interviews were audio-recorded, transcribed, and printed. This was particularly an important way to organize data and present it in a form that would be easy to analyze (Masinire, 2011). Thus, in the process of transcription, interviews for each participant were grouped and organized around the research questions. The interview transcriptions were organized into themes by coding. Open coding was used to condense the data by assigning codes to it. There was an identification of categories and themes emerging from the data. Data from the three interview schedules were analyzed separately at first to compare the responses of girl and boys learners, as well as teachers. This separation allowed for a comparison of responses between girl and boys learners, as well as teachers. By examining the data independently for each group, the researchers could identify patterns, differences, and

commonalities in the experiences and perspectives of both genders. This comparative analysis added depth to the research findings and contributed to a more nuanced understanding of the factors influencing gender dynamics in the context of Physical Science education in rural schools

Analyzing qualitative data can present challenges, not least for inexperienced researchers. To provide a clear understanding of the analytical process, I applied the Thematic Analysis framework proposed by Braun and Clarke (2006). The application of the Thematic Analysis framework provided a structured and systematic method for handling qualitative data. This approach has not only helped in addressing the research questions but has also contributed to a deeper understanding of the complexities surrounding gender dynamics and participation in Physical Sciences.

3.11 Trustworthiness

The data's trustworthiness was assured by focusing on its credibility, dependability, and transferability. According to Cope (2014), dependability refers to the consistency of data across similar contexts and circumstances, which will be ensured by involving my research supervisor in designing the research to evaluate its practicality and accuracy. Merriam (1998) notes that reliability in qualitative studies may be challenging due to human behavior variability, thus consistency in reporting results is crucial. Triangulation methods were employed, with varied semi-structured questions posed to teachers and learners, and raw data examination was conducted to verify research steps. Lincoln and Guba (1985) suggest employing an inquiry audit to assess both the process and the outcome of the research for consistency. The researcher ensured standard conditions for data collection by providing participants with identical instructions and allocating the same time frame for answering questions.

Therefore, this ensured that the research was conducted in a manner that would yield consistent results in similar rural areas. Cope (2014) further describes credibility as the truthfulness of the representation of participants' views by the researcher. To accurately capture the participants' perspectives, the interview conversations were audio recorded, and subsequently transcribed verbatim. This approach was employed to minimize the risk of misinterpretation during the compilation of the research report. Lastly, Cope (2014) states that transferability refers to the generalisability of the data across different contexts. To ensure transferability, the findings of

the study were rooted in specific literature, both conceptually and theoretically, to show its relevance in contexts beyond the selected rural area.

3.12 Ethical considerations

This study was conducted after ethical clearance was obtained from the University of Witwatersrand. In addition, written consent and assent for minors were obtained from all the participants regarding participation in the interviews which includes an audio recording and the use of data in the writing of the research report. All participants were informed that their participation was voluntary, as well as their right to withdraw consent and assent at any time. The school principal was informed about using the school's name in the research report and he gave consent. This agreement was reached after a thorough discussion of the research objectives, the potential implications of naming the school, and the measures in place to protect the confidentiality and privacy of all individuals involved. Lastly, the anonymity and confidentiality of the participants are guaranteed in the writing of the final research report. I had promised all the participants that their information would not be shared with anyone and would be treated in strict confidence.

3.13 Conclusion

The purpose of this section was to describe the research methodology and the data collection methods. I have outlined the research approach that this study has taken. Additionally, I highlighted the research design and procedure, focusing on girls' access and participation in Physical Sciences. In this process, I located myself about the context of this study, participants, and data. Lastly, I described how data was analyzed. The next chapter outlines the findings of the study.

CHAPTER 4: DATA PRESENTATION AND FINDINGS

4. 1 Introduction

The focus of this chapter is on presenting the findings derived from data from in-depth and open-ended interviews and observations during teaching and learning Physical Sciences. The findings of the research will be given and linked to the literature. This chapter offers insights on how are girls constructed in the Physical Science classroom, and how processes and practices of gender construction manifest within the Physical Science classroom. Four major themes are outlined: Gendered career aspirations in science, modeling gender roles in science, pedagogical practices in science classrooms, and persistence of gender inequality in science.

4.2 Interview data

Table 3 below includes teachers and learners (girls and boys), highlighting the total number of participants from each group. The summary provides an overview of the demographic composition, which is essential for understanding the context and focus of the data collected during the interviews. I used the terms "Girl" and "Boy", and “Female and Male” to indicate the sex of the participants to maintain consistency and clarity. This helps ensure that the table is straightforward, especially when including both students and teachers, who are adults, thus avoiding any potential confusion between age and sex-related categories.

Table 3: Representation of participants that were interviewed

Participants	Gender	Total
Teacher 1	Male	1
Teacher 2	Male	1
Teacher 3 (HOD)	Male	1
Learner 1	Girl	1
Learner 2	Girl	1

Learner 3	Girl	1
Learner 4	Girl	1
Learner 5	Girl	1
Learner 6	Boy	1
Learner 7	Boy	1
Learner 8	Boy	1
Learner 9	Boy	1
Learner 10	Boy	1
		13

4.3 Table 4 presents the key themes identified during the data analysis process, reflecting the progression from open coding to axial coding. The table illustrates how initial codes were refined and grouped into broader categories, ultimately revealing the main themes that emerged from the study. These themes sum up the core findings related to gender dynamics and identity construction in the Physical Science classroom, providing a clear framework for understanding the data in the context of this research.

Table 4: The coding stages of the study

Participants codes	Code assigned	Theme that emerged
"..I chose Physical Science because the career that I want has to have Physical Sciences. I want to be	girls considering career options perceived as more socially oriented or traditionally feminine.	***Gendered career aspirations in science.***

a Doctor." *Learner 1 (girl)*		
"..to be honest, most jobs in Physics require man power, boy do *better in that aspect." Learner 6 (boy)*	perceptions of gender capabilities in science	
"..when you know Physics, it is easier for you to know chemistry...society has taught us that boys can do hard subjects like Physics and girls can do better in literature." *Teacher 2*	Stereotypical gender roles in science participation.	

"..I think boys are more smart and pass Physical Science than boys because Physics deals with accelerations and motors and boys are good with mechanics, because they like cars, that is why they excel in Physical Sciences." *Learner 4 (girl)*	Gendered perceptions of competence in practical work.	
"Boys are more focused than girls in class. They are more helpful and are hard workers. They are hands on unlike girls and this is why I prefer working with them." *Learner 3 (girl)*	Preference working with boys.	***Modelling gender roles in science.***
"I would prefer working with girls when it comes with girls because they make me feel comfortable. Even if they struggle, at least they won't make me	Not comfortable working with s.	

uncomfortable." *Learner 4 (girl)*		
I only interact with s when we are joking around but never to school work. This is because I find it awkward to approach s related to school work, they tend to make one feel stupid for not understanding. I would prefer going to the teacher to ask for help instead *Learner 2 (girl)* .	Interaction in the classroom.	
"In this department of Sciences there are more boys than girls. *"Teacher 4 (HOD)*	Shortage of girl science teachers	***Persistence of gender inequality in science.***

	"Gender imbalance is a call for concern." *Teacher 1* "Gender imbalance is still prevalent." *Teacher 2*	Gender imbalance concern.	
	"My teacher always advise me to study harder if I want to pass Physical Science teachers." *Learner 3 (girl)*	Encouragement to study.	***Pedagogical practices in science classrooms.***
	"My teacher always says we should ask where we do not understand. He always encourages us to ask for help if were are confused." *Learner 5 (girl)*	Motivation from teacher to reach out for assistance.	
	"I do not normally ask for help from my teacher because I feel embarrassed quite often, this is because I perform poorly in Physics." *Learner 2 (girl)*	Not comfortable asking for help because of poor performance.	

Therefore, the four themes that emerged from the qualitative data is as follows:

1. *Gendered career aspirations in science.*
2. *Modelling gender roles in science.*
3. *Pedagogical practices in science classrooms.*
4. *Persistence of gender inequality in science.*

4.3 Gendered career aspirations in science

One of the objectives of the study was to explore the processes and practices of gender construction manifest in the Physical Science which may ultimately impact a girl's success in science. This theme highlights how the career choices of girl learners are concentrated in traditionally respected and gendered professions like Medicine and Law, reflecting societal expectations and norms that influence their aspirations within the field of Physical Sciences. Most learners attributed their choice of Physical Science to the job prospectus. The majority of girl learners indicated a preference for pursuing Physical Science with the specific career goal of becoming medical doctors while some are showing interest in Law. Interestingly, none of the girl students expressed aspirations outside the realms of Medicine and Law. Generally, girls showed more attraction to careers typically associated with girls, while s leaned towards those linked with boys . This suggests that women choose careers that deal with human interaction the most. Although Law is not a science-related field, it can be inferred that girls lean more towards people-oriented careers nonetheless. The interviews below illustrate why girls chose Physical Science due to its promising job prospects, yet nearly all of them share a common career interest.

Learner 5 (Girl),

> *I chose Physical Science because it has a lot of job opportunities. My dream is to be a Lawyer, but I might change in the future depending on what I might find interesting after High school. I like working with people and my choices will be based on anything that involves helping people.*

Learner 3 (Girl),

I chose Physical Science because the career that I want has to have Physical Sciences. I want to be a Doctor. Even though I am not a top performer in Physical Science I think as time goes by I will improve and make my dreams of becoming a Doctor true.

Learner 9 (Girl),

I chose to do Physical Science because it has a lot of job opportunities. A lot of people discouraged me from doing Physical Science because it is difficult and not a lot of people pass it. But because I want to be Doctor, that is why I am doing it.

Nevertheless, a significant number of s also indicated that their choice of Physical Science is motivated by specific career aspirations. Many expressed a desire to work in the mining industry, aspiring to become engineers who are actively involved in the extraction and processing of minerals. Some s also mentioned aspirations of pursuing careers of becoming businessmen, reflecting a broader spectrum of professional goals within the business sector.

For example, learner 6, (boy) said;

I chose Physical Science because I want to have choices. I want to be an artisan, like work in the mines. Or become a business man. I honestly want a job that pays a lot of money.

Learner 9 (boy),

I chose Physical Science because they say it has job opportunities. I love working with cars, so I might do mechanical engineering for work.

The research findings highlight a common thread among learners, as majority shared motivation for choosing Physical Science centred around the pursuit of job opportunities. This collective perspective sheds light on the pragmatic considerations that drive learners to opt for Physical Science as a subject in South African rural schools. The choice of Physical Sciences, driven by aspirations for medical careers, reflects a broader pattern wherein girls are drawn to professions that involve direct interaction with people, caregiving, and societal well-being. Choosing Physical Science to pursue medical careers signifies a larger trend where girls gravitate towards professions involving direct engagement with people, caregiving, and societal well-being. For instance, an observation noted that:

within the grade 10 Physical Science class at Zama Zama High School, instances during teaching and learning sessions exemplify this pattern. In one instance, a boy

sought help by asking for an extra pen, and a girl promptly offered assistance, presenting him with a choice between a blue and a black pen. Similarly, when another boy felt thirsty, he directly approached a girl who had ice water, and she readily provided him with the needed refreshment.

These interactions demonstrate how gender roles and expectations play out in the classroom environment, reflecting broader societal patterns of girls being perceived as caregivers and nurturers. Although these may seem like simple acts of kindness, they indirectly reinforces traditional gender roles.

Furthermore, teachers and some learners believe that there are natural differences between boys and girls when it comes to science. The following interviews show how teachers and learners see different traits in boys and girls when it comes to science.

Teacher 2,

..I think that boys and girls do not behave the same and do not like the same things.

Therefore, teacher 2 believes there are differences between boys and girls. His belief that boys and girls naturally have different behaviors and preferences implies a belief in gender stereotypes and traditional gender roles, where certain characteristics and interests are assigned to specific genders based on gender roles. This view was also supported by learners who believe that girls and boys are different and there is a difference in how they are supposed to act.

For example, learner 9 (boy) commented;

..I believe that boys are good with engineering and electricity in general because that is what we are mostly interested in. I think most girls are afraid of electricity, but boys are brave and can lift heavy things.

Learner 4 (girl) also attributed that:

..boys are smarter and pass Physical Science than girls because Physics deals with accelerations and motors and boys are good with mechanics because they like cars, that is why they excel in Physical Sciences.

These comments thereof suggest that boys and girls are different according to perceived gender roles. Learner 9's comment implies that boys are naturally more interested in and capable of handling engineering and electricity-related tasks, while girls are perceived as being afraid and

less capable in these areas. Similarly, learner 4 attributes boys' success in Physical Science to their supposed traits for mechanics and interest in cars, which she believes are characteristics inherent to boys. Overall, these comments reflect stereotypical beliefs about gender roles and abilities, linking certain traits to specific genders based on perceived gender differences. This view is supported by the opinion of a boys who believes that even girls in the Physical Science class are less competent and does see why most of them are majoring in it.

Learner 7 (boy) :

> *"...girls are studying Physical Science because they're following each other. Only a few understand it. I don't think some girls need to be in the Physical Science class. They're only there because they think it's cool to be in the science stream."*

He further commented that*:*

> *To be honest, most jobs in Physics require man power, boys do better in that aspect.*

Therefore, the belief that boy are inherently better suited for engineering and electricity due to their supposed interest and bravery, while girls are portrayed as afraid and lacking in these areas, reflects a gender construction that assigns specific traits to a certain gender. Additionally, the comments made by *leaner 7(boy)* for example, suggest a perception that some girls may be motivated to study Physical Science because of peer influence rather than naturally understanding of the subject implying that girls are not good in Physical Science reflects a stereotype on gender differences.

In summary, the above findings show that that there are stereotypes and biases regarding gender roles and abilities in science education. These biases often lead to the perception that boys are naturally more inclined and capable in Physical Sciences, while girls are seen as less competent or interested. Therefore, when girls choose Physical Science because of the potential for good job opportunities, it adds another aspect to the conversation. It shows that even though they are interested in a field often seen as more for boys, their long-term career goals still lean towards traditionally feminine professions like Medicine and Law, which are focused on helping people. The next theme will thus focus on how gender roles are modelled in the science classroom.

4.4 Modelling gender roles in science

The qualitative analysis reveals that processes and practices of gender construction manifest within the Physical Science classroom. Both girls and boys explained that they preferred working mainly with boys because they believed boys had more knowledge in Physical Sciences. The interviews below show that boys have an advantage in Physical Science because they are deemed to know better in Physics than girls do. This highlights how gender norms influence perceptions within the science classroom, potentially influencing the construction of girls in the classroom.

Learner 6 (boy), for example, stated that:

> *..there are topics which boys are good at and there are some which girls are good . Boys are good with mechanics because they are interested with cars, while girls are good with Chemistry because it is just in their nature. Therefore, if we are doing mechanics I will prefer with boys and work with girls on things like chemistry*

Similarly, *learner 7 (boy)* shared the same sentiments attributing Physics to man power and creativity when it comes to Physical Science project by alluding that:

> *I prefer working with boys when it comes to school projects because they are experienced in terms of practical work and have more knowledge in Physics than girls. Boys have more power and have better ideas when it comes to work that requires hands or projects they normally give to us.*

girls also expressed their preference being working with boys as one claimed that it is easier working with boys than girls. Learner 5 (girl) noted,

> *I would prefer working with boy in activities and projects because as girls we fight and we normally want to bring each other down. Boys on the other hand, listen and are good with Physics.*

Another girl learner confirmed this view.

Learner 3 (girl),

> *I prefer working with boys than girls and I spend most time in Class with boys because girls like fighting.*

and she further commented:

When we have projects for example, boys will always go all out to look for materials that we need. They have interest and they know these things of electricity and mechanics.

Although the matter of fighting might not directly affect whether girls understand Physical Science or not, these statements also highlight that their choice to work with boys is rooted in the perception that boys possess greater knowledge, particularly in Physics. This means that ideas about boys and girls affect how they interact in science class, which may have an influence on how girls are constructed in the Physical Science classroom.

Furthermore, these views by teachers may lead to differential expectations and treatment in the classroom. Teachers' biases, whether explicit or implicit, can influence the ways they engage with students, impacting the confidence and participation of girls. The teacher's perspective, emphasising that girls tend to perform better in Biology *(Life Sciences)* and Chemistry than in Physics, raises concerns and prompts questions about girls' overall abilities in the broader field of Physical Sciences. This view serve as a starting point for discussions on the ways in which pedagogical practices either contribute to or alleviate gender related issues in Physical Sciences. The next theme n pedagogical practices in the science classroom outline that in detail.

4.5 Pedagogical practices in science classrooms

One of the questions in this this study sought to answer how do processes and practices of gender construction manifest within the Physical Science. The findings revealed that teacher and learner interaction contribute to the construction of girls in the Physical Science classroom. Many girls however, attributed that they are comfortable in the Physical Science classroom and they get the assistance they need from teachers, even from other fellow learners.

For example, learner 1 (girl) commented:

I have never felt humiliated in my Physical Science class. My teacher always advise me to study harder if I want to pass Physical Sciences. I get assistance from some of my classmates and I think we have a good relationship.

Learner 3 (girl) also stated that:

I may be shy to ask questions, but our teacher is very supportive. He guides us and encourages us to study.

Another learner commented that:

> *I feel empowered in a Physical Science class. I love being there and enjoy the subject.*
>
> *always feel supported in class.* Learner 5 (girl)

Therefore, the findings reveals that majority of girls feel like the Physical Science classroom is welcoming for them and find their teacher supportive in their learning process. Despite the generally positive atmosphere described by many girls in the class, a different perspective emerged from other girl learners who expressed feeling uncomfortable asking questions in class due to their performance in Physical Sciences.

For example, learner 4 (girl) stated that:

> *I do not normally ask for help from my teacher because I feel embarrassed quite often, this is because I perform poorly in Physics*.

Another girl attributed about her feeling of discomfort with regards to asking questions in class, as she stated that:

> *I do feel humiliated sometimes because I have a heart disease. Thus, when it starts, they mock me because they think I am seeking attention. Because I get level 1in Physical Sciences, I do not ask questions because I am scared they might say I am seeking attention.* Learner2 (girl)

This therefore, indicates a potential impact of gender construction on girls' confidence and participation in Physical Sciences. The interviews below provide insights into their perceptions and interactions with girl learners during Physical Science lessons, offering a deeper understanding of the dynamics shaping the learning environment. These perceptions pave the way for examining how teachers' attitudes and behaviors may contribute to gender biases in Physical Sciences.

Teacher 2, for example, explained that,

> *Everyone is capable of doing Science. However, the society has taught us that boys can do hard subjects like Physics and girls can do better in literature. When you know Physics, it is easier for you to know chemistry and when you only know Chemistry, it can be difficult to know Physics. I have been taught by boys teachers since grade 10 until I completed my teaching degree, majoring in Sciences stream. This is because*

from the early stages when you look at the enrolment, boys are more dominant than girls in Science classes.

Teacher 1 stated that,

There is no difference in how girls and boys engage in the subject. What is important is how one engages with the content. Understanding is a matter of ability. There are however, learners who would say they enjoy chemistry than Physics itself, mostly guys show interest in Physics part. Both gender participate equally and it is more about individual interest. In class there is always a debate on how learners engage with the questions in class. It is mostly boys that like to spike debates.

Teacher 1 brings attention to the prevalence of debates within the class, often initiated by boys. On the other hand, Teacher 2 highlights the distinctions in behaviour and interests exhibited by boys and girls, particularly in the context of calculations. Interestingly, the complexity of the complexity of this idea is exemplified in my observation notes:

an interactive dialogue unfolded between the teacher and boys learners surrounding the response of one boys. girls, however, appeared more reserved, with only one actively participating and attempting to answer questions. Unfortunately, during an attempt by a girl to answer a question, she faced an interruption from a boys, prompting the teacher to intervene. Notably, girls engaged in separate conversations, and one girl experienced laughter from her peers after providing an incorrect formula. Boys also outnumbered girls and they were confident throughout the lesson.

In line of observation notes, learner 4 (girl), expressed that,

Mostly boys bully me in class and it hurts me sometimes. But mostly it's boys that make feel uncomfortable in class. I would prefer working with girls when it comes to school activities girls because they make me feel comfortable. Even if they struggle, at least they won't make me uncomfortable.

The acknowledgment of the discomfort and bullying experienced by some female learners highlights the need for teachers to be attentive to the social dynamics within the classroom. Therefore, these classroom observations and remarks made by both learners and teachers highlight the gendered dynamics in participation and behaviour. Although learners and teachers believed that there were no gender issues in science, yet girl learners offered examples of lingering implicit biases within the seemingly 'gender-balanced' perception of the science

department. This contradiction suggests a potential lack of awareness among learners and teachers regarding the persistent discriminatory attitudes towards girls in science. As such, the contrasting perspectives among teachers, as discussed earlier, reveal potential variations in teaching approaches and attitudes that may impact girls' engagement in the subject. For example, some teachers hold the belief that boys are naturally better suited for Physical Sciences, which could influence teaching methods, potentially resulting in a less inclusive environment for girls. Therefore, the last theme that emerged in the qualitative analysis; the persistence of gender inequality in science will be looked at below.

4.6 Persistence of gender inequality in science

The fourth theme that emerged in the qualitative analysis was the persistence of gender inequality in science. As per the observation notes:

> *At Zama Zama High School, there are a total of 7 Science teachers, with 5 being boys and 2 girl. The science department encompasses subjects like Geography, Agricultural Sciences, Mathematics, Life Sciences, and Physical Sciences. Remarkably, the girl teachers at the school are primarily responsible for teaching Geography and Agricultural Sciences, while their boys counterparts handle subjects like Maths, Life Sciences, and Physical Sciences. Additionally, the head of the department is a boys teacher.*

This distribution highlights a gender disparity within the science department, with male teachers predominantly occupying roles in Physical Sciences. This presents a notable male representation in Physical Sciences, indicating a predominant presence and influence of male teachers within the science department.

The gender distribution among teachers in the science department reflects a clear pattern of gender roles and expectations. The fact that male teachers are predominantly responsible for subjects like Maths and Physical Sciences, while female teachers are mainly assigned to Geography, Life Sciences, and Agricultural Sciences, suggests a gendered division of subjects. Furthermore, the observation that all Physical Science teachers and the Head of the Department are males, which indicates a hierarchical and leadership gender disparity within the Sciences department. This reflects how gender roles and expectations are constructed not only in the

distribution of subjects but also in leadership positions within the science department. The male teachers are aware of this gap and they said the below.

Teacher 3 (HOD), stated that:

> *There are unfortunately no female teachers that teaches Physical Science in the school. The reason why there are less female in the department is that I think women tend to be interested in other faculties which are higher than that of teaching (B Ed). I think women perform better in Science subjects and because men perform average and lower, this is why they eventually become teachers.*

The explanation provided implies a belief that women, on average, perform better in science subjects, leading them to pursue faculties beyond teaching, possibly implying higher academic qualifications. In contrast, men, according to the statement, tend to perform at an average or lower level in science, leading them to eventually become teachers. However, an alternative perspective emerges below. Some teachers allude that boys have better prospects in Physical Science and derive greater enjoyment from the subject.

Teacher 1, for example, stated that;

> *Gender imbalance is a call for concern.*

However, he provided these explanations as a means to explain the gender imbalance:

> *"Only few girls are willing to go the extra mile especially in terms of numbers and calculations. Maybe that is why we have few girl scientists and Physical Science teachers. In my opinion, girls like opting for things that are more easier so that they could get jobs."* Teacher 1

Teacher 2 also commented;

> *Gender imbalance is still prevalent*

And further justified by stating that:

> *.. boys and girls do not behave the same and do not like the same things. In my opinion girls are not good when it comes to calculations. Boys are more good with calculations than girls. I completed my degree in DUT and the Science department was divided into two sections, chemistry and physics. Most girls were doing chemistry while most boys did physics. And to be quite honest, chemistry does not have more complex calculations*

than physics. Even with Life Sciences, most girls prefer it because it has more content than numbers and most excel there that is why you see a lot of girls in Life Sciences"
Teacher 2

Overall, the composition of the science department, the assignment of specific subjects based on gender, and the concentration of boys in leadership roles within Physical Science collectively demonstrate how processes and practices of gender construction manifest within the science department.

4.7 Conclusion

This concluding section of the chapter reflects on the research findings in connection to the study's research questions outlined in Chapter 1. The primary research question aimed to investigate ways in which the pedagogical practices in rural schools can either support or hinder girls' participation in Physical Science classrooms, as well as how processes of gender construction manifest within these settings. The results indicated that teachers, consciously or unconsciously, can influence how girls perceive Physical Sciences. Furthermore, the findings highlighted the persistence of gender gaps in Physical Sciences, with other factors contributing to these disparities. The chapter that follows will delve into a discussion of these emergent factors, shedding light on elements that might hinder girls' access and participation in Physical Science.

CHAPTER 5: DISCUSSION OF FINDINGS

5.1 Introduction

Based on the findings and the subsequent analysis of data above, it is clear that various factors influence girls' participation in Physical Science classrooms. The findings revealed that teachers, whether intentionally or unintentionally, play a significant role in shaping girls' perceptions of Physical Sciences. Additionally, the results indicated that there are still prevalent disparities between boys and girls in Physical Science which affect the construction of girls in Physical Sciences. The following chapter will provide a detailed discussion of these emerging factors, aiming to explain elements that could potentially hinder girls' access and participation in Physical Sciences. Through a careful examination of both empirical evidence and existing literature, complexities surrounding the engagement of girls in Physical Science will be discussed.

5.2 Gendered career aspirations in science

This study found that girls tend to be more attracted to careers traditionally associated with girls, while boys lean towards those typically linked with boys . The majority of girls expressed aspirations to become doctors and lawyers, which are careers associated with working closely with people. As highlighted in chapter 2 of the literature review, individuals, whether women or men, may be drawn to different things, influenced either by biological differences or social constructs (Darling-Hammond et al. 2019; Hemsing, & Greaves 2020). However, it was evident from the literature that preference in things and people for girls and boys was not rooted in biological distinctions but rather shaped by societal norms and constructions of what is deemed appropriate for women and men. Furthermore, Stewart-William and Halsey (2021) argue that interpersonal interactions contribute to a stronger tendency for men to show a preference for things, whereas a larger proportion of women would exhibit a stronger interest in people. Another example from the literature by Dekhtyar et al. (2018) confirms this inclination indicating that women often give precedence to communal goals more than their

male counterparts, which may be influenced by the inspiration drawn from other women who came before them. Therefore, the study's findings are similar to the above literature as girls showed interest in careers demonstrating a strong interest in working with people. While the literature review demonstrated that biological differences matter in determining differences in boys ' and girls' intellectual capacities, this study seems to suggest otherwise; that girls did not prefer careers that involved working with people because of their biological innate but because of their interest. This finding appears to align with a few research studies that argue that biological differences do not matter in determining boys ' and girls' capacities and potential in Physical Science. (Greaves 2020; Paxton et al. 2020; Blickenstaff 2005; Hyde 2016). As such, it can be implied from the findings that the same logic in these studies explains what this study has found. Thus, emerging from the findings, it can be argued that the construction of gender within a social context is influenced by social constructs as a result of interpersonal interactions rather than a biological difference. This perspective aligns with the principles of decolonial feminist theory which challenges the coloniality of knowledge and gender, recognizing that traditional gender roles and norms are products of colonial and patriarchal systems of dominance, rather than natural or biological facts.

Additionally, another interesting observation from the findings is that some girls expressed aspirations of becoming lawyers, which is intriguing as one does not necessarily have to pursue sciences if their interests lie in humanities or management. However, there are several possible explanations for this observation. For example, Schulze (2018) argues that it is crucial to use science to build better learners. A view supporting this argument states that "not all students will or should pursue science careers, but all students will encounter and use scientifically developed technology and will have to make decisions about issues in which science plays a role" (Harvey, 1984, p.5). Therefore, this suggests that while pursuing a career in fields like law, which often involves extensive interaction with people, a foundation in science remains valuable. It is essential to acknowledge the significance of science as a fundamental educational component applicable to all learners, regardless of their specific career goals. However, it is crucial to highlight that the primary objective of this study was initially centred on empowering girls to explore and thrive in science fields, ensuring they have equal opportunities as their male counterparts in prominent scientific roles. The findings indicate that achieving gender equality in science, particularly in roles not traditionally associated with interpersonal interactions, remains a significant and ongoing challenge. Additionally, there is no evidence in the findings suggesting that pedagogical practices influence girls' decisions to lean toward

careers involving people. Some teachers expressed the view that girls are just as capable as boys in pursuing careers in Physical Science.

However, the disparities in the attention and engagement received by boys and girls may impact girls' experiences and outcomes in Physical Science education in several ways: limited participation and access, impact academic performance, and potentially reduce confidence and interest. Eccles (2006) argues that the interpersonal interaction between teachers and learners, as both individuals and as a group, comprises a large part of the classroom learning environment. For example, Levy (2003) argues that boys learners, when taught by male teachers, tend to perceive them as more helpful, friendly, and understanding compared to their girl peers taught by teachers of either gender. Literature revealed that science teachers engage more actively and are more communicative with boys than girls, and as a consequence, girls, who receive less attention from teachers, may perceive physics less favourably than boys (Oon et al., 2020). These research findings as a result, suggest that there might be gendered patterns in teacher-learner interactions, potentially influencing how gender roles and expectations are constructed or reinforced within the Physical Science class.

5.3 Modelling gender roles in science

Very little evidence was found in the literature on the universal importance of a foundation in sciences, regardless of one's career aspirations. However, what was apparent in the literature was that nurturing science among girls from earlier ages was crucial. The research findings, however, reveal that processes and practices of gender construction manifest within the Physical Science classroom through the interactions between teachers and learners, shaping perceptions of abilities and interests associated with specific genders. For example, both teachers and some boy learners shared these sentiments during their interviews in this study. The literature in Chapter 2 also emphasizes this as the study by Mutekwe and Modiba (2012) revealed that teachers think that boys know better than girls in Physical Science and because of this stereotype, they tend to pose more questions to boys than to girls during teaching and learning which eventually lead to feelings of isolation and discouragement. When the teacher asked questions in the Physical Science class, it was mostly boys attempting to answer questions and initiate interactions.

Furthermore, the numerical difference in attendance and interactions between boys and girls highlights an initial aspect of the gender landscape in the classroom. The study findings revealed there were more boys than girls in the Physical Science class and an increased vocalization and self-grouping among boys, coupled with their higher levels of confidence, which indicate a gendered pattern of behavior that could contribute to varying participation levels. In agreement with these observations, a study by Toma et al. (2019) revealed that boys tend to exhibit more positive attitudes toward science compared to girls. Evidence suggests gender differences in classroom interactions may be because boys initiate more interactions with their teachers than girls do (Altermatt et al., 1998; Eccles & Blumenfeld, 1985). This trend became apparent in this study through class observations, where boys took the initiative to engage in debates and pose more questions than their girl counterparts. Notably, the teacher actively facilitated and entertained most of these debates. Logan and Skamp (2013) argue that teachers directly impact students' interest in a subject, this is because "science teachers treat boys and girl students differently in science classrooms. girls, on average, receive less attention than boys in science classrooms" (Oon et al., 2020, p.91). The findings revealed that the teacher actively participated in the debates and interactions initiated by boys during class, inadvertently side-lining other girls who engaged in separate conversations as a result. Therefore, I argue that these gender constructions influence the pedagogical practices employed in the classroom. Teachers, consciously or unconsciously, may adopt teaching methods and create an environment that aligns with the traditional gender norms associated with science. This dynamic points to a potential imbalance in the teacher's attention and involvement, raising questions about the inclusivity of classroom interactions and the impact on the learning experiences of girls in science.

In addition, Fives and Gerald (2014) argue that teachers' beliefs influence their classroom decisions and behaviors. For example, if there is a widespread belief that boys are naturally better at calculations and creative thinking in physics, teachers might unintentionally provide more encouragement and opportunities to boys in these aspects, contributing to the reinforcement of gender stereotypes. The search findings highlighted that teachers believe that boys are better with calculations while girls are better with theory. Teachers attributed that boys do well in Physical Science while girls excel in subjects like Biology and chemistry in the science domain. Research literature reviewed in Chapter 2 confirms this view revealing that at higher levels of achievement, boys outperform girls but only in Physical Science (Spaull & Makaluza, 2019). Consequently, Camilla et al. (2020) revealed that Biology, as a scientific

discipline, has been perceived as an area where gender inequality is reversed, with a higher representation of girl students at the tertiary level. Thus, the prevailing belief among both teachers and learners who attributed that girls do better in Chemistry and biology indicates that there is a common perception that Physical Science is mainly considered a subject for boys. While some may dismiss this perspective as outdated, contending that modern teachers treat boys and girls equally in their classrooms, pointing to increased enrolment of girls in Physical Science classes as evidence of gender balance, the research findings reveal that the perception of Physical Science as primarily suited for boys continues to persist among teachers. Therefore, to answer the first question of this study, the persistence of gender bias within the perception of the subject may influence the pedagogical approaches employed by teachers, consciously or unconsciously, and can potentially create an environment that is less inclusive for girl students. In answering the second question, the processes, and practices of gender construction manifest within the Physical Science classroom through the prevailing belief among teachers and learners that science is predominantly a subject for boys. This perception contributes to the construction of gender roles and stereotypes within the Physical Science classroom. This is because girls might receive less encouragement to pursue Physical Sciences, leading to a potential hindrance in their participation and engagement in the subject. Furthermore, Pedagogical practices that encourage stereotypical gender roles or reinforce biases may inadvertently hinder the participation of girls by creating an atmosphere that does not promote inclusivity. Factors such as declining interest among girls may be influenced by situations or environments that perpetuate negative stereotypes or hinder their identification with Physics (Radulović et al., 2022).

5.4 Pedagogical practices in science classrooms

A majority of the girls have expressed that their reluctance to ask or answer questions stems from their satisfaction with the teacher's teaching style. Although literature suggests the majority of questions in science class require the recall of factual knowledge, there is a noted gender disparity, with boys dominating in questioning and answering more than girls (Eliasson et al. 2017; Archer et al., 2014). However, the findings of this study revealed otherwise, as the majority of girls expressed satisfaction with the teaching methods employed by Physical Science teachers, highlighting the teachers' attentiveness and support. The girls also shared that they feel comfortable seeking help from their teachers when they encounter challenges with

their schoolwork. Thus, these insights indicate a positive teacher-student dynamic, suggesting that the environment is conducive to girls' engagement and learning in Physical Sciences. Yet, certain girls who did not feel a sense of belonging in the Physical Science class often withdrew, inhibiting their ability to freely participate. The girls attributed that some boys make fun of them during class interactions with the teacher. A study by Williams (1996) on mixed-sex science classrooms revealed that girls participated infrequently in whole-class discussions due to intimidation by boys, predominantly engaging by asking questions; in small groups, girls felt more at ease participating in same-sex groups, and the presence of even one boys often resulted in their silence. The findings indeed revealed that girls had separate conversations during questioning and answering, and it can be inferred that they were more comfortable engaging in small groups amongst themselves. Therefore, emerging from these observations it can be argued that these girls are losing out on valuable learning experiences as they are deprived of the opportunity to address misunderstandings during class for fear of being mocked or made fun of, and as a result, this may refrain them from actively participating in the Physical Science class.

Furthermore, schools serve as influential environments in shaping children's perceptions of gender roles, both through the representation of adults in various roles and the content presented in educational materials. In the textbook they use at Zama Zama High School, there were evident gender disparities in terms of the examples and images of characters in the textbook. Women were portrayed as doctors and nurses, while men in boiler making and playing soccer in the field. These images already separate girls from boys and give a perception that science is exclusively for men. Moletsane and Reddy (2011) contend that the science curriculum in South Africa is unfavorable towards girls, as it fails to recognize them. Additionally, the textbook proved to carry gender-biased texts such as ‘soccer ball’ . The word ‘soccer ball’ is generally regarded as a word accommodating most boys and a few girls. In South Africa, soccer has been historically a sport for boys (Friedman, 2013). Girls do play soccer, however, those that do are sometimes mistaken for being ‘tom-boyish’. Tom boys are regarded as girls that show behaviours that are generally considered to be normal for boys (Reay, 2001). Hence, most girls do not bother aligning themselves with soccer for fear of being called ‘tom boy’. Thus, in South Africa, soccer is seen from the societal stance, a sport for boys (Mayeza, 2017). The use of ‘soccer ball’ is, thus, enticing boys learners in the class, getting them excited about learning Physical Science while it is doing the opposite for girl learners.

5.5 Persistence of gender inequality in science

There is a persistence of gender inequality in science to date. The study revealed that there are more boys teachers in the science department with no girl teachers teaching Physical Sciences, which emerged as the fourth theme of the qualitative analysis. The staffing patterns of these findings further reflect gender differences. Literature shows that the dearth of women in science is related to a complex interaction of several factors such as career choice, socialization systems, department climate, barriers to family and work balance, and an education system that may disadvantage and discourage women students who are interested in science (Callister 2006; Etzkowitz and Kemelgor 2001; Kemelgor and Etzkowitz 2001; Rapoport et al. 2002). According to Horn (2011) women are generally seen as less competent in science than men, although if a woman‘s competence has been established, she is considered less likable. For example, Clark (2005) argued that the majority of scientists and engineers in most developed countries are men. While the specific percentages may differ across various fields, the overarching trend is unmistakable. Similarly, the research findings showed that the science department at Zama Zama High School is mostly made up of male teachers, and interestingly, only male teachers are teaching Physical Sciences. This shows that there is a noticeable gender imbalance in both student enrolment and the teaching staff. Such a gender disparity may have implications for the representation and perspectives available to students, potentially influencing their experiences and opportunities in the science education domain.

5.6 Conclusion

The findings and existing literature provided no evidence indicating that girls' interest and participation in Physical Science are influenced by biological factors. Consequently, there is a need for research that specifically investigates how biological differences may contribute to these aspects. The connection between Physical Science and mathematics is also figured quite strongly and its impact is expected to be greater amongst girls if they are being exposed to the same treatment in both subjects. The idea that girls prefer careers that include working with people rather than with objects has already been pointed out as requiring further research. Further research on the contribution of each of the factors that have been identified needs to be conducted.

Even though progress has been made in closing the gender gap in various areas of achievement, there are still noticeable differences in achievement motivation between genders. This highlights the need to continue studying how gender dynamics play out in rural schools. It is essential to clarify that the goal of this thesis is not to diminish the importance of boys learners in rural schools. Instead, the aim is to bring attention to the existing masculine curriculum in South Africa and advocate for its transformation into a gender-sensitive curriculum. This call is not for a shift towards a feminine curriculum but rather an inclusive approach that recognizes and addresses gender-specific needs. The focus is on achieving educational equity, ensuring that neither girl nor boys learners suffer at the expense of the other.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The previous chapter discussed the research findings in light of the reviewed literature and the theoretical perspective that provided a lens into the data. Chapter 1 presented the background and issues related to the context of the study were highlighted. Chapter 2 presented a review of the relevant literature on the construction of girls in Physical Science classes which may hinder their access and participation in the discipline, focusing on schooling in rural areas. The purpose was to situate the study of the interplay of gender and schooling in South Africa in rural schools, particularly in Physical Sciences. Chapter 3 described and justified the methodological approaches chosen for the study by outlining the; research approach, paradigm, methods for collecting and analyzing data, sampling techniques, considerations for ensuring the reliability and validity of the findings, and ethical considerations. Furthermore, Chapter 4 presented the findings derived from data from in-depth and open-ended interviews and observations during teaching and learning Physical Science with three major themes outlined. Lastly, Chapter 5 discussed the research findings to highlight insights into the various factors that influenced girls' interest and participation in Physical Sciences. Therefore, in this chapter, the limitations and recommendations for future research will be outlined. Professional

6.2 Recommendations

Development Workshops: Implement regular workshops for teachers focused on gender-sensitive pedagogical practices. These workshops should include strategies for creating an inclusive classroom environment and addressing unconscious biases that may affect learners' perceptions of subjects like Physical Sciences. This should involve local experts and teachers who understand the rural context in the development and delivery of these workshops. This ensures that the training is relevant and applicable to the specific challenges faced by teachers in these areas.

Mentorship Programs: Establish mentorship programs where experienced educators guide and support newer teachers in developing gender-sensitive teaching methods. Mentors can share effective strategies and provide feedback on classroom practices. Additionally, provide training for mentors to equip them with the skills necessary to support their mentees effectively. This includes training on how to address and navigate gender issues specific to rural contexts.

Classroom observations and feedback: Implement a system of regular classroom observations with a focus on gender dynamics. Observers can offer constructive feedback and support to teachers in adopting gender-sensitive practices. These may include establishing networks of local educators who can observe each other’s classrooms and provide peer feedback. These networks can be organized within schools or across neighboring schools, creating a support system for sharing best practices and addressing gender-related issues. Ensure that those conducting observations are trained in gender sensitivity and cultural competence. Observers should be able to recognize and address gender biases and provide constructive, actionable feedback to their peers.

Student awareness programs: Develop programs for students that address gender stereotypes and encourage both girl and boys students to pursue Physical Sciences. These programs can include workshops, guest speakers, and interactive activities. This may include establishing clubs or societies focused on science subjects, specifically aimed at breaking down gender barriers. These clubs can provide a supportive environment for students interested in Physical Sciences and offer additional learning opportunities and resources, with girl learners being the target.

6.3 Recommendation for future research

This study had a limited scope, therefore, there is a need for extensive research focusing on a more comprehensive investigation, encompassing a broader range of schools across all provinces in the country. This expanded study is essential to explore the diverse pedagogical practices employed by teachers, which could either enable or hinder girls' access and participation in Physical Sciences. By examining a more extensive and varied sample, we can learn more about the ways pedagogical practices affect girls' opportunities to learn and participate in Physical science classrooms and uncover nuanced insights into the teaching approaches that contribute to gender disparities in science education.

Significantly, future research should look into mentorship and professional development programs designed to give teachers the tools and support they need to understand and handle gender dynamics in the classroom. This means carefully assessing how well current programs are working and coming up with new ideas to promote teaching methods that include everyone. The research should also explore how these programs affect teachers' awareness of gender biases, their skill in challenging stereotypical views, and the establishment of a classroom environment that encourages fair participation and success for all students

Making sure that young women who graduate from high school are equally well prepared to study science as young men is a worthy goal, but that alone will not solve the problem of under-representation in higher education and careers, therefore more research should look at the effectiveness of teacher training programs and classroom practices in promoting inclusivity, addressing potential biases, and fostering an environment that encourages girls to pursue Physical Sciences. Consequently, conducting thorough analyses of the Physical Science curriculum in South Africa to identify and address any gender biases or limitations, and ensuring that educational materials are inclusive and inspiring for all students is also crucial for future research. More broadly, research should focus on educational policymakers, teachers, community members, parents, and other stakeholders on how they can foster an inclusive learning environment that supports equal opportunities for all genders.

There a is need for texts which are girl-sensitive in Physical Science materials such as textbooks. Having teachers and texts that are girl-sensitive in rural schools is essential for promoting gender equity, breaking stereotypes, addressing learning needs, empowering girls, and overcoming social and cultural barriers. Although there has been progress in reducing gender bias in textbooks over the past 30 years, boys characters still outnumber their female counterparts in basal readers. Fleming (2000) argues that representations of men in educational

materials often remain more stereotyped than those of women. Therefore, Hill and Rose (2010) suggest that the consistent use of girl scientists as role models may help counter negative stereotypes by attracting and retaining girls in the field since they would see people of their gender being successful and doing well in the sciences. In attracting girls to sciences, learning materials such as posters, flyers, and images reflecting girl scientists should be developed and used during the facilitation of learning (Milgram, 2011). Therefore, the use of female scientists in the Physical Science CAPS documents and textbooks may also help in retaining girls participation in sciences.

6.3 Limitations of the study

Jansen (2019) notes that by acknowledging the limitations of a study, readers can gain a deeper understanding of the constraints that influenced the research findings and the overall context in which these claims are presented. This study faced limitations, including restricted access to schools due to the Department of Education's scheduling demands, which inconvenienced the researcher who was operating within a specific time frame. Additionally, some teachers did not give consent to participate in the study. Another limitation of this study is that the results have a lack of generalisability. Data was obtained from small sample sizes, and the study was based at one rural school in South Africa. The opportunity to observe the learners in practice during practical activities could have either confirmed what the interviewees mentioned or disproved it. An increased number of lesson observations and sample sizes would have improved the reliability of this study. It should also be noted that the LGBTQI community students were excluded from analysis in this study as the scope of gender was limited to boys and girls. Despite these limitations noted, the findings of this particular study remain valid and reliable given what was done to ensure that these important factors were not compromised.

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APPENDIX A: RESEARCHER OBSERVATION JOURNAL

1.1 Observation record (Using narrative)

Observations conducted during teaching and learning in a Physical Science classroom allowed the researcher to observe the physical environment, the teacher's behaviour, peer interactions, and other contextual factors influencing the relations between girls and boys. From these observations, the researcher was able to explore first-hand how gender identities were constructed in experience. Only the main sequence of events during the period relevant to the research questions was recorded. Additionally, direct, selected quotations of the teacher/student engagement were occasionally used, especially those that added powerfully to the broad focal questions of interest in the classroom observation.

Observation

The initial observation of the Grade 10 Physical Science lesson revealed several notable dynamics:

Gender Dynamics:

- The attendance comprised 13 boys and 10 girls.

- Boys demonstrated higher vocalization.
- Bpys tended to group themselves, displaying confidence and boldness.
- girls, on the other hand, seemed more attentive but engaged in separate conversations.

Classroom Activities:

- Learners (both girls and boys) had books on their desks and were actively writing.
- The teacher had to reprimand boys for making noise during the lesson.
- An interactive dialogue occurred between the teacher and the boys regarding an answer provided by one boys.
- Girls appeared more reserved, with one girl actively participating and attempting to answer questions.

Student Interactions:

- A girl attempting to answer a question faced an interjection from a boys, leading the teacher to intervene.
- Girlswere engaged in separate conversations, and one girl faced laughter from her peers after giving an incorrect formula.
- A masculine girl in the group of boys actively participated and expressed enthusiasm.

Classroom Atmosphere:

- The teacher remarked on increased interaction, attributing it to the presence of a visitor.
- girls complained about the heat in the classroom.
- Both boys and girls were writing in their notebooks, with some boys reluctant to share their books.
- Boys were more likely to answer complex questions and present their responses on the board.

Social Interactions:

- One boys borrowed a pen, and a girl threw it at him, resulting in a moment of tension before he retrieved it.
- Some boys and girls formed groups, with a mixed-gender group demonstrating active participation.

Student Engagement

- Learners appeared tired as the lesson progressed.
- girls yawned and complained about the heat, displaying signs of disengagement.
- Boys demonstrated higher enthusiasm, with more of them contributing to discussions and writing on the board.

The observed lesson reflected distinct gender-based behaviours, varying levels of participation, and social interactions that may impact the overall classroom dynamics. Further analysis will delve into the implications of these observations on gender perceptions and participation in Physical Sciences.

APPENDIX B: ETHICS APPROVAL

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | WSoE Wits School of Education

SCHOOL OF EDUCATION ETHICS COMMITTEE

CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: 2023ECE39M**
PROJECT TITLE	Girls' access participation and achievement in Grade 10 Physical Science Subject in a selected rural school in Sekhukhune district in South Africa
INVESTIGATOR	**Phumzile Mathibela**
SCHOOL/DEPARTMENT OF INVESTIGATOR	Wits School of Education
DATE CONSIDERED	10 July 2023
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	Minimal risk
EXPIRY DATE	Date of submission of the Research Report
ISSUE DATE OF CERTIFICATE	**CHAIRPERSON**
29 August 2023	Dr. Batseba Mofolo-Mbokane

cc: Dr Alfred Masinire

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

PMI Mathibela	**12/10/2023**
Signature	**Date**

APPENDIX E: LETTER OF INTRODUCTION

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG | WSoE Wits School of Education

Zama Zama secondary school

Hlogotlou Circuit

Groblersdal

20 October 2023

Dear Sir/Madam,

Re: Permission to conduct research in Zama Zama secondary school.

My name is Phumzile Mathibela and I am a Masters student at Witswatersrand University in the Education campus. I am writing to request permission to conduct research in your achool, A.M Mahego secondary school, as part of my Master of Education program. My research aims to investigate "Girls' Access, Participation, and achievement in the Grade 10 Physical Science Subject" in a rural school within the specified district, under the supervision of Dr. Alfred Masinire. The goal of this research is to better understand the challenges and opportunities faced by female students in the pursuit of their education in science. Moreover, the research seeks to contribute to the existing literature on gender and education by providing insights into the construction of girls in Limpopo classrooms. By uncovering the social and cultural dynamics that shape girls' identities and educational experiences, the research can inform interventions and policy recommendations to create more equitable and empowering educational environments for girls in Limpopo and beyond. Ultimately, the goal is to promote gender equality, challenge detrimental gender norms, and enhance the educational opportunities and outcomes for girls in South Africa.

I am aware that permission is required to conduct research in a school, and I assure you that this study will be conducted with the utmost care and respect for the school's rules, the learner's, and the school's schedule. I understand the importance of maintaining a safe and

productive learning environment. I have obtained the ethical clearance certificate from the University Human Research Ethics Committee (Non-medical) from University of the Witwatersrand, and awaiting approval from Limpopo provincial research ethics committee. I therefore, kindly request permission to access the school and participants (teachers and learners) for data collection. To gather data for this study, a combination of observations and semi-structured interviews will be used, therefore, making the risk of participants minimal. Participants will be observed during teaching and learning Physical Sciences in a grade 10 class, and will be interviewed thereof.

I am willing to comply with any procedures or requirements specified by the school or the Department. Written consent will be obtained from all the participants regarding participation in the interviews which includes an audio recording and the use of data in the writing of the research report. Furthermore, I will inform the participants of the voluntary nature of their participation, as well as their right to withdraw consent at any time.

I am looking forward to your positive response, and I am available for any further discussions or clarifications. Your support and cooperation in this research endeavour would be greatly appreciated.

Thank you for considering my request.

Sincerely,
Phumzile Mathibela
0711 3116 70
1153540@students.wits.ac.za

Dr. Alfred Masinire (Supervisor)
011 7173 056
Alfred.masinire@wits.ac.za

APPENDIX F: LETTER OF PERMISSON

CONFIDENTIAL

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE PREMIER

TO: DR MC MAKOLA

FROM: PROF I SWARTS

CHAIRPERSON: LIMPOPO PROVINCIAL RESEARCH ETHICS COMMITTEE (LPREC)

REVIEW DATE: 27 NOVEMBER 2023

SUBJECT: GIRLS' ACCESS PARTICIPATION AND ACHIEVEMENT IN GRADE 10 PHYSICAL SCIENCE SUBJECT IN A SELECTED RURAL SCHOOL IN HLOGOTLOU CIRCUIT SOUTH AFRICA

RESEARCHER: MATHIBELA P

Dear Colleague

The above researcher's research proposal served at the Limpopo Provincial Research Ethics Committee (LPREC). The committee is satisfied with methodological and ethical soundness of the proposed study.

Decision: The proposal is granted full approval.

Regards

Chairperson: Prof I Swarts

Swarts

Secretariat: Ms J Mokobi

Date: 16/01/2024

APPENDIX G: ETHICAL CLEARANCE FROM DEPARTMENT

CONFIDENTIAL

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE PREMIER

Office of the Premier

Research and Development Directorate

Private Bag X9483, Polokwane, 0700, South Africa

Tel: (015) 230 9910, Email: mokobij@premier.limpopo.gov.za

LIMPOPO PROVINCIAL RESEARCH ETHICS

COMMITTEE CLEARANCE CERTIFICATE

Review Date: 27 November 2023

Project Number: LPREC/147/2023: PG

Subject: Girls' Access Participation and Achievement in Grade 10 Physical Science Subject in a Selected Rural School in Hlogotlou Circuit South Africa

Researcher: Mathibela P

Chairperson: Prof I Swarts

Swarts

Chairperson: Limpopo Provincial Research Ethics Committee

The Limpopo Provincial Research Ethics Committee (LPREC) is registered with National Health Research Council (NHREC) Registration Number **REC-111513-038.**

Note:

i. **This study is categorized as a Low Risk Level in accordance with risk level descriptors as enshrined in LPREC Standard Operating Procedures (SOPs)**

ii. **Should there be any amendment to the approved research proposal; the researcher(s) must re-submit the proposal to the ethics committee for review prior data collection.**

iii. **The researcher(s) must provide annual reporting to the committee as well as the relevant department and also provide the department with the final report/thesis.**

iv. **The ethical clearance certificate is valid for 12 months. Should the need to extend the period for data collection arise then the researcher should renew the certificate through LPREC secretariat. PLEASE QUOTE THE PROJECT NUMBER IN ALL ENQUIRIES.**

APPENDIX H: PARTICIPATION LETTER FOR PARENTS

Participation sheet for parents

Dear parent/ Gurdian

My name is Phumzile Mathibela. I am a Masters student number 1153540 and I Study at the University of the Witwatersrand, Johannesburg. My supervisor is Dr Alfred Masinire, and I am conducting a research study about how girls are constructed in a Physical Science classroom in a rural school.

The study title is girls' Access participation and achievement in Grade 10 Physical Science Subject in a selected rural school in Sekhukhune district; Limpopo, South Africa. I am inviting your child to take part in an interview on how girls are constructed in a Physical Science classroom. If you permit your child to take part, their participation in this research study will last about 15 to 20 minutes. The interview/research activity will take place at their school (Zama Zama Secondary), either in the staff room or any located space within the school and during break time. With your permission, I would like to audio record the interview with your child. This data will be stored in a computer and locked and deleted after 2 years. Only the researcher will have access to the data.During the research activity, I will need to ask for some personal information about your child, including family background, their experiences as an individual in the school setting and their personal identity as a girl/boys in your institution.

The interview will be confidential. When I share the results of the research study, I will not include your child's name or anything else that could identify him/her. With your permission, other researchers may use the data collected from this research study, but your child's name and any personal information will not be used or passed on. If your child take part in the research study, it should be because you have permitted them to do so. It is not compulsory to take part. The child can stop being in the study at any time and do not have to answer any questions if she/he does not want to. Furthermore, your child will not get any direct benefits

she/he choose to join the research study. Taking part in the research study will not cost your child anything. Your child will not be paid for being in this research study.

If you have any questions during or afterwards about this research study, feel free to contact me or my supervisor on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Phumzile Mathibela, Masters Candidate

APPENDIX: INTERVIEW QUESTIONS

1.2 Semi-structured interviews

Semi-structured interviews allowed for both open and closed questions to explore further responses from participants in relation to the study. Consequently, both girl and boys learners, including teachers, had a set of questions that directed their responses to the study. Questions for all 10 learners (boys and girl) had similarities and slight differences to explore their perceptions of each other's genders. This approach aimed to shed light on the influences these perceptions may have had on how girls were constructed in the Physical Science classroom.

1.2.1 Questions for Girl learners

a) Why did you choose to study Physical Science as a major?
b) Do you feel empowered in a physical science class?
c) Please share one experience in the physical science classroom where you felt humiliated as a girl? This could be by the teacher, or other girls or boys
d) Please share one experience in the physical science classroom where you felt supported as a girl student? This could be by the teacher or other girls and boys.
e) Describe how you perceive the presence of boys in your Physical Science class? Do you feel equal to boys when participating in science?
f) In what situations do you normally interact with boys in class?
g) How do you describe the relationship between you and the boys in the classroom (Specifically Physical Sciences)?
h) Would you prefer to work with girls or boys during class activities, projects and experiments in Physical Science and why?

i) Do you think you are capable of studying anything related to Science after school?

1.2.2. Questions for boy learners

Include the same experience questions which I proposed for the girls (c & d)

What have you done to girls or one girls in science which you think undermined their self-worth?

a) Describe how you perceive the presence of girls in your Physical Science class?

b) In what situations do you normally interact with girls in class?

c) Do you think girls are equally capable in Physical Sciences? Why or why not?

d) How do you feel about collaborating with girls in Physical Science projects or experiments?

e) Would you prefer to work with girls or boys during class activities, projects and experiments in Physical Science and why?

f) What are your thoughts on girls pursuing careers in Science?

1.2.3 Interview questions for teachers

a) Are there any specific stereotypes or biases you have observed or heard regarding girls in Grade 10 Physical Science classes?
b) Please describe one or two experiences of girl gender discrimination or bias which you have observed in your science classes?
c) How do you normally deal with stereotypes and biases as a teacher?
d) Are there any differences you notice in the way girls' and boys' approach and engage with Science topics?
e) How do the attitudes and behaviours of boys towards girls in Science classes impact the girls' learning experiences?
f) In your opinion, what can you do as a teacher to encourage more girls to participate and excel in science subjects, Particularly Physical Sciences?