EXPLORING AND EXPANDING TEACHERS' GENDER AND CULTURALLY RESPONSIVE PRACTICES WHEN MEDIATING LEARNING OF CHEMISTRY IN RURAL SCHOOLS IN NAMIBIA

A thesis submitted in fulfilment of the requirements for the degree

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By

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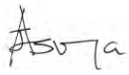
DECLARATION

I, **Johanna Shetulimba Haimene** (15A8714), undersigned, hereby declare that this thesis is my original work and it has not been previously submitted in its entirety or part for examination at any other university for degree purposes. Where I have drawn on the words or ideas of others, these have been acknowledged using complete references according to Departmental Guidelines.

Signature:  Date: October 2023

DEDICATION

This study is dedicated to my husband, Sakaria Amutenya. He constantly encouraged me to do a PhD or do a course in Information Technology (IT). Because of his words of encouragement, I decided to pursue a doctoral study. You played a big role in the completion of this study.

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ABSTRACT

Gender and cultural dimensions are critical aspects of the education system. Schools are full of gender and cultural stereotypes when it comes to the teaching and learning of science. This calls for the teachers to be gender and culturally responsive in their science classrooms. This is also to ensure that the educational needs of both boys and girls are addressed. The Namibian National Curriculum for Basic Education advocates the application of gender equity at all levels and in every aspect of the curriculum and teachers are central to the implementation of this curriculum. However, while the policy has been formulated at the macro level of the education system, little if any research has been done in Namibia on exploring how teachers are coping with and implementing the curriculum based on gender and cultural aspects. This includes how teachers are responding to gender issues and how they eradicate bias and discrimination to ensure equality and equity for both boys and girls in their science teaching. Against this backdrop, this study aimed to explore and expand Grade 9 Physical Science teachers' gender and culturally responsive practices in science classrooms when mediating learning of chemistry topics using acids and bases and combustion reactions as examples.

The study focused on working with teachers with the purpose of improving their practices through collaborative partnerships and enriching all the participants (teachers and researcher) as they were seen as co-learners and co-researchers. Hence, this study was underpinned by interpretivist and critical paradigms. It adopted a case study research design. Six Grade 9 Physical Science teachers from the Oshikoto Region were the participants in this study. Qualitative data were generated using questionnaires, interviews (semi-structured and stimulated recall), classroom observations and Change Laboratory Workshops (CLWs) in which we co-developed a tool to address gender and cultural responsiveness. Vygotsky's socio-cultural theory and Engeström's cultural-historical activity theory (CHAT) were used as theoretical frameworks to surface contradictions or tensions that exist in the teaching and learning process. A thematic approach to data analysis was employed to come up with sub-themes and themes.

The findings of the study revealed that the teachers seemed to have an understanding of being gender and culturally responsive when they are mediating their lessons. However, some contradictions constrained them from being gender and culturally responsive. The surfaced contradictions included the lack of examples that are not gender and culturally biased, poor participation of the learners during lesson presentation and low confidence among the learners and language barriers. In addition, the findings revealed that teachers need professional development in interpreting policies and the curriculum and techniques for analysing gender and cultural issues pertaining to the teaching and learning process. Through CLWs, we co-developed a mediational tool that could guide teachers on how to be gender and culturally responsive. The findings also revealed that participation of teachers in the CLWs equipped them with resources on how to be gender and culturally responsive in their classrooms.

The study recommends that teachers need to be involved in continuing professional development to support them with the correct interpretation and enactment of the curriculum and other policies. The policy developers need to be in contact with the policy implementers to evaluate the implementation of these policies and provide guidance where necessary. Moreover, teachers need to form professional learning communities in order to share their best practices and transform them. This might assist them in addressing gender and cultural issues that are encountered in the teaching and learning process.

Keywords: Chemistry; acids and bases; combustion reactions; gender and culturally responsive practices; Socio-Cultural Theory; Cultural-Historical Activity Theory; Change Laboratory; expansive learning

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LIST OF ABBREVIATIONS AND/OR ACRONYMS

AS	: Advanced Subsidiary
CHAT	: Cultural-Historical Activity Theory
CL	: Change Laboratory
CLWs	: Change Laboratory Workshops
CPD	: Continuing Professional Development
CRP	: Culturally Responsive Pedagogy
ESD	: Education for Sustainable Development
EU	: European Union
FAWE	: Forum of African Women Educationalists
GRP	: Gender Responsive Pedagogy
HIGCSE	: International General Certificate of Secondary Education Higher Level
IGCSE	: International General Certificate of Secondary Education Ordinary Level
IK	: Indigenous Knowledge
JSC	: Junior Secondary Certificate
JSSEE	: Junior Secondary Semi-External Examination
LTSMs	: Learning and Teaching Support Materials
MDGs	: Millennium Development Goals
MKOs	: More Knowledgeable Others
NCBE	: National Curriculum for Basic Education
MoEAC	: Ministry of Education, Arts, and Culture
NSSCO	: Namibia Senior Secondary Certificate Ordinary Level
PCK:	: Pedagogical Content Knowledge
PLC	: Professional Learning Communities
PQA	: Programmes and Quality Assurance

SCT : Socio-cultural Theory

SDGs : Sustainable Development Goals

STEM : Science, Technology, Engineering and Mathematics

TSPCK : Topic Specific Pedagogical Content Knowledge

UNESCO : United Nations Educational, Scientific and Cultural Organization

ZPD : Zone of Proximal Development

CHAPTER ONE: SITUATING THE STUDY

> Curricula and teaching materials should accommodate the pupils' experiences and interests equally without emphasizing one sex over the other. Great care, however, should be taken in curriculum and teaching material development not to convey stereotyped images of males and females. (Sinnes & Løken, 2014, p. 249)

1.1 Introduction

The purpose of this study was to explore and expand gender and culturally responsive practices of Physical Science teachers when mediating learning of chemistry using acids and bases and combustion reactions as examples in rural schools in the Oshikoto Region in Namibia. Acids and bases was used during the classroom observation and combustion reactions were used in the teaching of the exemplar lesson. Hence, these two topics were both used as examples of being gender and culturally responsive when mediating chemistry. It was triggered and motivated by the lack of professional development for teachers on how to be gender and culturally responsive since they are curriculum implementers. Even though these concepts are being advocated in the curriculum and other educational policies, little has been done to assist the teachers in implementing them and evaluating the implementation of gender equity and gender equality. This may lead to gender and cultural discrimination in the science classroom.

This chapter thus introduces the study by presenting the contextual background, situating myself in the study as a female Physical Science teacher. The chapter also highlights my positionality and reflexivity as a researcher and how it affected the research process. The statement of the problem and significance of the study are discussed. The chapter also highlights the focus of the study by outlining the research goal, research objectives and research questions. Moreover, I summarise the methods used to gather data, the theoretical frameworks, research orientation and methodology and the approach to data analysis. I explain how I

addressed the ethical issues during the research process. Lastly, I present a brief definition and description of the key concepts used in this thesis and an overview of each chapter.

1.2 Contextual Background

International organisations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), World Bank and the European Union (EU) have all included gender equality in their education policies (Chikunda, 2014), and many efforts have been made to eradicate gender discrimination to create a gender-friendly environment in the education system (Fentie, 2017). Some of those efforts are made by international communities such as UN Millennium Development Goals (MDGs) and the World Declaration on Education for All (Fentie, 2017). Similarly, the Namibian government has also made several national efforts to eliminate gender disparities in education.

There are long-term historical pedigrees of variances in gender roles and gender gaps across societies and these are transmitted from parents to children, and they still persist today (Giuliano, 2017). This scholar further pointed out that in agriculture, women are limited to specialising in activities within their homes and men are dedicated to working in other activities that are outside their houses. In other words, cultural stereotypes contribute to gender inequity in science, such as women being traditionally linked with domestic rather than professional environments (Mthembu et al., 2023). In terms of education, only a few women learnt how to read and write, and thus their education lagged further behind compared to their male counterparts (Mwetulundila, 2000). For this reason, Wood (2019) expressed that stereotyping of women in society holds them back from expressing their full potential. These stereotypes have the authority to produce gender inequity in science because they are internalised and unconscious (Mthembu et al., 2023). These scholars further emphasised that, because these stereotypes are unrealised and implicit particularly in the science environment, they are hard to recognise and address.

In this regard, Risman (2018) suggested that understanding gender as a social structure requires all stakeholders to focus on dynamisms in the system. It is for this reason that the purpose of this study was to support the science teachers in coming up with pedagogies that accommodate both gender and cultural responsiveness in their science classrooms. These concepts shape the

livelihood of individuals as they determine what is accepted, permitted and valued for both male and females in a particular context (Omoyibo & Ujayi, 2011; Wood, 2019). This shows that gender identities and gender relations are critical components of culture and shape the lives of individuals in general. Like other countries, the Namibian education system was also full of gender and cultural stereotypes prior to independence.

Before independence, Namibian education was not designed to offer equal access to all citizens (Hangula et al., 2018). Instead, it was targeted at reinforcing apartheid policies (Shafuda & De, 2020). For instance, the teacher programmes were controlled and structured by various ethnic establishments and were aimed at preparing teachers for the ethnic government that controlled them (Swarts, 2019). This also included the Bantu education that served to impose class supremacy and racial suppression (Angula, 2019).

However, The National Constitution of the Republic of Namibia (1990, p. 2) guaranteed "equality of women, and recognises the need to advance the position of women in the Namibian society". Article 10 of the Namibian Constitution (1990, p. 10) also stated that "all persons are equal before the law and that no one should be discriminated against on the grounds of sex, race, colour, ethnic group, religion, creed or social and economic status". It further emphasised that it

> shall be permissible to have regard to the fact that women in Namibia have traditionally suffered special discrimination, and that they need to be encouraged and enabled to play a full, equal and effective role in the political, social, economic and cultural life of the nation. (Republic of Namibia, 2009, p. 16)

It is for these reasons that after independence the Namibian government democratised the education system intending to close the educational gap made during apartheid (Ninkova, 2020). Hence, it pledged to address the educational issues and provide access to education for all groups (Shafuda & De, 2020). The government also developed educational polices that were intended to liquidate the domination of Afrikaner nationalist philosophies in education and training (Angula, 2019). For instance, the Namibian Ministry of Education, Arts, and Culture (MoEAC) introduced an education policy aimed at redressing prior inequalities and social disadvantages (Shanyanana & Cross, 2014). This was also done to ensure that the four major

goals of education, viz. *access*, *equity*, *quality*, and *democracy* were attained (Shiimi, 2018). Equally, the MoEAC's (2018) National Curriculum for Basic Education (NCBE) advocates gender-responsive education.

On the other hand, while other African countries such as Ethiopia, Burkina Faso, Senegal and Nigeria have embarked on making education gender responsive (Wanjama & Njuguna, 2015**)**, little has been done in Namibia regarding professional development for teachers to be gender and culturally responsive when mediating learning in their classrooms. In addition, in the Namibian context, I have not come across a study that looks at how teachers can be gender and culturally responsive as an interventionist study. Thus, the context within which I base my argument for gender and culturally responsive science teaching, is that while acknowledging the presence of various policies that promote gender and cultural responsiveness such as the NCBE, I strongly argue that in the Namibian context, there seems to be a gap between the educational policies and their implementation. It is against this background that this study aimed to explore and expand gender and culturally responsive practices for science teachers, in particular when mediating the learning of chemistry topics using acids and bases and combustion reactions as examples.

According to Hanson et al. (2018), access to science is a human right notwithstanding *gender*, *culture* (my emphasis)*,* race or social class. However, in most cases, science was regarded as for males only (Archer et al., 2012), and in science classrooms, boys were allowed to manipulate equipment and girls were given mainly secretarial roles (Chikunda, 2013). In Africa, the lack of encouragement for girls, gender stereotypes, traditional gender cultures and expectations about family roles among others are some of the factors that in part work against the participation of girls in science (Hanson et al., 2018). In addition, girls are not permitted to participate in explorative risky activities while boys are encouraged to be self-confident and challenge their mental characteristics (Ganley et al., 2014; Iwu & Azoro, 2017). These gender socialisations lead to certain personality characteristics regarded as masculine or feminine independent qualities (Iwu & Azoro, 2017). These scholars further pointed out the association of qualities such as creativity and confidence with boys while on the other hand dependency and compliance with girls. The combination of these permissions for boys and constraints for

girls results cumulatively in gender discrimination. It is then the responsibility of the teachers to address these gender socialisations in their science classrooms.

Various studies have been carried out on how to make science universal, such as gender and sustainability-responsive pedagogies in teacher education curriculum practices (Chikunda, 2013) and identity formation of female students' perceptions and participation in physics (Gudyanga, 2016). However, in the Namibian context, while the educational policies and curriculum are formulated on how teachers should be gender responsive during the teaching and learning of science, little if anything has been done to look at how teachers are implementing the curriculum. That is, professional development is lacking in the teaching profession to assist teachers to be gender and culturally responsive (personal experience). It also does not support teachers in evaluating whether they are enacting gender and cultural responsiveness in their science classrooms. Thus, this study aimed to engage the teachers in being gender and culturally responsive when mediating the teaching and learning of science through CLWs. In addition, this study co-develops a mediational tool that is gender and culturally responsive that teachers can use when mediating chemistry lessons using acids and bases and combustion reactions as examples.

The topic of acids and bases was used as an example because this study was derived from the results of my master's study. In this master's study, learners worked with easily accessible resources in testing for acids and bases. Hence, the study explored how their conceptions, dispositions and sense making when mediating the learning of acids and bases might be influenced by the integration of indigenous local knowledge (Haimene, 2018). In this study, I explored the gender and cultural responsiveness of teachers when mediating learning of chemistry using the same topic of acids and bases as an example. Moreover, the topic of combustion reactions was used in the planning of exemplar lessons during the CLWs. This is because the study focused on chemistry topics in Grade 9 Physical Science that were used to expand teachers' gender and cultural responsiveness.

According to Mlama et al. (2005), gender responsiveness deals with taking action to eliminate gender bias and discrimination to enable gender equality and equity. These scholars defined gender equality as "the elimination of all forms of discrimination based on gender so that girls

and women, boys and men have equal opportunities and benefits" (p. 1). Other scholars expanded the definition by asserting that "gender equality refers to that stage of human social development at which the rights, responsibilities and opportunities of individuals will not be determined by the fact of being born male or female" (Omoyibo & Ajayi, 2011, p. 3734). To Mlama et al. (2005, p. 1) gender equity is about "giving equal treatment to both girls and boys, women and men to access resources and opportunities". In the context of education, it means ensuring that girls and boys should have equal access to enrolment and other educational opportunities (Mlama et al., 2005). This implies that teachers need to attend to all the gender issues such as gender bias and practices discriminating against a specific gender and gender stereotypes as is stated in the epigraph above. Teachers should also attend to anticipated differences in terms of attainments, involvement and interests between boys and girls (Andersson et al., 2009). On this note, Gullberg et al. (2017) emphasised that it is significant for both boys and girls to have an unconstrained variety of opportunities and equal chances to advance and reconnoitre their capabilities and interests. These issues have to be addressed in science classrooms as they might hinder gender equality and gender equity. I believe that it is through gender and culturally responsive practices that learners are offered the opportunities to take part equitably in the learning environment. Thus, it must be done in line with the four major goals of Namibian education.

To Mlama et al. (2005), for teachers to be gender responsive in their classrooms they have to pay attention to the following aspects: teaching and learning materials (are materials biased, depicting the image of a certain gender as superior to the other); teaching methods; learning activities; classroom set-up and interactions (arrangement of classroom enhances the participation of both boys and girls); management of other gender constraints to learning inside the classroom (management of sexual maturation, teachers are sensitive and offer supportive and appropriate counselling for both boys and girls); and feedback and assessment. Hopefully, this might lead to teachers demonstrating gender responsive practices in their science teaching.

A significant aspect of gender in the African context is presented by Mwetulundila (2000) who argued that in many cultures, especially in rural areas, girls are perceived as less intelligent than boys and as having no authority or power. The role of a woman is mainly seen as providing labour on farms, housekeeping and raising the children. This means that women live in a culture

where men are usually travellers and organisers of the home while women with insufficient resources are expected to be home-centred and subordinate to men (Lips, 2016). In many communities, men have higher status, more access to resources and positions of supremacy compared to women (Goodhew et al., 2022). Lips (2016) explained that each community to some extent makes up its own rules to define what it means to be a woman or man, and these are constructed through interactions and by behaving in ways that are deemed appropriate. In terms of education, some of these social structural factors operate together to pull girls and women or boys and men towards some Science, Technology, Engineering and Mathematics (STEM) fields while pushing them away from others. Thus, Chikunda (2013) highlighted that traditional patriarchal roles and gender division of labour could be the reason for the deterioration of girls' performances in science as they grow up. For this reason, Cheryan et al. (2017) pointed out that interferences that impact individual girls or women may not be operational in decreasing gender disparities if the bigger cultural factors that shape women's participation in the fields are not considered – this might then lead to various countries reaching their visions of being gender and culturally responsive.

In the Namibian context, to achieve Namibia's Vision 2030, one of the Sustainable Development Goals (SDGs) is to ensure that all girls and boys complete primary and secondary education and that all gender disparities in education are eliminated with the hope that all citizens will be able to realise their full potential (The Global Partnership for Education, 2017; Ministry of Education, Arts and Culture [MoEAC], 2018). Similarly, SDGs endorse and intensify the solid connection between gender equality and quality education (The Global Partnership for Education, 2017). In this regard, Abraha et al. (2019) averred that the goal of development cannot be achieved without considering the significant component of gender. Equally, education for sustainable development (ESD) can be achieved by offering an impartial learning atmosphere for all learners regardless of their sex, social status, and ethnicity (Mhewa et al., 2021).

Arguably, equitable education provides equal opportunity for both males and females in participating in all spheres of society (MoEAC, 2015). Specifically, in the science curriculum, the gender perspective is vital in raising awareness of gender stereotyping (MoEAC, 2015). Gender stereotypes amplify the apparent repercussions of classifying people by their gender

and offer an over-generalised interpretation of reality (Ellemers, 2018). Thus, education plays a crucial role in the growth of people and the modification of their personalities – this will be attained when equality is guaranteed in education (Fentie, 2017). Moreover, it plays a crucial role in the development of any nation as it means providing for the well-being of individuals as well as society in general (Abraha et al., 2019).

Notably, gender responsiveness entails responding to gender issues by finding ways of eliminating bias and discrimination to ensure equality and equity (Chikunda, 2014; Mlama et al., 2005). It is for these reasons that this task is placed on the teachers who are at the grassroots of implementing such a curriculum.

In terms of cultural responsiveness, Namibia is one of the African countries that had long standing colonial dominance in its educational system. African countries have a long history of Science, Technology, Engineering and Mathematics (STEM) education that employs methods or procedures that are developed based on the western culture (Onowugbeda et al., 2023). That means that learners are mostly taught westernised knowledge. Similarly, teachers were also trained in the Eurocentric way at their teacher training colleges (Mutanho, 2021). However, it should be acknowledged that the advantage of being culturally responsive is that teachers attend to the learners' needs by exposing them to curricula that build on their preceding knowledge and experiences (Broom, 2019). Subsequently, they enhance their conceptual understanding and uphold their academic growth (Ladson-Billing, 1995).

Nevertheless, the significance of cultural responsiveness in STEM is one of the least researched areas and thus weakens the teaching and learning concepts within learners' cultural environment (Brown et al., 2019; Onowugbeda et al., 2023). Hence, the NCBE (MoEAC, 2018) advocates teachers to be culturally responsive when mediating learning of their lessons. This means that, as the curriculum implementers, they need to know how to be culturally responsive in their classrooms. This resonates with the use of local indigenous knowledge (IK), thereby allowing learners to use their cultural knowledge in their science classrooms in learning science and making meaning of science. Yet, teachers have been trained in westernised ways. This suggests that teachers might not be able to properly support their learners from diverse socio-cultural backgrounds in their classrooms (Biraimah, 2016; Mavuru & Ramnarain, 2020).

Resultantly, they might not be able to assist their learners in such a way that they use the learners' knowledge and experiences. It is against this backdrop that I deliberated in this study to develop a mediational tool that is gender and culturally responsive. I had hoped that this study might shed light on how to enact curriculum effectively by being gender and culturally responsive. I now look at my personal life history and situate myself in this study.

1.3 My Personal Life History – Situating Myself in the Study

> Individuals are a reflection of what they have been surrounded with. Our perceptions of situations and their interpretation are socially determined. Thus, child socialisation is very important in determining what we become. Gender roles provide a prime example. (Sithole et al., 2017, p. 53)

Being the author of this project, I deliberated on the ideas of Sithole et al. (2017) in explaining my experiences and upbringing as a girl from the rural areas and of being a Physical Science and Mathematics teachers for 15 years as well as in explaining my academic journey as a researcher and what triggered me to undertake this study.

I am the sixth child of nine siblings (six boys and three girls, me being the youngest of the girls). I grew up with my parents and with some of my siblings. When growing up, some of my older siblings were at secondary school and some were working away from home, while some were being brought up by other relatives. Hence, I grew up with my parents and my three brothers, that is, the brother that I followed from birth and my two young brothers. I grew up as the only girl in the house because my older sister was at secondary school and the other sister was brought up by other relatives. Being the only girl in the house meant that I was responsible for all the house chores that are regarded for girls such as cooking, pounding mahangu (Simasiku, 2022) and washing. I carried out these duties from the age of 11. The boys were responsible only for looking after animals and fetching water. This was a norm for Aawambo people, that different genders have their roles allocated in this way. Thus, it was adopted and internalised that these representations were true and natural as pointed out by Abraha et al. (2021). Similarly, Chikunda and Chikunda (2016) also pointed out that gender socialisation may affect and have an impact on learners' progress.

In terms of my primary education, I attended school with my siblings. Unfortunately, my brother failed Grade 6, and this meant we were in the same grade from Grade 6 to 12. This

made us compete and make sure that one of us took either the first, second or third position in class. Even though we were in the same grade, I was required to finish my household chores first before I could start studying. It did not bother me much as I understood that that is how it was supposed to be. In connection with this issue, Zahro et al. (2020) pointed out that being treated differently due to the gender societal conditions is the common practice for members of society. My brother would be allowed to study with his friends after playing soccer in the afternoon. It is only now that I think of it that I ask why my brother could go and study while I was required to first complete the household chores. Why could we not share those responsibilities, and both be allowed to study since we were in the same grade? What would happen to the boys if they were to cook, clean and do the laundry? Are these not gender socialisations that are accepted and seen as normal? It is for this reason that Zahro et al. (2020) suggested that societal rules are always worth debating or renewing, particularly if these rules contain biased practices or prejudice for social construction.

When I was doing my Junior Secondary Certificate (JSC) (Grade 10), we had to apply for Grade 11 choosing our fields of study. I applied for science because I loved mathematics and science but not because I was good at these subjects. However, I was advised to apply for social sciences because I obtained good symbols there, especially in history. In most cases, girls are stereotyped in that they are not meant to study science. Hence it is these kinds of stereotypes that can negatively affect the academic performance of learners as pointed out by Ertl et al. (2017). Since these were not my favourite subjects, I refused and went ahead to apply in the field of science. I remembered from primary to secondary school we only had male science teachers. I must admit, they were very good, and this made me love science subjects particularly Physical Science and Mathematics.

Previously in the Namibian curriculum, subjects were offered at a higher level which is the Higher International General Certificate of Secondary Education (HIGCSE) Level and the International General Certificate of Secondary Education (IGCSE) ordinary Level. On the ordinary level, the subject could further be divided into two components which are Extended and Core. This was also the case for Mathematics and Physical Science. The learners had to choose which level to do. In most cases, it was the teacher who chose a certain level for the learners based on their “ability”.

The fields of mathematics and science in society are gender stereotyped (Gullberg et al., 2017) and these gender stereotypes begin to emerge at a young age (McGuire et al., 2020) where the boys are seen as good in mathematics and science. Hence, this has long-lasting consequences for the engagement of the learners, particularly the girls, in the STEM subjects (McGuire et al., 2020). Thus, I remember that when learners were chosen to do mathematics at the extended level, only three girls among all the boys took that level in the whole school (see Figure 1.1). As is shown in this figure, there was gender differentiation in the teaching and learning of this subject. This indicates a gap in learning between the boys and girls. Looking back at this photo, I always feel proud of myself for being one of the few girls who took mathematics at the extended level. This was also regarded as a male dominated area. As for Physical Science, all learners in the school were allowed to do ordinary level.

Figure 1.1: Grade 11-12 Mathematics extended class, Iipumbu SS (me, first girl on the left)

During my schooling years, we were not exposed to the use of our cultural background experiences or taught to build on these experiences. We were always required to learn according to westernised knowledge. Thus, I felt that I was neglected as I did not get a chance to use my cultural experiences when being taught science. Even though there were easily accessible resources, these were not used during our schooling. However, this blame cannot be placed on the teachers, since not all teachers are able to use the cultural backgrounds of the learners in their teaching as pointed out by Samuel (2018). This includes the use of easily accessible resources in the environment.

After graduating and being appointed as a Physical Science and Mathematics teacher, it seemed to me that my learners felt that I could not teach them well. This was because their previous teacher was male. I was constantly reminded that that was not how their teacher used to teach them, particularly when doing revision of the chapters that were covered by the previous teacher. These complaints came mainly from the boys. This resonates with other female teachers who are constantly subjected to gender stereotyping when it comes to teaching and learning science. Thus, a study by Makarova et al. (2019) found that the male stereotype of science and of being a scientist starts from kindergarten and continues to be persistent in older learners. Since at that time I was not aware how gender plays a role in the teaching and learning process, I could not really articulate the reactions of the girls towards my teaching methods. However, this did not demoralise me; hence, I received numerous awards for being the best Physical Science and Mathematics teacher in the circuit (see Figure 1.2). This indicated that every person, man or woman, is capable of teaching science and it should thus not be regarded for males only.

Figure 1.2: Johanna with some of the certificates and trophies awarded as best Physical Science and Mathematics teacher in the circuit

In 2017–2018, I registered for a master's degree, where my focus was to explore how the use of IK influences learners' conceptions, dispositions and sense making when mediating the learning of acids and bases. The learners were required to bring in materials from their environment that they could use in the science class. To my amazement, the learners,

particularly the girls, performed poorly compared to the boys. I became curious to understand how teachers work with the learners based on their gender and cultural aspects. In making observations mainly in the classroom, I found that the boys were the ones carrying out the experiments and girls were the secretaries as shown in Figure 1.3. In all the groups, the boys were the ones manipulating the apparatus and girls wrote, except in cases where that group was comprised of girls only. This resonates with what Chikunda (2013) and Toma et al. (2019) stated, as explained earlier. During that time of data gathering, I did not pay much attention to what was happening. It was only after I undertook this project that I developed a curiosity in understanding how teachers can be gender and culturally responsive when they are teaching science. Hence, herein lies the importance of my study.

Learners carrying out the experiment

Boys assisting the teacher during the experiment

Learners writing concept maps and mind maps after the experiment

Figure 1.3: Conduct of learners during the experiments (master's study)

Similarly, to my earlier experiences of teaching, during my master's study I did not concentrate on the issue of gender. If I had been aware, I could have engaged both boys and girls in the division of labour, for instance, in assisting me in setting up the apparatus as shown in Figure 1.3. I now look at how positionality and reflexivity of this kind plays a role in the research process.

1.4 My Positionality and Reflexivity

Positionality is a significant element in the production of knowledge. It necessitates introspection which is crucial in identifying power relations embedded in the research process

(Crossa, 2012). It is determined by relationships between oneself and others (Greene, 2014) as well as how the researcher views their positionality and how they are viewed by others (Ozano & Khatri, 2018). The factors that influence positionality include gender, race, position, and economic status (Bettez, 2015; Creswell & Creswell, 2018; Holmes, 2020).

Thus, positionality affects the type of data collected, how it is collected, and how it is interpreted (Greene, 2014). The researcher can be an insider (from the same social group, organisation or culture in which the study is conducted) or an outsider (someone who has no prior knowledge of the community or the members under study) (Greene, 2014). I positioned myself both as an outsider and insider in this study since this study was comprised of two phases. In phase one, I positioned myself as an outsider. The advantage of being an outsider was that it offered me an opportunity to see what is happening from an objective perspective (Saidin & Yaacob, 2016). That is, I was able to see what is happening in the science classes before engaging with the participants and managed to get a clear understanding of the teaching practices of these teachers in terms of being gender and culturally responsive. I had to look at their teaching practices objectively in order to have a better understanding of their experiences. Notwithstanding, the disadvantage could be that of gaining access and trust from the participants (Liu & Burner, 2022). For instance, I had participants who I met for the first time and hence it was a challenge working with them during this phase.

On the other hand, I positioned myself as an insider in this study. The advantage of being an insider is that I was able to understand the natural setting of the teachers' classes. Moreover, I had the background on how science is perceived in their schools and was able to gain a deeper understanding of the gender and cultural responsiveness of these science teachers. Additionally, the reason I considered myself as an insider was that we shared a similar language (*Oshiwambo*), race (black Namibians) and geographical location (teaching at rural schools) as well as occupation (we were all Physical Science teachers), even though we differed in gender as some participants were female and others male. Nevertheless, some scholars pointed out the challenges of being an insider. These include loss of being objective and biased (Saidin & Yaacob, 2016; Xu, 2016) which prevents the gaining of authentic knowledge and issues of confidentiality and sensitivity of information accessible to researchers (Saidin & Yaacob, 2016). All these have influence on the research process.

In the same vein, being the school principal in the same region as the participants and as a PhD researcher, power relations might have influenced the study. My participants might have viewed me as someone with power as identified by Ozano and Khatri (2018). To ameliorate this, I explained and negotiated with my participants and positioned myself as a co-learner during the whole process. Moreover, being a married woman, my participants might see me as someone who needed to be respected (in our culture, someone who is married is more respected compared to those who are not) and they might feel that because of my marital status they were obliged to take part in the study. In light of this, I explained to the participants that we were going to work together to improve our teaching practices. I negotiated with my participants, assuring them that they should not feel obliged to participate in the study. I had to establish rapport and trust with these teachers. As alluded to earlier, I also presented and positioned myself as a co-learner by trying to work with the participants in developing the mediational tool that could be used in our Physical Science teaching. I encouraged them to feel free to express themselves without being intimidated to do so. Thus, the purpose of the study was explained to them before data generation.

Based on what I have explained above in terms of negotiating power differentials and having a better understanding of how positionality impacts the research process, reflexivity comes into effect (Ozano & Khatri, 2018). This is because the background of the researcher shapes the study (Creswell, 2014). For this reason, as a researcher, I needed to acknowledge and disclose how these factors might have influenced the research process by adopting the reflexive approach (Holmes, 2020).

To explain reflexivity further, Holmes (2020) extended that reflexivity deals with reflecting and taking action throughout the research process and considering one's positionality that is never fixed; instead, it is always situational and context dependent. This self-reflection creates an open and honest narrative that will resonate well with the readers (Creswell & Creswell, 2018). During reflexivity, the researchers look at themselves and their positionality as part of the research process. This is because the researcher brings their biography and values to the research situation, and participants behave in a particular way in their presence (Cohen et al., 2018). That is, researchers reflect on how their own biases, values and personal backgrounds such as gender, history, culture and socio-economic status influence their interpretations

formed during a study (Creswell, 2014). I kept a journal where I recorded all the accounts that took place throughout the research process. I also encouraged my participants to reflect on the research process, especially during the workshops. This gave me ample opportunity to make changes where possible.

1.5 Statement of the Problem

The MoEAC's (2018) NCBE advocates the application of *gender equity* at all levels and in every aspect of the curriculum and teachers are central to the implementation of this policy. This includes how teachers respond to gender issues and how they eradicate bias and discrimination to ensure *equality* and *equity* for both boys and girls in their science teaching.

For instance, as part of my master's interventionist study, I administered a pre-test and post-test to my learners. The purpose of these tests was to explore whether the integration of local indigenous knowledge (IK) in the teaching of acids and bases influenced (or not) learners' conceptions, dispositions, interests and sense making. To my bewilderment, I found that most girls performed poorly in the post-test compared to the boys even though they were all exposed to the same hands-on practical activities (Asheela et al., 2021). Notably, all the materials that were used during the intervention were those that could be found in all learners' immediate environments (both girls and boys) since they all came from the same socio-cultural background (Mavuru & Ramnarain, 2020). From these findings, it could be hypothesised that these learners (girls in particular) were not able to relate science to the everyday materials that they used in their homes (Gwekwerere, 2016; Oloruntegbe & Ikpe, 2011). Since the materials used were the same and were from the same environment, that triggered my interest to establish how teachers' gender and culturally responsive practices influence (or not) the mediation of chemistry topics using acids and bases and combustion reactions as examples, and in rural schools in particular.

Moreover, the national examiners' reports for Grade 9 JSSEE, 2018; Grade 10 JSC, 2016; Grade 12 NSSCO, 2014 and 2020 for Physical Science revealed that learners faced challenges when answering chemistry questions compared to physics. Hence, I chose to focus on chemistry topics in this study. Essentially, this study hoped to contribute to closing the gap between the policies on gender and the teaching practices of the teachers (that is, contradictions

in curriculum formulation and curriculum implementation) in science classrooms using acids and bases and combustion reactions as examples. Basically, this study took cognisance of the problems experienced in the master's study, and highlighted by the examiners' reports, to attempt to assist teachers in being gender and culturally responsive when mediating the learning of chemistry topics using acids and bases and combustion reactions as examples.

1.6 Purpose and Significance of the Study

The purpose of this study was to explore and expand Grade 9 Physical Science teachers' gender and culturally responsive practices when mediating the learning of chemistry using acids and bases and combustion reactions as examples. This was achieved through working with teachers to develop a mediational tool that is gender and culturally responsive that Physical Science teachers could use to mediate the teaching and learning of science, particularly chemistry.

Gender and culture play a major role in teaching and learning. Gender is an imperative control and socio-cultural factor that influences individual beliefs (Gullberg et al., 2017). Thus, an important tool to create a prosperous and peaceful, socially just society is education that addresses the gender dimension for sustainable development (Paudel, n.d.).

This study, therefore, provides the platform for Grade 9 Physical Science teachers to promote gender-friendly classrooms and teaching instructions when mediating learning of chemistry topics. It will also help the teachers to select pedagogies that would accommodate all learners, regardless of their gender differences. In addition, it will assist teachers to understand the significance of being gender and culturally responsive as an all-inclusive development of both boys and girls in science classrooms. In other words, this study is of importance to the participants and all science teachers as it creates prospects for them to improve their pedagogical content knowledge (PCK) on how to be gender and culturally responsive in their science lessons (Ogunniyi, 2018; Shulman, 1986).

The study also developed a mediational tool that has the potential to expand gender and culturally responsive practices of Physical Science teachers. This seems to resonate with the principles of inclusivity as advocated by the MoEAC, Physical Science syllabus (2015), development of the Zone of Proximal Development (ZPD) as advocated by Vygotsky (1978),

and culturally responsive pedagogies as espoused by Mhakure and Otulaja (2017) and other scholars.

At a personal and professional level, this study also helped me to improve my teaching practices concerning how I could deal with such classrooms based on gender and cultural issues when teaching Physical Science. Put differently, it assisted me on how to address gender and cultural stereotypes that are mostly practised in science classrooms. In other words, I have gained knowledge on how to engage both boys and girls in the lessons particularly in Physical Science.

1.7 Research Goal, Objectives and Research Questions

This section highlights the research goal, research objectives and research questions for this study.

1.7.1 Research goal

The goal of this study was to explore and expand Grade 9 Physical Science teachers' gender and culturally responsive practices in science classrooms when mediating learning of chemistry and develop a mediational tool that is gender and culturally responsive using acids and bases and combustion reactions as examples. The study was informed by the following research objectives.

1.7.2 Research objectives

1. To determine Grade 9 Physical Science teachers' perspectives and pedagogical insights on gender and culturally responsive practices when mediating learning of acids and bases.
2. To surface the underlying contradictions (if any) that enabled and/or constrained gender and culturally responsive practices in Grade 9 Physical Science teachers' science classrooms.
3. To support expansive learning and develop a mediational tool for gender and culturally responsive practices in Physical Science teaching using acids and bases and combustion reactions as examples.

4. To determine how the group discussions and reflections through CLWs influenced (or not) the implementation of the mediational tool when Grade 9 Physical Science teachers mediated the learning of their lessons.

1.7.3 Research questions

To achieve these objectives, the following research questions were addressed:

1. What are Grade 9 Physical Science teachers' perspectives and pedagogical insights on gender and culturally responsive practices when mediating learning of acids and bases?
2. What are the underlying contradictions (if any) that enable and/or constrain gender and culturally responsive practices in Grade 9 Physical Science teachers' science classrooms?
3. What expansive learning and mediational tools can the study develop to support gender and culturally responsive practices in Physical Science teaching using acids and bases and combustion reactions as examples?
4. How do group discussions and reflections through CLWs influence (or not) the implementation of mediational tools when Grade 9 Physical Science teachers mediate the learning of their lessons?

1.8 Data Generation Methods

Data were generated through various research instruments. For question 1, for instance, data were generated using questionnaires and semi-structured interviews. These methods were intended to aid me in understanding the perspectives and pedagogical insights based on the gender and culturally responsive practices of Physical Science teachers. That is, they afforded me an opportunity to understand their views and awareness of being gender and culturally responsive (or not) when mediating science lessons.

For question 2, data were generated from semi-structured interviews, classroom observations and stimulated recall interviews. These helped me to understand the mediation process that took place during the teaching and learning process. It also helped me to surface any contradictions (Engeström, 2001; Sannino et al., 2009) that were experienced by the science teachers by being gender and culturally responsive when mediating learning. In addition, these

methods helped me to triangulate data gathered from questionnaires and semi-structured interviews.

For research questions 3 and 4, data were generated through group discussions and reflections during CLWs. This was intended to create professional learning communities among the teachers (Brodie, 2020). Teachers engaged in the conversations to critically interrogate their teaching practices (Chauraya & Brodie, 2018). These conversations assisted me and my participants to develop a mediational tool that could be used to mediate any chemistry topic, hence supporting teachers' teaching practices (Feldman, 2020).

1.9 Theoretical Frameworks

The theoretical framework is an important component of any research study. The theoretical frameworks of this study were underpinned by Vygotsky's (1978) socio-cultural theory (SCT) concurrently with Engeström's (2001) cultural-historical activity theory (CHAT). With the SCT which provided the broad theoretical framework as a lens informing this study, I focused on the mediation of learning, culture and language, social interactions and the ZPD. On the other hand, CHAT provided the methodological and analytical tools for this study.

1.9.1 Socio-cultural theory

The SCT was originated by Vygotsky (1897, 1936), who placed education between individual and culture in his writings (Panhwar et al., 2016). Vygotsky's (1978) socio-cultural learning theory views learning as a product of a social-mediated process in which knowledge is attained through collaborative activities with more knowledgeable others (MKOs). Humans do not act directly on the physical world; however, they depend on tools to mediate their actions (Nussbaumer, 2012; Vygotsky, 1978). Thus, symbolic tools or signs mediate human relationships with each other and their environment (Vygotsky, 1978). Consequently, it explains how individual mental functioning is related to the cultural, historical and institutional contexts (Scott & Palincsar, 2013; Shabani, 2016). It focuses on the role that participation in social interactions and culturally organised activities play in influencing psychological development. Underpinning SCT in this study is the view of teacher learning as an evolving endless process. Thus, this view attempts to inform, train and improve teachers who can effectively meet the requirements of the social, historical and cultural contexts in which they

are teaching (Ebadi & Gheisari, 2016). The study focused on the four components, namely, mediation of learning, culture and language, social interactions and Zone of Proximal Development.

1.9.1.1 Mediation of learning

Vygotsky (1978) elucidated mediation as a tool, for instance cultural artefacts used in cognitive change. He further explained that human activities take place in cultural, social, institutional, and historical contexts and are mediated by language and other symbolic systems. In the context of my study, the way teachers mediated the teaching and learning of chemistry topics determined their gender and cultural responsiveness. Consequently, their mediation was also influenced by culture and language. These are important tools in the science classroom.

1.9.1.2 Culture and Language

In terms of culture and language, Vygotsky's theory infers that our thinking is the internalised product of a social-historical culture (Selepe & Moll, 2016). According to Vygotsky, it is not possible to understand human thinking and its development without scrutinising the signs (tools of thought) that are provided by culture. Thus, Vygotsky (1978) asserted that culture is a social environment, an organisation of social standards rather than a mediator of human freedom.

In the context of my study, the language used by teachers determines the way they mediate learning as it might enforce gender discrimination which might lead to gender inequality. Thus, Di Tullio (2019) warned that gender discrimination is often unobserved as it fits with what people have adopted as ordinary and accepted. This scholar further explained that gender discrimination comprises social attitudes that are regarded as conventional and therefore accepted in the dominant culture. Hence, teachers should cautiously ponder the language used when they mediate or communicate the ideas and science concepts to learners during their classroom interactions. That is, they should endeavour topromote social interactions.

1.9.1.3 Social interactions

To Vygotsky (1978), social interaction is the foundation of learning and development. Learning is a socially mediated process that starts on an inter-psychological plane (social relationship as

the learner interacts with their peers and the knowledgeable others) to the intra-psychological plane (assimilation and internalising of the knowledge which is acquired) through the interaction (Stott, 2016; Vygotsky, 1978). Hence, this study looked at how teachers interacted with the learners during the mediation of learning. Equally, the study also observed the social interactions of the teachers during the Change Laboratory Workshops (CLWs) and enhanced their ZPDs in being gender and culturally responsive.

1.9.1.4 Zone of Proximal Development

According to Vygotsky (1978, p. 86), the ZPD "is the distance between the actual developmental level as determined by the independent problem solving of an individual and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers". Even though Vygotsky developed his theory to understand child development, in this study the participants were adults. Thus, the concept of ZPD could not be applied in the Vygotskian sense. This was a limitation in this study.

1.9.2 Cultural-historical activity theory

Cultural-historical activity theory (CHAT) was developed from Levy Vygotsky's work by his students and followers and was popularised by Engeström (Nussbaumer, 2012). It is one of several practice-based approaches that provide a powerful framework for examining professional work practices, including social service provision (Foot, 2014). CHAT offers the researcher conceptual, methodological, and analytical tools (Mukute & Lotz-Sisitka, 2012). That is, it allows researchers to analyse multifaceted and changing professional practices and practitioners to engage in reflective research (Foot, 2014).

CHAT informed a methodology called Developmental Work Research (DWR). The developmental work activities were established as a "new kind of collaboration between a group of practitioners and the researcher" (Virkkunen & Newnham, 2013, p. 23). It offers a process framework for intensifying learning and can be used to conquer existing contradictions in and between activity systems (Mukute & Lotz-Sisitka, 2012). These scholars further explained that DWR can also be regarded as a *collectivist interpretation of learning*, where a group of people with different experiences and perspectives work together on the same object and seek to jointly develop new knowledge or tools to address the problems. The

developmental work activities were attained through a series of workshops called Change Laboratory Workshops (CLWs) (Virkkunen & Newnham, 2013).

In this study, CHAT was chosen because it enabled me to explore deeply and find the underlying factors influencing the actions of science teachers in terms of being gender and culturally responsive when mediating science. It also helped to surface the underlying contradictions that constrain them from being gender and culturally responsive when mediating the learning of science, that is, the cultural and historical factors. In other words, this framework helped me in understanding the connection between the teachers and their social and cultural settings in which they acted. It enabled me to gain insights into teachers' pedagogies and how they are influenced by the social and cultural factors, particularly in the enactment of being gender and culturally responsive in their science classrooms. I now look at what an object is in the activity system of this study.

1.9.2.1 Object of the activity system

An object is regarded as the prime unit of analysis (Engeström, 2000) and is something on which human efforts are focused (Sannino et al., 2016). Foot (2014) explained that the object is the principal entity or the anticipated result, which is supported by Ploettner and Tresseras (2016), who highlighted that the object of the activity system refers to what drives the activity. That is, it provides the meaning and importance of actions within the system. Foot (2014) further pointed out that an object comprises three features. These are classified as the things to be acted upon, the objectified motive and the desired outcome. Thus, Engeström and Sannino (2010) believe that the object is both resilient raw material and the imminent oriented purpose of the activity system. In this regard, Foot (2014) posits that the construction of the object encompasses the interactions between the aspects of the subject's individual experiences and the subject's relationship with the community. Hence, an object becomes the cultural entity and object-oriented action becomes the key to understanding individual essence (Engeström, 2001).

In this study, the object was gender and culturally responsive practices. The prime focus was to explore and expand teachers' gender and cultural responsiveness when mediating learning of chemistry. Concentrating on this unit of analysis helped me to understand the nature and complexity of the teachers' gender and culturally responsive practices when mediating learning

of chemistry topics. This allowed the teachers to surface contradictions in their teaching practices.

1.9.2.2. Contradictions in an activity system

Contradictions are sources of change and development (Engeström, 2001). Thus, they are considered motives of change within and between the activity systems (Engeström & Sannino, 2010). To Foot (2014, p. 16), contradictions "reveal an opportunity for creative innovations and for new ways of structuring and enacting the activity". They are regarded as the driving forces of expansive learning as they are dealt with in such a way that a novel object is identified and turned into a motive (Engeström & Sannino, 2010). In other words, contradictions may lead to more nuanced viewpoints and innovative solutions.

Notable is that teachers and learners are members of different activity systems (see Figure 3.4) and hence, are exposed to contradictions from these activity systems. These activity systems are school and home and both influence teaching and learning. These contradictions serve as the enablers in assessing the activity system. Thus, they are crucial as the starting point in the change laboratory workshops which led to the transformative agency.

For this reason, Virkunnen (2012) highlighted that contradictions are vital for offering people an opportunity to search for certain solutions which make development possible. Put differently, contradictions offer an opportunity to question normalcy and search for innovative options (Haapasaari et al., 2016). In this study, I surfaced the contradictions that constrained or enabled the teachers to be gender and culturally responsive. Surfacing these contradictions allowed the teachers and I to collectively work together in addressing them through the development of a mediational tool (see Appendix K). I now shift to the research orientation and methodology.

1.10 Research Orientation and Methodology

This study employed a qualitative research orientation. A qualitative research orientation granted me the opportunity to explore the problem at hand by developing a thorough understanding of teachers' gender and culturally responsive practices when mediating science by providing rich data or information (Creswell, 2012). Correspondingly, it helped in exploring

and understanding the meaning that individuals or groups attributed to a social or human problem (Creswell, 2014). Hence, incorporates an emancipatory aim of enlightening and empowering individuals and organisations in the community setting (Plano-Clark & Creswell, 2015). In this study, my focus was on exploring and expanding gender and culturally responsive practices for Physical Science teachers when mediating chemistry topics using acids and bases and combustion reactions as examples. Thus, I intended to explore the current gender and culturally responsive practices of science teachers by surfacing the contradictions that constrain them in their practices and then co-develop the mediational tool which then brings the transformational process into their practice.

The study took an interpretive and critical stance on educational research, combined with a formative intervention. I adopted an interpretive stance to have a better understanding of the

world in which the participants live regarding the situation being studied (gender and culturally responsive) (Creswell & Creswell, 2018). Similarly, I complemented it with a critical stance of my research as it was centred on the philosophy of structuralism, which focuses on the structures and power relations within a society (Maree, 2014). Consequently, participants raise their cognisance or advance an agenda for change in their practices to improve their lives (Creswell & Creswell, 2018). The data collection techniques that were used were questionnaires, semi-structured interviews, classroom observations, stimulated recall interviews, group discussions and reflections through CLWs.

1.11 Data Analysis

Data analysis is an approach to moving from data to understanding, explaining and interpreting the phenomenon (Cohen et al., 2018). This involves reading through the information, coding data, developing the descriptions of the codes and interpreting the meaning of the themes formed (Creswell, 2014). In this study, data were transcribed and then colour coded to identify the emerging themes. Additionally, I used the constructs from my theoretical lenses in analysing the data. Hence, data were deductively and inductively analysed.

1.12 Dealing with Ethical Issues

Ethics concerns what is good and bad, right and wrong (Cohen et al., 2018). These scholars further emphasised that ethical research concerns what the researcher should and should not do in their research and research conduct. The researcher needs to be engaged in ethical practices at every step of the research process (Cohen et al., 2018; Creswell, 2014) and take ethical decisions. Ethical decisions are contextually situated as they are socially, politically, institutionally, culturally and personally oriented (Cohen et al., 2018).

For this study, the purpose and objectives of the research proposal were clearly articulated to the Higher Degrees Committee of the Education Faculty (Rhodes University). The clearance certificate was granted for undertaking the study (see Appendix A). The letter of consent, in which the research process was explained to the participants was obtained (see Appendix B). Since the lessons were videotaped, assent letters for the learners were obtained from their parents or guardians (see Appendix C). The permission for conducting the research at schools was obtained from both school principals and the Director of Education of the Oshikoto Region (see Appendices D1 & D2).

1.13 Definition and Descriptions of Concepts

In this section, I provide definitions and descriptions of key concepts that I worked with as mediation tools and deemed important in exploring and expanding gender and culturally responsive practices of Physical Science teachers. To give the theoretical standpoint of each concept, I have used relevant literature.

1.13.1 Gender equity

Equity is successfully enacted when all individuals are accorded the needed number and types of resources so that they accomplish equal outcomes in comparison with other groups. To warrant fairness, provisional constructive actions must often be put in place to recompense the historical and social disadvantages that inhibit women and men from working on an equal playing field (The Global Partnership for Education, 2017).

1.13.2 Gender equality

Gender equality has become the target of extensive unease regarding social justice and pluralism (Busyro, 2017). However, gender equality is not a women's issue but should concern and fully engage both men and women in such a way that equality is a human rights issue and a precondition for and indicator of sustainable people-centred development (Busyro, 2017; UN Women). This is because, previously, efforts on gender equality were being seen as a synonym for women and girls (The Global Partnership for Education, 2017). Gender equality serves the purpose of removing deep-seated barriers to equality of opportunities (Fentie, 2017; Mlama et al., 2005), thus producing quality education. Fentie (2017) asserted that education that lacked gender equality is regarded as gender biased. It should be noted that gender issues are not only concerned with women or girls but also men or boys (Busyro, 2017). This is because boys and girls, women and men are all affected by gender roles that shape anticipations of them in their homes, in their communities and in society at large (The Global Partnership for Education, 2017). Hence, gender responsiveness helps improve the quality of education (Paudel, n.d.). Thus, this calls for teachers to employ gender-responsive practices when mediating teaching and learning activities.

1.13.3 Gender-responsive practices

Teachers practice gender responsiveness when they offer content and activities that match the needs of boys and girls in their science classrooms. This requires identifying additional tools and resources to support the teachers in an organised way and undertaking gender analysis and developing gender-responsive approaches (The Global Partnership for Education, 2017).

1.13.4 Gender responsive

Gender responsive is a method that embraces understanding and contemplation of socio-cultural factors that cause sex-based discrimination as well as taking action to improve gender equality (European Institute for Gender Equality, 2019). It involves working towards practical gender equality that includes, where appropriate, measures employed to promote equality (Götzmann & Bainton, 2021)**.** It is a policy or programme which accomplishes two basic principles: gender norms, roles and relations are deliberated, and procedures are taken to

actively lessen the detrimental effects of gender norms, roles and relations – including gender inequality (The Global Partnership for Education, 2017).

1.13.5 Gender awareness

This is the ability to "identify problems arising from gender discrimination and bias which affect males' and females' ability to access and control resources and/or even access and control benefits from the resources even when problems are swept under the carpet" (Chikunda, 2013, p. 1).

1.1.3.6 Gender stereotypes

These are general expectations about members of particular social groups, and these comprise primary importance attached to specific performance when judging men in the social relationship when considering women (Ellemers, 2018). In the context of education, boys are regarded as talented in science subjects compared to girls (Leslie et al., 2015).

1.13.7 Culture and learning

Culture is defined as a collective setting, a system of social standards rather than a facilitator of human independence (Vygotsky, 1986). Vygotsky (1978) believed that culture plays a significant role in driving and determining development and consequently, according to him, development is relatively influenced by culture.

1.13.8 Culturally responsive pedagogy

Culturally responsive teaching or pedagogy is described as a method of using the cultural knowledge, prior experiences and frames of reference of ethnically varied students to make learning more relevant and effective to the learners (Gay, 2010). It follows that equitable learning experiences require cultural and linguistic backgrounds (Brown, 2017), thus, easing border crossing between dominant cultural practices at school and those practised at home (Aikenhead, 2006). In other words, it requires employing different pedagogies that use learners' cultures during the teaching and learning process (Gay, 2010). It requires the teacher to filter curriculum content and teaching approaches through learners' cultural frames of reference to make content more relevant and easier to understand (Mavuru & Ramnarain, 2020; Mensah, 2021).

1.13.9 Teachers' conceptions

Conceptions are ideas, values and attitudes that people hold towards something (for instance what they think it is and how it is structured) and what is its purpose (Brown & Gao, 2015).

1.13.10 Teachers' dispositions

Dispositions are visible patterns in behaviour demonstrated by teachers as they interact with individual learners, their priority with a certain group of learners, and their habits of mind that influence other aspects of their decision making (Warren, 2018). Thus, Mpofu and Nthontho (2017) argued that dispositions are not only embedded in experience, knowledge, personal beliefs and values but are also culturally instituted and moulded by interactions with others in a social context (Vygotsky, 1978).

1.13.11 Patriarchy

This is a type of masculine-centred society, where men hold power and play dominant roles in political governance and moral authority, societal honour and control over properties (Cho & Jang, 2021).

1.14 Thesis Outline

In this section, I will briefly outline the structure of this thesis. This thesis comprises eight chapters as outlined below.

Chapter One is an introductory chapter that aimed at situating the study. It discussed the context in which the research emerged and highlighted the efforts made by international organisations in achieving gender equality and equity. I also looked at the Namibian education system before independence and the changes that were made after independence regarding education. The chapter also highlighted my personal life as I situated myself in the study. It also explained how positionality could influence a study and how to be reflexive during the research process. The chapter also focused on the statement of the problem and the significance of the study. I also highlighted the research goal and objectives and the research questions that the study intended to answer. This chapter also highlighted the theoretical frameworks that guided the study, namely SCT and CHAT. The chapter ends with a brief description of key concepts used in the study, the thesis outline and the chapter summary.

Chapter Two engages with the literature that is relevant to my research topic and looks at the crucial aspects of this study which are gender and culturally responsive practices. The chapter starts with the teaching of chemistry topics. This focuses on the basic competencies that learners are expected to master when learning acids and bases and combustion reactions. I engage with teaching science and gender issues experienced in science classrooms. The chapter also looks at the cultural factors as the underlying mechanisms of gender and cultural stereotypes. Literature related to gender-responsive practices is explored. The chapter also looks at IK and how it plays a role in the teaching and learning process. I also look at the literature on teachers' cultural backgrounds and their culturally responsive pedagogy when mediating the teaching and learning of science. The chapter also discusses teachers' perspectives in mediating learning, particularly science. The chapter then looks at teachers' Professional Learning Communities (PLC) and PCK concerning the teaching and learning process. The chapter ends with the nature of professional development programmes in Namibia and the chapter summary.

Chapter Three presents the theoretical framework lenses that inform this study, namely the SCT and CHAT. On SCT, I focus on its components, particularly mediation of learning, culture and language, social interactions and ZPD. I also discuss CHAT, focusing on its components of the triad, its applicability to this study, its principles, expansive learning and the change laboratory. The chapter ends with the chapter summary.

Chapter Four is the research methodology chapter. It presents the research paradigms and explains the step-by-step process of how data were gathered, analysed and managed. The chapter highlights the research goal and the research questions that the study aimed to answer. It also looks at the research site, sampling and the participants. In this study, questionnaires, semi-structured interviews, classroom observations, stimulated recall interviews, group discussions and reflections through CLWs are discussed, concerning how each method was used to generate data. It also explains in detail the research process in both phase one and phase two. The chapter also discusses how data were presented and analysed as well as its validity and trustworthiness. It ends with ethical considerations and a chapter summary.

Chapter Five focuses on the first part of the explorative phase and deals with the presentation and discussion of data gathered from questionnaires and semi-structured interviews. This addresses the first two questions which are: *What are Grade 9 Physical Science teachers' perspectives and pedagogical insights on gender and culturally responsive practices when mediating learning of acids and bases? What are the underlying contradictions (if any) that enable and/or constrain gender and culturally responsive practices in Grade 9 Physical Science teachers' science classrooms?*

The first part of the explorative phase positioned the participants' understanding and views of gender and culturally responsive practices for the second part of the explorative phase.

Chapter Six focuses on the second part of the explorative phase. This deals with the presentation and discussion of data gathered from classroom observation and stimulated recall interviews. These instruments were used for triangulation with data gathered from questionnaires and interviews and to inform the intervention phase. In summary, the chapter focuses on the understanding of gender and culturally responsive practices and surfaces the contradictions that constrain teachers from being gender and culturally responsive when mediating the learning of science.

Chapter Seven focuses on data generated from phase two which was the formative intervention phase and answers the last two research questions which are: *What expansive learning and mediational tools can the study develop to support gender and culturally responsive practices in Physical Science teaching using acids and bases and combustion reactions as examples? How do group discussions and reflections through CLWs influence (or not) the implementation of mediational tools when Grade 9 Physical Science teachers mediate the learning of their lessons?*

Phase two engaged the participants in group discussions and reflections. These were done through the CLWs following the expansive learning cycle. In this chapter, I present, analyse and discuss the data and findings of the intervention phase. This chapter gives an account of how participants and I worked together and navigated ZPDs for gender and culturally responsive practices when mediating science. It also explains the process of developing the mediational tool to support gender and culturally responsive practices for science teachers.

Chapter Eight contains the summary of the findings of this study. It highlights my journey reflections throughout this process and the experiences gained from this study. The chapter institutes the implications, conclusions drawn, new knowledge generated by this study and the recommendations arising from the findings.

1.15 Chapter Summary

In this chapter, I introduced the study by presenting the contextual background and highlighted the interventions made at the international level and in the Namibian context. Moreover, the chapter highlighted how I situated myself in the study and my positionality and reflexivity during the research process. I stated the problem statement and the significance of the study. The chapter also highlighted the goal, the research objectives and the research questions the study intended to answer. Furthermore, it gave a brief definition of the key concepts used in the study. The chapter also gave a brief overview of the theoretical frameworks as is further discussed in Chapter Three. It also highlighted the research methodology, data analysis and issues regarding ethics which is also discussed in detail in Chapter Four. The chapter ended with the outline of the thesis. In the next chapter I look at the literature related to this study.

CHAPTER TWO: LITERATURE SYNTHESIS

> Gender-responsive pedagogy has been advocated to enhance fair treatment between boys and girls in classrooms, which in turn can enhance equitable participation in learning. (Mhewa et al., 2021, pp. 253-254)

2.1 Introduction

A literature review is a summary that defines the previous and current state of information on the topic of the research study (Creswell, 2014). “It is the analysis, critical evaluation and synthesis of existing knowledge relevant to the research problem” (Hart, 2018, p. 3). In this section, to ground my study in the body of knowledge the literature based on previous studies is discussed. It also looks at teaching of chemistry topics in Physical Science and the teaching of acids and bases and combustion reactions. It focuses on the competencies that learners are expected to achieve as outlined in the Namibian Physical Science syllabus. Equally, the chapter explores the cultural factors as the underlying mechanisms that lead to gender and cultural stereotypes and explains how culture plays a role in the life of the individuals. Likewise, I also synthesise literature pertaining to science teaching and gender issues. The chapter also looks at literature about gender-responsive pedagogy, IKS, and literature that considers socio-cultural backgrounds of learners in the teaching and learning process. In the same vein, this chapter looks at teachers’ perspectives about the teaching of science. Furthermore, it explores the teachers’ PLC as well as PCK in terms of science teaching. Lastly, I look at the nature of professional development programmes in the Namibian context and then end with a chapter summary. I now look at teaching of chemistry topics focusing on acids and bases and combustion reactions.

2.2 The Teaching of Acids and Bases and Combustion Reactions in Physical Science

Chemistry courses are crucial targets for transformation as they are departures for access to an extensive range of careers in science, health and technology (Mahaffy et al., 2017). Essentially, chemistry is an important branch of science that helps the learners to make sense of the natural phenomena of things happening in the surroundings (Colen, 2013). With this in mind, chemistry education should be taught in such a way that it enables the learners to develop positive attitudes toward chemistry (Rüschenpöhler & Markic, 2020). In other words, chemistry must be taught in the context that is significant and appropriate to the society. Acids and bases are the basic components of chemistry in the curriculum (Kala et al., 2013). It plays an important role in biological activity and in our daily lives (Ural & Gençoğlan, 2019). It is also part of everyday life in context and is contained in everyday activities (Drechler & Van Driel, 2007). This means that learners are exposed to everyday materials in their science classroom. The study carried out by Haimene (2018) found that there are many examples of acids and bases that can be found in learners' homes. For instance, one of the examples of acids is *oshikundu*[1], a non-alcoholic traditional brew for the Aawambo. This beverage is normally prepared by the women and is thus associated with gender roles that are assigned to individuals. Therefore, these gender roles could negatively affect learners when they are exposed to activities that they are not familiar with. It is for this reason that the NCBE (MoEAC, 2018) advocated that teachers need to be sensitive and address any gender issues that arise in the classroom. The MoEAC Physical Science syllabus (2015, p. 36) for Grade 9 outlines:

> Learners are expected to identify and name examples of acids in everyday life. Discuss that acids are common in foods, particularly fruits, and that they have a sour taste. Identify and name examples of bases used in everyday life. Recognise that bases are common in cleaning materials and that they have a bitter taste and a soapy feel when rubbed between fingers.

[1]Non-alcoholic beverage prepared mostly by Aawambo community. This beverage is normally prepared by the girls (Shinana et al., 2021).

Similar to acids and bases, combustion reactions are also one of the basic concepts in chemistry (Usak et al., 2011). In the MoEAC Physical Science syllabus (2015, p. 34) the learners are expected to achieve the following basic competencies:

> Describe combustion and recognise that combustion, corrosion of metals and respiration are all examples of the same type of reaction which involves the reaction of a substance with oxygen. Suggest examples of combustion from everyday life (e.g., burning a match, a fire, a candle, fuel, methylated spirits or paraffin). Discuss examples of the combustion of elements which require heat to initiate (start) the reaction and predict the products of combustion. Write down word equations for the combustion reactions above.

Looking at these basic competencies, teachers are expected to mediate the topic of acids and bases with what learners have experienced from their socio-cultural backgrounds (Mavuru & Ramnarain, 2020) to make science relevant and applicable to learners' everyday life worlds (Gwekwerere, 2016; Mavuru, 2022).

Correspondingly, the topic of acids and bases and combustion reactions are some of the topics that require hands-on activities. According to Ajayi and Ogbeba (2017), hands-on activities countenance the learners to handle and manipulate scientific processes through interacting with the materials and apparatus. During hands-on activities, learners could use the easily accessible resources in their science classrooms (Asheela et al., 2021), thus bridging the gap between home and school science (Shinana, 2019).

However, while acknowledging that the use of easily accessible resources would be appropriate for creating culturally responsive pedagogies (Mhakure & Otulaja, 2017), it is crucial for the teacher to play a role in ensuring that both boys and girls receive the opportunity to take part in the teaching and learning process. That is, teachers need to know how to do address the needs of both boys and girls. Consequently, here lies the importance of gender and cultural responsiveness when mediating the learning of science. Teachers need to take note of these and ensure that all learners receive equitable education. In other words, the socio-cultural context is crucial for the formation of learners' concepts, and depends on the social relationships in schools and the cultural context at large (Mahaffy et al., 2017). It is then the responsibility of the teachers to be culturally responsive (using cultural features for teaching to be efficient)

(Harrison & Skrebneva, 2020) and gender responsive (paying attention to specific needs of girls and boys) (Mlama et al., 2005) should come into effect. In this study, acids and bases were used as example in phase one. This refers to understanding teachers' perspectives and pedagogical insights and surfacing contradictions that enable or constrain teachers. In addition, combustion reactions was used as an example in phase two. It was used in the planning of the exemplar lesson in which the mediational tool was implemented, thus these topics served as examples in the teaching and learning process.

In the next section I look at how cultural factors play a role as the underlying mechanisms for the teachers and learners in a patriarchal society.

2.3 Cultural Factors as Underlying Mechanisms of Gender and Cultural Stereotypes

Social gender inequality is witnessed in communities in which traditional gender responsibilities play the major role (Başar & Demirci, 2018). This means that the existence of patriarchy leads to women being placed in negligible roles and seen as inferior individuals (Mawaddah et al., 2021). Thus, Cho and Jang (2021) postulated that this patriarchy has a critical influence on the numerous extents of life. These patriarchal tenets are suppressed and maintained through different organisations (Wayan & Nyoman, 2020). This is because people often have misunderstanding and cannot differentiate between nature and gender roles (Mawaddah et al., 2021). Hence these traits such as "domination, control, assertiveness, and aggression are perceived as masculine and relation-oriented dependent traits are regarded as feminine" (Cho & Jang, 2021, p. 2). It is these patriarchal social structures that determined the gender roles of the individuals (Başar & Demirci, 2018). These traits are learnt from the community and then enacted in the school (Mogari, 2017). Consequently, what learners and teachers learnt from home or community seems to be in contrast with what happens in schools (Mogari, 2017). This scholar further explained that gender biases are influenced by the cultural beliefs and practices in the community and in the class, teachers are expected to provide equal opportunities to the learners. It seems that these scholars are acknowledging the role that patriarchal social structures play in the lives of individuals. These might be the underlying mechanisms in being gender and culturally responsive, subsequently serving as contradictions

in the teaching and learning process. I now look at the teaching of science and gender issues in the science classroom.

2.4 Science Teaching and Gender Issues

Various studies have acknowledged that science is regarded as being for males and it is frequently associated with masculinity (Archer et al., 2012), and equity is a persistent challenge in science education (Penuel, 2017). Participation of females in science is vital, but socialisation and traditional roles assigned to girls at birth still determine the level of their participation. This is because a person's life is influenced and affected by socio-cultural factors (Iwu & Azoro, 2017). Gender socialisation both at home and school might have an impact on the progress of learners, particularly girls (Chikunda & Chikunda, 2016). In the same vein, learners who are exposed to the representation of gender stereotypes adopt and internalise these representations as true and natural (Abraha et al., 2021). It is then vitally important that science teachers address such bias in their gender-responsive classrooms. This is because teachers are crucial agents in contesting gender-stereotyped ways of thinking and gender-stereotyped choices of education (Gullberg et al., 2017). Put differently, teachers are central to teaching and learning, thus their consideration and cognizance of gender responsiveness are substantial to the effective involvement of both boys and girls in the learning process (Satiya, 2021). Consequently, a key strategy for promoting equity in science education is to incorporate everyday science into learning (Penuel, 2017). In other words, engaging with science in everyday activities and designing informal settings allows the learners to cross and connect to school science (Aikenhead, 2006).

In addition, teachers should ask themselves which boys and girls are most excluded from education (particularly science) based on the local context and where there is a combination of factors such as poverty ethnicity, disability, and location of school (The Global Partnership for Education, 2017). In this regard, the ability of teachers to adopt and practise gender-responsive education begins with their acquaintance and understanding of the concept of responsiveness itself and the skill to apply this concept (Kahamba et al., 2017). Thus, Ebadi and Gheisari (2016) suggested that teachers need a toolkit of teaching ideas, methods, and materials that they can draw on when meeting the challenges in their teaching practices and building their

professional character. Hence, this leads to teachers' change and development as they transform their practices.

Similarly, learners learn about masculine and feminine roles at a young age as they start schooling and from the knowledge that they acquire from their home and society in general (McGuire et al., 2020; Mutekwe & Mutekwe, 2012). That is, the culture that influences the child's interests begins early and it depends on how the adults present and involve the children in the various activities (Gullberg et al., 2018). Moreover, the stereotype communicated by science teachers in their classes may particularly negatively affect the academic development of children (Ertl et al., 2017). Furthermore, teachers' erroneous expectations may lead to a self-fulfilling prophecy whereby prior beliefs are self-confirming in equilibrium (Papageorge et al., 2018). Chikunda and Chikunda (2016) highlighted that teachers who are central to change in society are the products of gender construction in any society. Thus, Subero et al. (2018) asserted that the relationship between human development and their environment is culturally conditioned or mediated. Consequently, the MoEAC Physical Science syllabus (2015) calls for science teachers to include gender perspectives as an important aspect of the science curriculum to raise awareness of gender stereotyping. In this regard, Sinnes and Løken (2014) believe that teachers should play a role in ensuring that they avoid treating males and females differently; instead, they should give equal attention to both girls and boys.

In addition, teachers have to be aware of gender issues and how to address those issues in their classrooms (Karlson & Simonsson, 2011). Both girls and boys should be exposed to the same opportunities and challenges to ensure equality in science classrooms (Sinnes & Løken, 2014). In other words, both boys and girls must have an unconstrained choice of options and equal opportunities to advance and explore their abilities and interest (Gullberg et al., 2018).

Equally, science teachers play an exceptional and influential role in their science classrooms in addressing issues of gender equity, particularly in valuing the insights, perspectives and experiences of learners (girls) who were historically underserved in science (Bang et al., 2017) and in the same vein ensuring that boys are not disadvantaged (Kimani & Mwikimba, 2017). Thus, the SCT has been used to improve instructional practices that amend disparities in the

current education system (Stott, 2016). This can be realised through the social interaction of teachers with learners as supported by Vygotsky (1978).

Furthermore, gender equality is realised when gender stereotypes are replaced by gender awareness (The Global Partnership for Education, 2017). In light of these arguments, Huang and Fraser (2009) warned that unequal perceptions and expectations for science learning by girls and boys can transform into a yawning gender gap in actual achievement. Moreover, teachers might be exposed to gender concepts in various topics, and they might not know how to act gender responsively for all learners to participate in learning equitably. Thus, once the teacher starts considering gendered circumstances, the probability of continuing to do so intensifies as well as being able to respond and self-reflect (Gullberg et al., 2018). I now look at teachers' gender responsive pedagogy.

2.5 Teachers' Gender-responsive Pedagogies

Gender-responsive pedagogy is significant for teachers to create a gender-responsive educational environment (Dorji, 2020). However, before I engage with gender responsive pedagogy, I will look at the issue of sex and gender. In the context of this study, understanding the difference between these two concepts is important. According to Paudel (n.d.), sex is the biological variance between women and men while gender refers to the roles allocated to women and men in a particular society. Gender means socially determined roles and relations between females and males (Mlama et al., 2005). Thus, it can be altered to attain equality and equity for both men and women (UNESCO, 2005). For this reason, gender supports comprehensive and collaborative learning practices that balance men's and women's involvement in various activities (Chapin et al., 2020).

Gender responsive institutes respond to gender issues by finding ways of eliminating bias and discrimination to ensure equality and equity (Chikunda, 2014; Mlama et al., 2005). This includes the teachers' pedagogies. Pedagogy is what is taught (content), how teaching takes place (teaching process), and how what is taught is taught or learnt (Fentie, 2017; Mlama et al., 2005). Thus, gender-responsive pedagogy refers to teaching and learning processes that pay attention to the specific learning needs of girls and boys alike (Abraha et al., 2020; Mlama et

al., 2005). It is similar to quality education as it implies that gender equality in education leads to quality education (Fentie, 2017).

Admittedly, teachers are central to delivering the curriculum and hence are in charge of choosing those teaching and learning techniques that are appropriate to the specific class (Kahamba et al., 2017). In other words, for teachers to be gender responsive they have to take an all-encompassing gender approach in the process of lesson planning, classroom management as well as the assessment of the teaching and learning process (Satiya, 2021). In light of this and extending on Vygotsky's (1978) seminal work, Kahamba et al. (2017) accentuated that teachers' day-to-day interactions with learners offer an exceptional opportunity to either support the status quo in classrooms or make a transformation that will affect the learners' achievements. These scholars further argued that for equitable education to be realised, teachers should adopt gender-sensitive pedagogies. This includes teachers' manifold strategies and interventions during their teaching practices in their day-to-day conversations to ensure that learners have equal opportunities to be able to both create and achieve their goals (Bakshi, 2016). Thus, gender responsiveness allows teachers to develop and use gender-responsive methodologies to ensure that there is equal participation of both boys and girls in the learning process (Abraha et al., 2020). This leads to equitable education as pointed out in the epigraph above.

Similarly, gender responsive pedagogy is recognised as a means for attaining gender equality in the wider community (Mhewa et al., 2021). Thus, to achieve gender equity, teachers are the crucial link in realising this through education (Bakshi, 2016). Gender responsive is similar to quality education as it implies that gender equality in education leads to quality education (Fentie, 2017). Put differently, gender responsiveness is maintained through knowledge sharing, where teachers learn from the experiences of others and then apply it in their practices (The Global Partnership for Education, 2017). This allows teachers to have social interactions and consequently develop their zone of proximal development (ZPD) (Vygotsky, 1978) on how to be gender responsive when mediating learning in the science classroom.

Furthermore, in the gender-responsive classroom, teachers do not sideline less assertive learners; instead, they motivate both boys and girls to participate which leads to equal

opportunity for both genders (Dorji, 2020). To Chikunda (2014), gender-responsive practices should involve responding to gender issues in an attempt to find ways of eliminating bias, discrimination, or marginalisation. These might thereby ensure equality and equity for both girls and boys during science lessons. In this regard, Vanner (2019) asserted that gender-responsive components comprise empowering teachers and learners to contest the overbearing gender norms and implement principles to support and respond to the specific needs of boys and girls regarding their academic, physical, and social development. That is, teachers should look, examine and reflect on their teaching practices (Götzmann & Bainton, 2021). Put differently, it encompasses working towards functional gender equality by employing provisional and special measures where possible to promote equality as suggested by these scholars.

Mhewa et al. (2021) accentuated that the efficacy of gender responsive pedagogy as an approach for gender equality in education and the classroom is determined by the extent of all stakeholders' promptness to intercede in the traditional practices. Hence, Chapin and Warne (2020) warned that it is poor pedagogical practices that replicate gender inequalities in the classroom. In an attempt to address this, teachers need to be gender responsive in their everyday teaching to enhance their learners' positive mind that is set on gender equity, and in return create a gender-responsive academic environment (Dorji, 2020). This suggests that if schools do not acknowledge the danger of gender inequalities within their environment the necessary human resources and social services may not be provided (McElroy et al., 2009). Hence, Dorji (2020) posited that once gender becomes a focal lens within teaching, then teaching and learning become inclusive and interactive where the participation of both boys and girls is balanced. In light of this, gender-responsive learning must facilitate the different learning trends of both boys and girls (Zahro et al., 2020). This affords both boys and girls the opportunity to be actively involved in the teaching and learning process (Dorji, 2020).

The indicators for being gender responsive in the classroom are teaching and learning materials, teaching methods, learning activities, classroom set-up and interactions, management of other gender constraints to learning inside the classroom, feedback, and assessment (Dorji, 2020; Mlama et al., 2005). Essentially, gender-responsive practice starts with lesson planning. Thus, Kahamba et al. (2017) reiterated that the planning of the lesson

should be based on the needs of both boys and girls. It should be planned in such a way that both boys and girls have, for example, access to participate in manipulating equipment and use of chemicals during the lessons and that one gender such as the girls should not be assigned as secretaries by default as identified by Chikunda (2013) and Toma et al. (2019). Moreover, teachers should also use teaching methodologies that will ensure that both boys and girls have the opportunity to participate in lessons or activities such as group activities, pair work, and discussions (Abraha et al., 2021).

Moreover, learning and teaching support materials (LTSMs) should not contain gender stereotypes – for instance, that only males are heroes or only men drive while household chores are for women (Dorji, 2020) – they should portray a positive image of both genders. The Forum of African Women Educationalists (FAWE) (2006) emphasised that, during the planning of lessons, the teacher needs to scrutinise all teaching resources available to identify any elements of gender stereotypes and replace them with substitute gender-balanced resources. If teachers use materials that portray stereotypes, for instance, this might make girls limit their goals and objectives to conform to societal expectations (Abraha et al., 2021). These scholars also added that teachers should review teaching and learning aids to ensure that all biased aids are addressed to make teaching and learning more inclusive for the betterment of all learners' academic performance.

Thus, Heijnen-Maathuis (2008) opined that teachers should confirm that curriculum and textbooks are educationally and instructionally excellent with constructive images of both boys and girls and other facets of variety challenging dominant stereotypes. At times, teachers might not be aware of the gender-specific needs of boys and girls; for instance, most of the LTSMs used in the classroom consist of gender stereotypes and gender blindness (Chapin et al., 2020). Hence, Paudel (n.d.) suggested that teachers need to analyse the curricular content and develop instructional approaches that are structured in a more significant way for engaging all learners adequately. Correspondingly, it is important to add interpretations and examples that are gender responsive to counter the gender-biased illustrations that can be found in textbooks and other LTSMs (Abraha et al., 2021).

In addition, the language used for teaching and learning should also be considered when mediating the learning of science. That is, teachers should not use language that reinforces gender differences and inequality in the classroom. The language that reflects male dominance and relegates females to inferior positions might cause inequality in the classroom or vice versa (Kahamba et al., 2017). Mlama et al. (2005) opined that teachers' verbal and non-verbal language and textbooks used in the classroom for learning may unintentionally endorse a gender bias that limits equal access for learners to quality education. To avoid this, teachers should use language that is encouraging and inclusive.

Furthermore, the classroom should also be conducive to learning with furniture that is appropriate for all learners. The classroom set-up should be arranged in such a way that it enhances the participation of both boys and girls (Bakshi, 2016) and should include mixing boys and girls. Classroom interactions should also invite all learners, both boys and girls, to participate in the discussions. This calls for the teacher to respond and have good listening skills and recognise disruptions to teaching and learning such as bullying. Regarding the management of sexual maturation, teachers need to be sensitive and offer support and appropriate counselling to both boys and girls.

Moreover, teachers need to pay attention to assessments and feedback given during the lesson presentations. This involves formative assessment also known as assessment for learning (Sheehama, 2017). Formative assessment focuses on teachers' feedback given to learners based on the learners' learning (Andersson & Palm, 2017). Thus, in gender-responsive classes, the teachers must make time for sufficient feedback from both boys and girls and ensure that both boys and girls understand the lesson taught (Mlama et al., 2005). In addition, formative assessment is useful since it allows for interaction between the teacher and learners and helps identify the learning needs of the individual learners (Kahamba et al., 2017). This means treating all learners equally in the classroom by developing a variety of assessment mechanisms and putting them in the lesson plans.

Furthermore, being gender responsive it requires teachers to provide productive and progressive feedback to both boys and girls (Ananga 2021; Kahamba et al., 2018), giving equally thorough and positive feedback to both boys and girls (Ananga, 2021). Hence, through

assessment, the teacher should enhance classroom participation by ensuring that both boys and girls have answered the questions (Mlama et al., 2005). Kahamba et al. (2017) acknowledged that teachers using formative assessment methodologies and practices are well equipped to meet varied learners' needs through diversity and variation for teaching to advance levels of learners' achievements and accomplish a greater equity in terms of learners' outcomes. I now look at culturally responsive pedagogies and mediation of learning.

2.6 Teachers' Culturally Responsive Pedagogy and Mediation of Learning

Notably, not only do the teachers' teaching pedagogies influence learners' learning but their socio-cultural backgrounds also do so. That is, the teaching of science can be influenced by teachers' socio-cultural backgrounds (Mavuru & Ramnarain, 2020; Vygotsky, 1978). Cultural background refers to the set of knowledge, beliefs, and behaviour patterns shared by a social group that characterises them and therefore differentiates them from other groups (Toma et al., 2019). Teaching should consider learners' cultural backgrounds and this deals with culturally responsive pedagogy (Harrison & Skrebneva, 2020). However, only a few teachers are well equipped to link cultural differences to their pedagogies, ensuring that all learners have equal chances to learn and thrive (Bottiani et al., 2018); thus, science teachers often struggle with enacting culturally responsive pedagogies (Brown & Crippen, 2017).

Culturally responsive pedagogy (CRP) is similar to what is referred to as culturally responsive teaching (Gay, 2010) and culturally relevant teaching (Ladson-Billings, 1995). Even though these are two frameworks that originated from different philosophical orientations, they have common features, and thus they are used interchangeably (Mensah, 2021). Both frameworks are derived from cultural difference theory, which presumes that the cultural knowledge, practices, and beliefs of students that have been historically denied vary from the dominant culture of schools (Howard, 2010) and invite teachers to focus their attention on transforming the curriculum to include the cultural backgrounds and interests of all learners (Harrison & Skrebneva, 2020). Hence, in this study these concepts have been used interchangeably.

According to Ladson-Billings (1995, p. 469), culturally relevant teaching is defined as a "theoretical model that not only addresses student achievement but also helps students to accept and affirm their cultural identity while developing critical perspectives that challenge inequities

that schools (and other institutions) perpetuate". This scholar further added that this is an approach to teaching that embraces cultural orientations and recognises the significance of learners' socio-cultural backgrounds and experiences in all facets of learning. To Gay (2010, p. 36), culturally responsive teaching is regarded as "using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant to and effective for them". In other words, the focus is on connecting learners' cultures to learning to increase the academic achievement of these culturally diverse learners (Mensah, 2021). Mhakure and Otulaja (2017) opined that CRP is the positioned science learning that adopts and contextualises local culture and knowledge in African axiology. In other words, culturally responsive teachers can efficiently teach learners from all backgrounds and institute compassionate learning communities (Miller, 2020). That is, teachers must identify the cultural backgrounds of the learners in addition to the knowledge and skills that these learners need to learn in the classroom.

To Villegas and Lucas (2002, p. 20), the culturally responsive teachers:

> (a) are socio-culturally conscious, (b) have affirming views of students from diverse backgrounds, (c) see themselves as responsible for and capable of bringing about change to make schools more equitable, (d) understand how learners construct knowledge and are capable of promoting knowledge construction, (e) know about the lives of their students, and (f) design instruction that builds on what their students already know while stretching them beyond the familiar.

This suggests that culturally responsive teachers have certain approaches, philosophies, and practices that inform how they identify learners (Parker et al., 2017) and they are encouraged to select curriculum content sensibly keeping cultural responsiveness in mind (Miller, 2020). These culturally responsive school practices might be supportive since they uncover the experiences of the learners and can prompt the engagement and accomplishment of all learners (Vass, 2017). In other words, culturally responsive teachers distinguish the presence of culture, power, and privilege in society and the associated influences on learners' participation in learning in school (Parker et al., 2017). To achieve this, the teachers need to cultivate a suite of skills and knowledge that permit them to support their learners (Vass, 2017).

Samuels (2018) also asserted that CRP is beneficial as it can make a positive impact on classroom culture and nurture positive relationships that build solid trust between learners and teachers. In other words, including learners' culture in the curriculum, valuing their identities and their home cultures and adopting significant and appropriate educational models and instructional pedagogies have a positive influence on learners' academic achievement (Kayaalp, 2019). This scholar added that culture can be demonstrated in teachers' attitudes, anticipations, and behaviour concerning their learners' performance and skills. Put differently, in addition to offering content knowledge, culturally responsive teachers also offer wide-ranging and multidimensional education by resolutely developing learners' attitudes and values (Brown, 2017). This seems to resonate with the reformed Namibian NCBE (MoEAC, 2018), which proposes that effective teaching should embrace the learners' prior everyday knowledge (Kuhlane, 2011). Hence, scholars such as Mavuru and Ramnarain (2017) and Mhakure and Otulaja (2017) emphasised the importance of taking into consideration learners' socio-cultural backgrounds. This affords learners from different socio-cultural backgrounds equal opportunities to succeed at school (Mavuru & Ramnarain, 2020). Thus, Gay (2010) maintained that connecting teaching and learning to the experiences and resources from learners' cultural backgrounds they bring to school assists the learners to engage in learning, hence improving their academic performance.

Furthermore, Harrison and Skrebneva (2020) explained that culturally responsive teaching must account for cultural beliefs, experiences, values, and perceptions of culturally diverse learners as channels for teaching them more efficiently. Similarly, Samuels (2018) opined that cultural responsiveness is considered by teachers who are committed to cultural competence, institute great expectations, and place themselves as both facilitators and learners. Cultural responsiveness focuses on the teaching practices that address specific cultural characteristics that make learners differ from one another and from the teacher (Rychly & Graves, 2012).

Chikunda (2013) asserted that communicative events are shaped by cultural and historical factors. In this way, the ability to recognise cultural miscellany in class endows the teachers to tap into the varied social and cultural capital within the classroom to improve the learning experience (Fomunyam & Ferrera, 2017). In light of this, Koç and Köybaşi (2016) emphasised that teaching needs to be constructed in such a way that learners' differences are considered.

These scholars further added that the experiences that learners obtain from their culture constitute a substantial facet of individual differences and should be reflected in the teaching environment. In the same vein, Mensah (2021) accentuated that the nature of the learner-teacher relationship cannot be addressed without teachers getting to know the various personalities of their learners since learners are raced, classed, and gendered. In other words, teachers need to be responsible for learning about cultural and social issues, societal contexts, imbalances of power, and educational and social disparities and how they affect the academic achievements of learners (Kayaalp, 2019). That is, for teachers to be culturally responsive they need to understand learners' culture and their backgrounds and use such awareness of learners to develop learners' learning and cultural competence (Parker et al., 2017). In a nutshell, the principle of cultural responsiveness is that it affords learners from all cultures equity and access to education (Foxx et al., 2020).

The knowledge of learners' experiences, strengths, and needs permits the teacher to identify the specific learning needs of learners and make needed modifications to their teaching methods (Brown & Crippen, 2017). Thus, Adkins (2012) pointed out that CRP is made up of four dimensions: incorporating curriculum and instruction that is relevant to learners and meaningful to students and discovering societal disparities, prejudices, and traditions; identifying the learners' voices and experiences in all instructions to construct meaning and developing literacy skills for social change; facilitating classroom communities by encouraging collaboration among members; and using the diverse tool in providing feedback for formative and summative assessment. Consequently**,** teachers' culturally responsive pedagogies influence how they mediate science. It is for this reason that teachers struggle in the vernacular language (Probyn, 2009) to make science meaningful to learners. That is, the teacher uses the language that learners understand in order to explain the science concepts. Hence, teachers who endorse CRP instil and trust that learners of all racial, ethnic, and cultural backgrounds can succeed educationally (Mensah, 2021). Hereafter, teachers need to be culturally competent (Kayaalp, 2019).

In this regard, Griner and Stewart (2012) felt that teachers who adopt CRP can act as change agents in their schools to help bridge the divide and encourage a more equitable schooling experience. Consequently, this simplifies border crossing between the cultural practices of

normal schooling and those practised at home (Aikenhead, 2006). Concurring, Durden and Truscott (2013) explained that teachers are engaged in numerous levels of scrutinising classroom phenomena linked to the teaching and learning of culturally diverse learners. This is because a culturally responsive teacher always aims to achieve academic excellence and cultural competencies simultaneously (Brown & Crippen, 2017). Hence, these scholars further suggested that science teachers need to be supported in developing cultural responsiveness since it has a great influence on the learners' learning and academic performance. The cultural responsiveness of teachers leads them to be able to demonstrate cultural awareness of learners to respect and value the identity of learners (Perso, 2012). This suggests that CRP asserts, liberates, and empowers culturally diverse learners (Jett et al., 2016; Mhakure & Otulaja, 2017). Similarly, teachers work to build a bridge where learners' primary discourse (what they learn from their community) and learners' secondary discourse (what they learn in school) intersect (Moje et al., 2004).

However, Richard et al. (2007) believe that if teachers and learners in a school originate from a society that promulgates gender-biased social and cultural norms, teaching and learning processes in such schools are likely to feature the same elements of gender partiality. This is because some gender disparities are influenced by socio-cultural factors (Ceci et al., 2014). These socio-cultural factors include messages in mass media or the opinions of teachers or other peers (Miller et al., 2015). Thus, sometimes teachers might not be aware of the circumstances that are based on gender during their teaching (Abraha et al., 2019). Vanner (2019) further believes that schools that institutionalise gender discrimination through unequal opportunities are unlikely to enable the learners to engage in social change for equality and non-violence. In addition, teachers might have a narrow understanding of learners' cultures and experiences and hence might not be able to be culturally responsive (Samuels, 2018). It is against this caveat that in this study I explored how teachers' culturally responsive practices influence (or not) their teaching of acids and bases with their socio-cultural backgrounds. This was done through classroom observations to ascertain how much teachers are aware of their CRP and to find ways to expand their culturally responsive practices. I now look at IK and teaching. These go hand-in-hand with culturally responsive pedagogies.

2.7 Indigenous Knowledge and Science Teaching

Indigenous Knowledge (IK) and CRP both require learners to have access to local knowledge. Over the past few years, IK has come to the forefront and garnered attention particularly for underdeveloped and developing countries (Mikulecký & Punčochářová, 2022). Numerous literature sources advocate the integration of IK in teaching and learning of science (Erinosho 2013; Mavuru, 2022; Nyika, 2017; Shizha, 2013). Conferences have also been held on a range of matters concerning IK comprising epistemologies and practical queries associated with conversational practices and how IK is appreciated and used (Mkosi, 2005).

Since IK is a globally discussed concept, different definitions have emerged (William, 2018; Zidny et al., 2020). It is defined as a place-based knowledge, imbedded in local cultures, and mostly connected with long-settled communities which have strong links to their natural environment (Orlove et al., 2010). To Chikaire et al. (2012), IK refers to native knowledge that is exclusive to a specified culture and attained by local people through the development of understanding and informal and close experiences of the environment in a certain culture. Indigenous knowledge (IK) comprises cultural values, songs, beliefs, rituals, community laws, proverbs, local languages, agricultural practices, plants and animal species (Nyika, 2017). This scholar further elaborated that in contrast with western science (WS), which is learnt in classrooms and laboratories, IK is empirical. That is, it is learnt through experience and passed from one generation to the other orally or by action (Kibirige & Van Rooyen, 2006). Thus, the community uses this information to make decisions regarding agriculture, hunting, nutrition, health, food preparation and governance (Nyika, 2017).

From the work of various scholars, it is believed that the incorporation of IK in teaching and learning benefits learners (Cronje et al., 2015; Mavuru, 2022). The consideration of learners' cultural background in planning and teaching makes teaching more learner centred (Abah et al., 2015). That is, it embraces affordances for abstract development of learners in the classroom (Cronje et al., 2015). Put differently, IK forms the prior knowledge of the learners which provides the foundation to form and clarify new ideas (Nyika, 2017). This suggests that the integration of IK in the lessons may serve as the initial point in teaching science concepts (Simasiku et al., 2017). Similarly, for the child to learn with significant applied reference from their societies, science needs to be stretched in such a way that the subject matter content is

converted into wide-ranging forms that the learners can grasp and apply (Abah et al., 2015). That can revitalise African culture in order to produce assurance and reciprocated trust (Masuku, 2019). Thus Mikulecký and Punčochářová (2022) emphasised that it is crucial to connect learning with the cultural and historical uniqueness of learners and the local environment in which learning takes place. This leads to personal relevance of what these learners learn, and they acquire the ability to comprehend the resources used to teach them while they are at school (Nyika, 2017). In other words, IK localises science and can be contextualised within the learners' socio-cultural contexts (Mavuru & Ramnarain, 2017). Concurring and acknowledging Vygotsky's (1978) seminal work, Mavuru and Ramnarain (2017) accentuated the significance of considering learners' socio-cultural backgrounds during science lessons, believed to be helpful in contextualising and making science appropriate to learners' everyday lives.

For these reasons, proper integration of IK in the teaching and learning process means that the learners develop and understand concepts rather than memorise facts because the concepts are offered in relation to the local meaning (Abah et al., 2015). This means that learners are endowed with the opportunity to take part in the construction of knowledge since they are exposed to appropriate learning and knowledge creation (Nyika, 2017). Thus Aikenhead and Jegede (1999) and Kaino (2013) opined that artefacts that are available in the local environment are essential tools that can be used to bridge the gap between what is learnt in the classroom and what exists in the society.

For this to be realised, teachers need to understand the subject matter intensely and flexibly so that they can assist learners to create cognitive maps and address the misconceptions that the learners might encounter and the relationships between ideas (Shulman, 1987). Hence, by understanding IK, teachers might be able to be culturally responsive when mediating their lessons. The way the teachers mediate science through enactment of gender and cultural responsiveness is informed by their perspectives of and attitudes towards science.

However, as much as scholars advocate the inclusion of IK in the teaching and learning process, some scholars such as Horsthemke and Schafer (2007) criticised the integration of IK. These scholars warned that IK should not be perceived as the solution to teaching science as tensions

might ascend. To this, Cronje et al. (2015) and Ogunniyi (2007a) argued that some teachers were taught in western ways of knowing, hence, they might experience problems in integrating IK in their teaching. Similarly, Mhakure and Otulaja (2017) pointed out that IK might be misinterpreted if teachers do not have a comprehensive understanding of the relationship between IK and WS. They further maintained that the syllabus also does not stipulate clearly how to integrate IK in the classroom, and this can be a challenge to teachers. Thus, integrating IK in the classroom requires a thorough understanding of it and how to integrate it. I now shift my focus to teachers' perspectives of and attitudes towards science teaching.

2.8 Teachers' Perspectives of and Attitudes Towards Science Teaching

Perspectives are conceptions and dispositions of an individual. Conceptions are the views that learners hold on the subject and what they believe is required in learning and doing the subject (Agunbiade et al., 2017; Atallah et al., 2010). Teachers' conceptions refer to cognizant or unconscious beliefs, consideration, meaning, mental images, and predilections of teachers (Leatham, 2006). Teachers' conceptions are associated with their perceptions of experiencing teaching and it could be prompted by their epistemologies (Chen & Tsai, 2021). These are beliefs that teachers hold regarding the teaching and learning methods that they favour (Koç & Köybaşi, 2016). In other words, conceptions are lenses through which we observe and understand the world around us (Hsieh & Tsai, 2017). Consequently, teachers' cognisant and unconscious views about the subject, gender, and children impact their pedagogical practices (Gullberg et al., 2018). In the same way, teachers' conceptions have effects on their teaching practices (Savasci & Berlin, 2012) and it affects the way they approach their teaching which will affect learners' learning (Ross, 2017). Thus, Tavakoli and Baniasad-Azad (2017) asserted that there is a relationship between teachers' conceptions and their practices. Even though they are not visible, these conceptions have a tangible influence on teaching practices (Hsieh & Tsai, 2017).

Furthermore, teachers' conceptions and understanding of their subject area have a substantial influence on their teaching pedagogies, their educational decisions, and their approaches to the relevant curriculum (Li & Chen, 2018; Yilmaz, 2008). This means that conceptions are constructed upon individual opinions which are claims about traits of the perceived world that may or may not be true (Wilsey et al., 2020**)** and about teachers' assumptions, understanding,

and views about teaching and learning (Ross, 2017). Since gender issues are embedded in *culture* and *history*, in return, they influence teachers' perceptions, thinking, and practices (Chikunda, 2014).

The indicators of conceptions that were used in this study were adapted from Atallah et al. (2010). These indicators describe the teachers' ideas or thoughts about gender and culturally responsive practices, what they believe is required in a gender and culturally responsive classroom, what they believe is required to be done in a gender and culturally responsive classroom, what they think is the purpose of gender and culturally responsiveness when mediating chemistry topics, and what they believe indicates that they have learnt about gender and cultural responsiveness (how they know that they have learnt). I now shift to dispositions.

The definition of disposition has been used interchangeably with values, beliefs, and professional commitments and actions due to the absence of simplicity in the definition of the term in teacher education (Altan et al., 2019). It is defined as a recurrent and voluntary habit of thought and action (Agunbiade et al., 2017). Attitude is defined as a concept that embodies the emotional orientation of a person to respond favourably or unfavourably to things, people, events, or ideas. Similarly, attitudes are also viewed as a complex combination of personality, beliefs, behaviour, and motivations (Ambusaidi & Al-Farei, 2017). Both disposition and attitudes could be echoed in someone's performance (Altan & Lane, 2018), thus, dispositions and attitudes are used interchangeably in this study. Dispositions and attitudes together with environmental aspects such as professional support also influence teachers' professional practices and learners' learning outcomes (Häkkinen et al., 2019).

According to Atallah et al. (2010), dispositions are views and trends that exhibit frequent, conscious, and voluntary behaviour directed towards the learning of a subject. In other words, dispositions deal with personality traits, values, attitudes, and beliefs (Stephens, 2019). To Sutrisno (2020), dispositions are characteristics that bring a person to a particular experience and to make individual choices. The Council for the Accreditation of Educator Preparation (CAEP, 2013) defines dispositions as the values, commitment, and professional ethics that influence behaviours towards learners, families, colleagues, and communities that affect learners' learning, motivation, and development as well as the teachers' professional growth.

Thus, teachers' dispositions are regarded as habits of mind and are mirrored in their teaching practices (Altan & Lane, 2018), and these dispositions are reckoned as key to effective teaching (Jensen et al., 2018). That is to say, teachers' dispositions influence their actions and reflections (Bialka, 2017). In other words, dispositions offer information concerning one's personality, code of ethics, particular qualities, and ultimately one's practice (Stephens, 2019). Mpofu and Nthontho (2017) defined dispositions as the characteristics and individual abilities that affect how people act and interrelate with others. Arguably, equality in classrooms is deep-rooted in teachers' attitudes, skills, and beliefs in teaching boys and girls with diverse languages, cultures, experiences, and readiness to learn (Heijnen-Maathuis, 2008). That is, dispositions are revealed in manners and actions that teachers voluntarily perform in the implementation of their duties (Mpofu & Nthontho, 2017).

Furthermore, Christidou (2011) noted that teachers and their teaching practices are fundamental aspects considered to negatively affect learners' attitudes towards the science discipline. In other words, teachers' knowledge of the child will in turn affect the child's learning (Gullberg et al., 2018). For instance, teachers' classroom behaviour and attitudes are factors that affect learners' attitudes and views of themselves (MoEAC, 2018). For this, the NCBE (MoEAC, 2018) emphasises that teachers need to portray a positive role when it comes to their behaviour and should be aware of how much attention they need to pay to girls and boys alike when teaching. For that reason, teachers' unequal insights and anticipations about science learning by girls and boys can transform into a gap in actual attainment.

The indicators for dispositions that are used in this study were adapted from Atallah et al. (2010). These indicators describe teachers' ability in being gender responsive when mediating chemistry topics, the expectations about being gender responsive in their teaching, and the evidence that they would provide to others as 'proof' that they have learnt how to conduct science lessons that are gender and culturally responsive (see Appendix E). Consequently, in this study, these indicators for dispositions were used to determine how teachers view gender-responsive practices and how their dispositions play a role when mediating chemistry topics. Mpofu and Nthontho (2017) explained teachers' disposition as indicated in Figure 2.1.

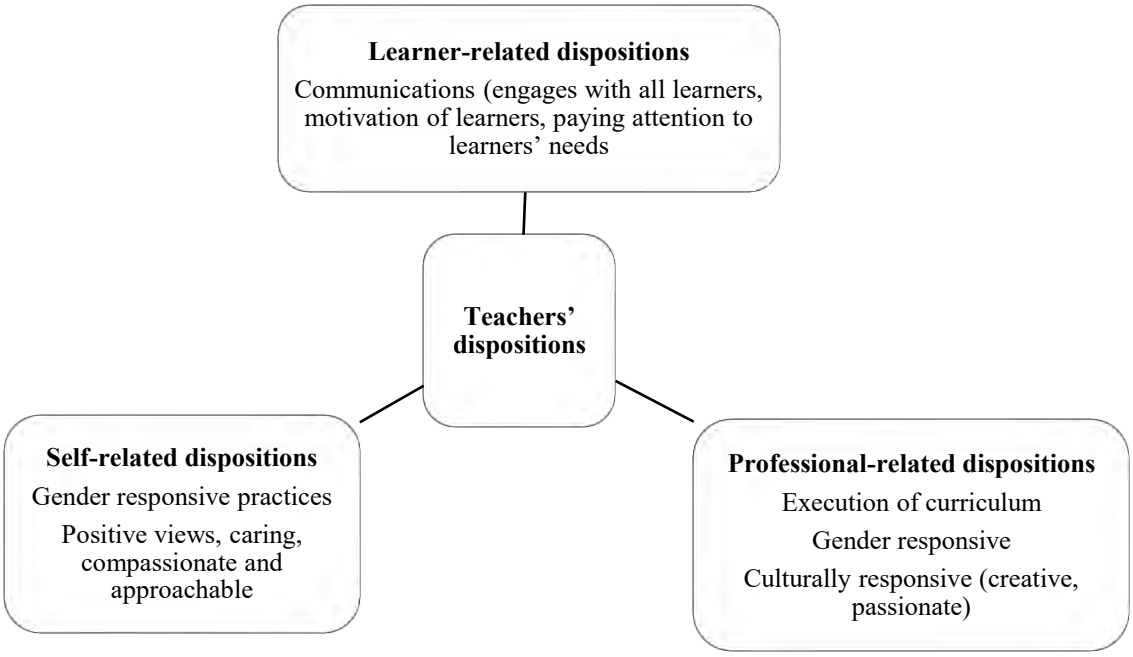


Figure 2.1: Teaching dispositions (adapted from Mpofu & Nthontho, 2017, p. 10300)

Self-related teaching dispositions require the teachers to possess a good sense of self-worth which guides their actions when they interact with others (Mpofu & Nthontho, 2017). That is, these procedures allow them opportunities to design improved operative approaches to elucidate the nature of ideas and to study their relationships with others (Jensen et al., 2018). These qualities include being caring, reflective, emphatic, and open (Mpofu & Nthontho, 2017). In other words, teachers are empathic when they can identify their privileges, reflect on social inequalities, and appreciate cultural differences among their students (Jensen et al., 2018). It is crucial to ascertain that the classroom is directed by individuals who are both considerate and passionate in addition to being proficient (Stephens, 2019). Hence, by employing a reflective process, teachers can develop a greater level of self-awareness about the nature and impact of their performances (Bialka, 2019). Thus, Altan et al. (2019) emphasised that dispositions are assembled around habits of mind and are related directly to educational learning about introspection and to learning theories that support learning and mindfulness.

Learner-related teaching dispositions comprehend all the comportments that encourage the learners to learn successfully (Mpofu & Nthontho, 2017). These include the teachers' abilities to recognise the classroom from the learners' standpoints (Rychly & Graves, 2012). Hence, this determines the quality of learning that takes place in the classroom (Mpofu & Nthontho, 2017). This is to say that dispositions also focus on meeting the needs of the learners. Thus, the communication and commitment of the teachers in the classroom determine how the teachers provide opportunities for the learners to engage in the subject content knowledge. In addition, the learners interact with others and the teachers invest time in the growth of their learners hence developing their ZPD as espoused by Vygotsky (1978). In other words, this includes how the teacher pays attention to the learners' learning needs by being gender responsive (Mlama et al., 2005) and culturally responsive (Gay, 2018). These are important aspects of learners' learning experiences (Altan & Lane, 2018). Stephens (2019) suggested that teachers must genuinely care for their learners and be devoted to ensuring that high expectations are established for every child.

Professional-related teaching dispositions involve teachers who are professionally oriented and inquisitive about others, particularly those who impact their work (Mpofu & Nthontho, 2017). This requires the teachers to appreciate the community context within which they work and design fair and high-quality instruction that allows them to learn from their learners and their families (Jensen et al., 2018). This means that the dispositions reflected by teachers should include professional obligations and positive relationships with all stakeholders (Johnston et al., 2018). Relationships between stakeholders can be referred to as negotiation dispositions that are a principal component of collaboration in which individuals need to discuss, take others' viewpoints into account and modify their actions according to the associated group (Häkkinen et al., 2019). In other words, teachers should be eager to question their cultural practices to comprehend their learners' worldviews (Mpofu & Nthontho, 2017). Thus, in cultivating this disposition it is important for teachers to construct an understanding of their teaching practices and to recognise that one's dispositions are also affected by their life experiences before entering the classroom (Stephens, 2019).

Dispositions are manifested within the classroom, and they impact pedagogy and the learning process (Thornton, 2006). This includes assessments such as learners' competencies and their

success, and instruction which is concerned with the use of learners' everyday lives as emphasised by this scholar. From the above discussion, the importance of PLCs and teachers' PCK can be noted. I now look at PLCs and PCK in terms of gender and culturally responsive practices.

2.9 Teachers' Professional Learning Communities and Pedagogical Content Knowledge

To Ngcoza and Southwood (2019) effective curriculum restructurings necessitate a comprehensive standard modification in terms of teachers' knowledge, dispositions, skills, and beliefs. This infers that continuing professional development should not be conducted once. It should be conducted in such a way that it is supportive and empowers teachers to collaborate and engage in being reflective to explore and find ways to solve problems that they encounter in their teaching practices, thus forming PLC. According to Admiraal et al. (2021), in PLC people constantly magnify their capability to generate results that they justly aspiration and innovative extensive patterns of thoughts are developed, hence they learn together. The PLC aims to advance teachers' professionalism and well-being that produce progressive impacts on the learners' learning (Antinluoma et al., 2018). This means that teachers are allowed to find the solution to their teaching practices. In other words, in PLC teachers are provided with an environment that encourages professional development, collaboration and innovation (Brown et al., 2018). In the context of this study, the teachers collaborate in exploring gender and culturally responsive practices when mediating the learning of science. This resonates well with what Virkunnen and Newnman (2013) suggested.

Put differently, PLC is not only intended to decide what learners will study but also to provide an opportunity for teachers to have an understanding of how to counter when learners do not learn (Hoaglund et al., 2014). Thus, this calls for the teachers to have PCK in delivering the lessons. According to Shulman (1987), PCK is all about the knowledge that teachers gained over time through experience on how to teach the content in such a way that it enhances learning. That means teachers have to be creative in selecting how they can teach the content, transform it and simplify it so that it makes it easier for the learners to understand it. That includes pedagogical knowledge on how to deal with learners from diverse cultural backgrounds and accommodate these learners in the teaching and learning process. This is

because being in PLC enhances PCK as it supports comprehensible intangible learning for both teachers and learners (Gess-Newsome et al., 2019). Hence, PCK represents the unification of content and instruction into a thought of how certain matters are structured and modified to the varied interest and capabilities of the learners and presented for instruction (Shulman, 1987).

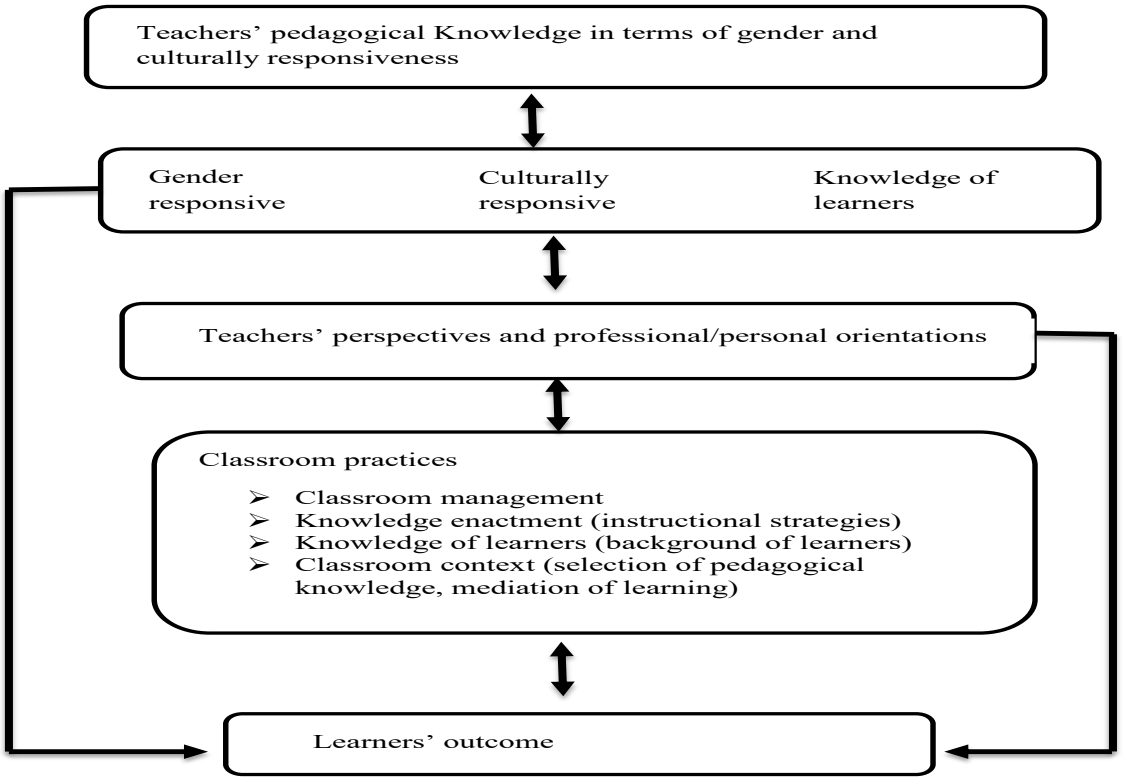


Figure 2.2: Teachers' pedagogical knowledge model (Adapted from Gess-Newsome et al., 2019, p. 19)

Figure 2.2 above shows how the teachers' pedagogical knowledge influences the learners' outcomes. Teachers have to be gender responsive when they are selecting the content that they are teaching as well as they have to take an all-encompassing gender approach in the process of lesson planning and classroom management as well as assessment of the teaching and learning process (Satiya, 2021). The teachers have to be culturally responsive as well and have a good knowledge of their learners. Thus, all these influence teachers' perspectives and orientations, both professional and personal. Hence, PCK is essential for thinking about teachers' professional knowledge and practices, including a consideration of what way and why teachers support learners to learn, for instance, science (Kind & Chan, 2019). In other words,

teachers' perspectives and orientations determine what is happening in the classroom. This includes classroom management, enactment of knowledge (whether it is gender or culturally responsive), knowledge of learners (learners' background) and classroom context (selection of pedagogical knowledge and how to mediate the learning in that classroom). I now turn my attention to the nature of professional development in Namibia.

2.10 Inquiries of Professional Development Programmes in Namibia

In the Namibian context, even though the government has formulated policies to guide teachers on how to address gender-responsive practices, tensions still exist. This is similar to the study carried out by Chikunda **(**2014). For instance, teachers could acknowledge the imbalance in science teaching, but they could not articulate the causes of it. This shows that teachers might not possess the required tools to deeply analyse the causes of gender disparities in their science classrooms. In addition, one of the obstacles is that teachers lack the gender skills necessary for instruction, hence, teachers' gender responsiveness can be strengthened if teachers receive teaching skills that are gender responsive (Mlama et al., 2005). As alluded to earlier, Chikunda further pointed out that gender issues are embedded in *culture* and *history*. Thus, teachers' gender and culturally responsive practices when teaching, for example, acids and bases, can only be understood against their cultural-historical daily practices (Engeström, 2001).

Resultantly, these invariably influence one's perceptions and practices. Also, it seems teachers are not receiving enough skills training from their teacher education on how to engage with social issues such as gender responsiveness in their practices (Chikunda, 2014). Consequently, there is a gap between policy, theory, and practice (Chikunda, 2012; Griner & Stewart, 2012). Even if the policies are put in place, it is in vain if teachers lack the tools and skills on how to handle gender issues. This is what is happening in the Namibian context, as there are no professional development programmes on how teachers might be gender responsive in their science classrooms which creates tensions between curriculum formulation and curriculum implementation. Heijnen-Maathuis (2008) recommended that teachers need to be trained and supported to understand the issue of social and gender discrimination. In this regard, Mhewa et al. (2021) pointed out that even though the ministry has pronounced that teachers need to be gender responsive, the teachers might not know how to be gender responsive. It is against this caveat that this study sought to explore and expand gender-responsive practices by developing

mediation tools that could support and expand teachers' gender-responsive practices when mediating chemistry topics using acids and bases and combustion reactions as examples.

2.11 The Gap in the Literature

What I found missing in the literature above is the focus on how the teachers can be empowered in being gender and culturally responsive. Many studies focus on *what is expected* from teachers in being gender and culturally responsive (Abraha et al., 2020; Götzmann & Bainton, 2021; Kahamba et al., 2017). Most of this literature focused on how being gender and culturally responsive is beneficial to teaching and learning, but I did not come across a study that focuses on *how* to engage the teachers for them to successfully enact gender and cultural responsiveness in their science lessons. Even though the studies highlighted how being gender and culturally responsive might help the learner in being involved in the lessons, little is done on how to help these teachers. Thus, continuing professional development (CPD) on how to be gender and culturally responsive is not featured in the teachers' CPD but rather focuses on the interpretation of the syllabus. Hence, the need for this study which might close the gap in terms of empowering and transforming teachers' practices and also helped in interpreting educational policies. Thus, this study sought to bring the teachers together to expand their gender and cultural responsiveness when mediating their science lessons.

2.12 Chapter Summary

This chapter focused on reviewing literature that sought to explore the pertinent issues of this study. The chapter discussed the teaching of chemistry topics, mainly focusing on the concepts of acids and bases as well as combustion reactions. It emphasised the competencies that learners need to master as is prescribed in the Physical Science syllabus. Furthermore, the chapter discussed the teaching of science and the gender issues associated with it, for instance, gender stereotypes and socialisations that learners have from home. Thus, this chapter emphasised the need for teachers to be gender responsive and eliminate any gender disparities to provide equitable quality education for all learners regardless of their gender. The chapter also explored the teachers' gender responsive pedagogy, looking at what constitutes gender responsiveness and what is expected from the teachers in being gender responsive. This focused

on gender responsiveness concerning lesson planning, teaching and learning materials, classroom set-up, language usage as well as assessment and feedback.

The chapter also looked at IK systems and how they play a role in the teaching and learning process. The ability of the teachers to recognise IK in their teaching enables them to provide CRP when mediating the learning of science. It accentuated focusing on learners' cultural backgrounds and experiences, intending to make science relevant to learners. For this to be achieved, teachers need to be gender responsive as well as being culturally responsive. The chapter also looked at teachers' perspectives which are conceptions and dispositions. The literature has pointed out that these concepts influence teachers' pedagogies. Additionally, the chapter also discussed how PLC and PCK play a role in the teaching and learning process. Lastly, the chapter looked at the nature of professional development in Namibia, regarding what is experienced by a science teacher in terms of being gender and culturally responsive as well as with regard to their personal experience. I now look at the theoretical and analytical framework of this study.

CHAPTER THREE: THEORETICAL FRAMEWORKS

> As teachers think about implementing culturally relevant or culturally responsive teaching in their instruction and curriculum, there is no "one-size-fits- all" way of doing so. Therefore, the creativity in developing science curriculum, while paying attention to the knowledge and identities of your students makes teaching in these ways creative and engaging for teachers and students. (Mensah, 2021, p. 13)

3.1 Introduction

Theoretical frameworks are theories, beliefs and prior research findings that guide or inform the research and what literature and preliminary studies the researcher will draw on for understanding the people or issues. In this study, Vygotsky's (1978) SCT was used as a theoretical framework. I augmented this theory with Engeström's (2001) CHAT as an analytical framework. I now discuss these below starting with the SCT.

3.2 Socio-cultural Theory

Socio-cultural theory (SCT) elucidates how individual mental functioning is related to its cultural, historical, and institutional context (Scott & Palincsar, 2013; Shabani, 2016). It is informed by the notion that learning is a product of social interactions involving adults and peers (Vygotsky, 1978). Vygotsky further emphasised that human activities take place in a cultural context and are mediated by language and other symbols. Lantolf et al. (2015) opine that through socio-cultural interactions humans are understood to employ existing artefacts and generate new cultural artefacts to permit them to adjust and monitor and control their behaviour. That is, it attends to the broader social system in which learning is taking place and it draws on the interpretations of individual thinking and development based on their participation in culturally organised activities (Stott, 2016). This is because socio-cultural factors provide one of the explanations for different gender views, thereby influencing learners' choices (Gullberg et al., 2017). Within Vygotsky's SCT I will use the following tenets: *mediation of learning,*

culture and language, *social interaction,* and the *ZPD*. I now discuss each tenet and how it was applicable to this study.

3.2.1 Mediation of learning

Mediation of learning refers to the use of cultural tools to achieve goals and make learning meaningful (Vygotsky, 1978). It comprises the support of a more capable person and the verbal collaborations that transpire among the participants in the group (Eun, 2019). To Ramasike (2016), mediation of learning is a technique or skill used to answer how knowledge is attained in the learning process. In this regard, Vygotsky argues that humans can use symbols as tools to mediate their physical activities. He further explains that mediation can be used as a tool for cognitive change. Shabani (2016) asserts that the relationships between humans and the world are not direct, but are mediated by physical and symbolic tools. Ramasike (2016) supports the incorporation of mediational tools in mediating science. She further points out that the involvement of teachers in professional development can alert them to the importance of utilising mediational tools to enrich learning.

Through mediation, a teacher can teach challenging concepts to the learners. Similarly, for teachers to mediate the learning effectively, they need to understand learners' cultural backgrounds. Hence, Morales (2021) points out that mediation occurs through three processes: through cultural artefacts and activities, scientific concepts and through interactions. Thus, in this study, I observed how teachers mediated learning while responding to gender and cultural issues in their science classrooms.

3.2.2 Culture and language

The mediation of learning might be influenced by culture and language. Thus, culture is an important social factor not to be ignored in the analysis of gender relations (Chikunda & Chikunda, 2015). It plays a vital role in influencing and shaping development (Vygotsky, 1978). Knowledge and experiences are constructed and developed in societal contexts (Gupta, 2006; Vygotsky, 1978). That is, personal development is influenced by the culture and social environment where that individual belongs (Silalahi, 2019; Vygotsky, 1978). Hence, teachers need to recognise the important influence culture has on learning and make teaching processes compatible with the socio-cultural context (Harrison & Skrebneva, 2020). In other words,

teachers must know how culture operates in the classroom dynamics and build a learning atmosphere that radiates cultural and ethnic miscellany and ease the academic accomplishment of all learners (Gay, 2018). Explicitly, knowledge about cultural variation is imperative to meeting the educational prerequisites of culturally diverse students (Harrison & Skrebneva, 2020; Mhakure & Otulaja, 2017). In similar vein, Gullberg et al. (2017) suggest that, for teachers to provide equal access to learning of science to learners, they need to have an understanding of how gender operates in society's different structural levels, that is, how science is viewed culturally regarding boys and girls. Thus, opportunities must be provided for all learners from diverse ethnic backgrounds as this allows them to express themselves freely so that their voices and experiences can be amalgamated into the teaching aid learning process regularly (Gay, 2018).

Similarly, culture comprises many aspects that teachers need to be aware of including the implications of gender role socialisation in different ethnic groups; this enables teachers to implement equitable practices in classroom instructions (Harrison & Skrebneva, 2020; Makhure & Otulaja, 2017). Teachers should, therefore, understand the role of culture and uphold collective approaches to learning among learners and communities to utilise students' distinctive cultural backgrounds as a foundation for learning (Jett et al., 2016). Moreover, societies need to change and bring about social justice for those who have been disadvantaged based on gender and socio-economic background among other factors and it is education that plays a crucial role in ensuring those changes (Heijnen-Maathuis, 2008). Thus, in the context of science, culturally responsive teaching involves connecting learners' home experiences to the curriculum, embedding real-world problems in the curriculum, and using examples that are connected to learners' experiences (Mensah, 2021). For instance, the teachers need to give examples of how gender is viewed in the learners' communities and raise awareness of how to remove any gender stereotypes that are experienced by these learners in their community. In this regard Mavuru and Ramnarain (2017) assert that teachers should be sensitive to learners' culture and their everyday lives in their teaching to strengthen both learning and development opportunities in their classrooms. It is for this reason that Erinosho (2013) suggests that meaningful learning is culture-bound and is advanced through social encounters.

Teachers should also be aware that being culturally responsive is not a one-size-fits-all mentality as explained in the epigraph above. In fact, teachers should be creative and develop the science curriculum while paying attention to the individual needs of the learners, considering their knowledge and identity, and making teaching creative and engaging to both the teacher and learners (Mensah, 2021) through social interactions (Vygotsky, 1978). The exchange of thoughts through language between people in a social setting hints at active participation and that leads to social interactions. In this way, these dialogues associated with socio-cultural consciousness and diversity awareness are embraced (Samuels, 2018). The language that is used during those dialogues and the mediation process plays a role in how learners might achieve the learning objectives. This is because the language used might strengthen the gender differences and inequalities as it might reflect male dominance and relegate females to sub-standard positions (Kahamba et al., 2017). In my view, the language used should be a substantial means of providing communication within society and not reinforce inequality.

In this study I looked at how teachers used the cultural background of the learners in the teaching and learning process. An awareness of cultural background allows teachers to use the local IK of learners. With this notion, IK is viewed as the cultural knowledge used to respond to cultural needs of the community to understand and solve problems (Mukwambo, 2012). In other words, this can be achieved by using the cultural resources as teaching and learning aids. Hence, I observed what cultural artefacts the teachers or learners brought to the classroom to mediate the learning of science. Moreover, the language used in mediation of learning was also observed. This was to investigate how teachers addressed learners of different genders and the language that they used in teaching and learning.

3.2.3 Social interaction

Vygotsky (1978) viewed learning as a process that is socially mediated and social activity as a focal point for cognitive development. Daneshfar, and Moharami (2018) and John-Steiner and Mahn (1996) express similar views explaining that the development of an individual relies on the transmitted experiences of others. This means that learning does not take place in isolation and which resonates with McRobbie and Tobin's (1997) notion of social and individual planes, according to which knowledge is first attained through the inter-psychological plane (the

interactions with people and the immediate environment) and then later through the intra-psychological plane (assimilation and internalising of the knowledge which is learnt) for personal value (McRobbie & Tobin, 1997; Stott, 2016; Vygotsky, 1978). Notably, interactions with others support mental functioning and processes from the social to the individual level (Scott & Palincsar, 2013; Vygotsky, 1981).

Thus, socio-cultural theorists maintain that social interactions are mediated through the use of cultural tools, symbols and artefacts, of which language is the key tool (Mutanho, 2021). Keeping this in mind, Vygotsky (1978) articulated that, just as humans need tools to act upon their physical environment, they also require cultural tools and artefacts to mediate their understanding of the world. Hence this might be achieved through social interactions. People learn as they co-operate with others to develop activities related to the shared practices of their communities (Morales, 2021). In the context of this study, through group discussions and reflections, teachers might internalise the learnt knowledge (Eun, 2008) on how to be gender and culturally responsive. Similarly, Stott (2016) argues that cognitive development is the product of alliances in the construction of knowledge. That is, meaningful learning takes place when people learn through social interactions and with materials from their socio-cultural backgrounds (Mavhunga & Kibirige, 2018; Mavuru & Ramnarain, 2020). Moreover, knowledge is built on experiences which are culturally shaped (Fomunyam & Ferrera, 2017), and thus teachers' ability to recognise this allows them to give learning opportunities to everyone in the classroom, hence allowing for equality and equity.

However, Shabani (2016) points out that development cannot be attained if social interaction and collaboration are stopped before internalisation occurs. This scholar further believes that social interactions must be framed through the activity where the purpose is clearly defined for it to lead to development. Thus, through social interactions, the ZPD might be developed. Hence, Panhwar et al. (2016) opined that learning depends equally on both outside socio-cultural factors and internal stimuli. In the context of my study, the classroom is the social unit where teachers and learners interact, and gender-responsive practices might (or might not) be enacted through this interaction. This also includes how teachers were mediating the learning of acids and bases. Additionally, during group discussions and reflections teachers were interacting and thus through these social interactions, the ZPD might be developed.

3.2.4 Zone of proximal development

The significant aspect to consider when defining the ZPD is how individuals are related within the group and the social context (Eun, 2019). According to Vygotsky (1978), the ZPD is the difference between what the child can do on their own and what the child can do with the help of a knowledgeable person. He further extended his explanation by asserting that what a child can do in collaboration with others today they can carry out tomorrow on their own. To Stott (2016), the actual development zone is the skills that a learner possesses which can be used to tackle a particular problem without assistance. She further adds that a potential zone is that which can be developed through assistance from knowledgeable others or peers.

While Vygotsky's theory was designed to understand how children learn, the participants in this study were adults. Therefore, this study involved reconceptualising the science teaching activities through exploring and expanding new ways of mediating science in a gender culturally responsive way. Shabani (2016) opined that through collaborative engagement and discussions the group members (in this case the teachers) could provide shared support for each other to remedy their instructional problems. Hence, in this study, the potential zone of teachers might be developed through group discussions and reflections. On the other hand, while Vygotsky (1978) emphasised the MKO, in this study where none of us was an expert in the field of gender responsiveness, no one took up the position of the MKO. Instead, this position was interchangeable between the participants and me (the researcher) in sharing the ideas and knowledge of how the teachers could be gender and culturally responsive when mediating the learning of science, particularly chemistry topics. Thus, may have helped to create an emancipatory environment for all of us as we are all co-learners. As a result, this might lead to teacher agency. According to Calvert (2016), teacher agency entails the capacity of the teachers to act tenaciously and productively to direct their professional growth as well as contribute to the growth of their colleagues. Hence this active knowledge construction introduces new knowledge in a significant way, aiding teachers to be profoundly cognisant of new insights (Esteve, 2020). In this study, the potential zone of teachers was developed through group discussions and reflections during the CLWs.

Similarly, the ZPD is the foundation of mediation in the learning context which defines the shift of learners (teachers in this study) from the actual level to the potential level. Daneshfar

and Moharami (2018) and Eun (2019) opine that the ZPD emphasises the process of social revolution as individuals engage in collective efforts to create new forms of social practices. Subsequently, a mediational tool was developed through these discussions. Learning can take many pathways, thus for teachers to have opportunities to learn they need to be provided with professional development that will lead to teachers' and learners' growth (Skaggs, 2020). Consequently, Vygotsky (1978) suggested that people who are working collaboratively increase their ZPDs compared to those working individually. Moreover, Daneshfar and Moharami (2018) argue that the ZPD is about individual growth, which is offered through mediation.

It was hoped that SCT might help me to understand the cultural contexts of the teachers which might influence their gender and culturally responsive practices when mediating the learning of acids and bases. This includes teachers, how their socio-cultural background influenced their teaching as well as how the teachers were taking into account the influence that culture had on the learners, such as gender stereotypes that learners might have acquired from their communities. Socio-cultural theory (SCT) also helped me to engage the teachers in the activities so that their ZPDs could be developed through gender and culturally responsive practices and being able to address the gender and cultural issues in their science classrooms. Thus, in this regard Ebadi and Gheisari (2016) suggested a solution to the problem of incongruence between curriculum formulation and curriculum implementation of science teachers, and the tenets of Vygotsky's SCT; for instance, mediation and the ZPD were viewed as helpful. Socio-cultural lenses were used in this study in conjunction with the CHAT to understand how this formative intervention transformed the gender and culturally responsive practices of Grade 9 teachers when mediating the learning of chemistry. Now I shift my attention to CHAT as an analytical framework.

3.3 Cultural-historical Activity Theory

Cultural-historical activity theory (CHAT) originated from the work of the Russian scholar Lev Vygotsky in the 1920s who described the relationship between individuals and their social environment (Engeström, 2001; Yamagata-Lynch, 2010). According to Engeström and Sannino (2021), CHAT progressed through four generations of research. The first generation draws on Vygotsky's work in the 1920s and 1930s, focusing on individual activity. Vygotsky explained

learning as a mediated action through social interactions mediated through the use of artefacts (Yamagata-Lynch, 2010). The second generation is an expansion of Vygotsky's work by Leont'ev (1978/1981). He focused on the collective activity as the unit of analysis where the rules, community, and division of labour components were added to the socio-historical aspects of mediation that were omitted by Vygotsky (Yamagata-Lynch, 2010). The significance of second-generation CHAT was that it brought together the interrelations between the components of the activity system. Thus, this played an important role in this study as it identified the primary contradictions within the activity system. The third generation focuses on multiple activity systems (Engeström, 1999). The fourth generation is a heterogeneous theory that is aimed at resolving wicked societal problems (Engeström & Sannino, 2021).

CHAT is a multi-disciplinary research framework that has become popular in recent years (Gedera & Williams, 2016). Figure 3.1 below shows the activity system model with its components and how they relate to one another.

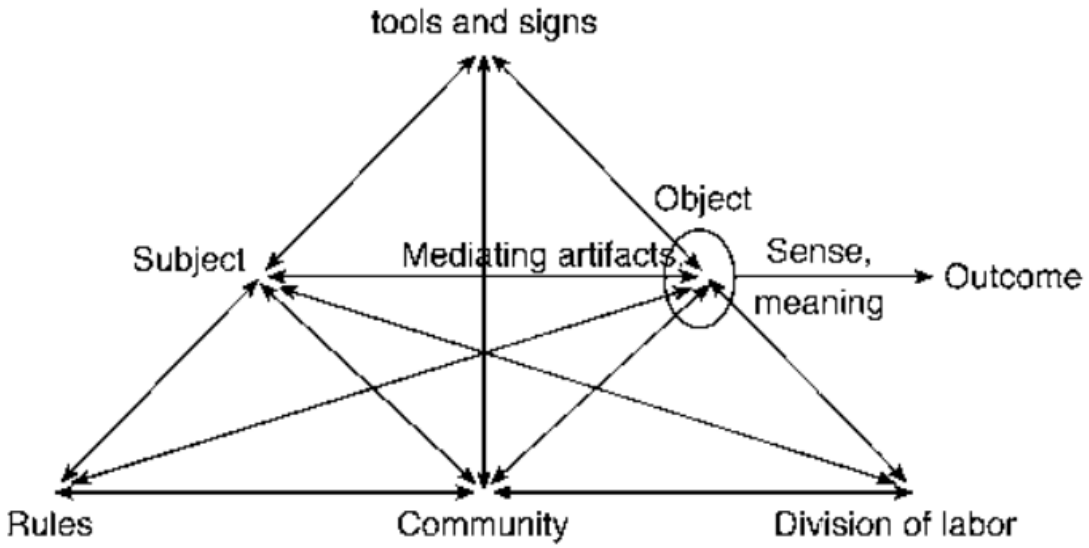


Figure 3.1: The structure of human activity (Adopted from Engeström, 2001, p. 135)

According to Engeström (2001), the activity system is defined as an object-oriented, artefact-mediated, multi-layered and multi-voiced system that is influenced by contextual and historical factors. He further explains that a human activity comprises complex interrelating factors and

those include the subjects, the mediating tools, the rules, the object, the community, and the division of labour. These factors make up the basic elements of an activity system.

A subject is an individual or subgroup whose position and points of view are selected as the viewpoint of the exploration and analysis (Engeström & Sannino, 2010; Sannino & Engeström, 2018). In my study, the subject consisted of Grade 9 Physical Science teachers. The object is the focal entity and/or the desired outcome (Foot, 2014). It is what the activity is focused on (Sannino & Engeström, 2018). It is the 'primal matter' or trouble on which the activity is focused (Engeström & Sannino, 2010). In this study, the object was the gender and culturally responsive practices of Grade 9 Physical Science teachers when mediating the chemistry topics using acids and bases and combustion reactions as examples (see section 2.2). Tools included social others and artefacts that acted as psychological or technical tools (Amory & Hardman, 2014; Yamagata-Lynch, 2010). In this study, the tools were language, teaching methods, and teaching materials (easily accessible resources) that were used by the teacher in delivering the science lessons (Asheela et al., 2021). Rules are any formal or informal regulations that can constrain or liberate the activity; they guide the subject on what are the correct procedures (Yamagata-Lynch, 2010).

The rules mediate the interaction between the subject and the community and between the subject and the object (Engeström, 2016; Engeström & Sannino, 2010; Sannino et al., 2016). In my study, the rules that guided the subject were the Physical Science subject policy, the curriculum for the Namibian education system, and the Physical Science syllabus. All these documents provide guidelines on how teachers should address gender issues in their classrooms. Additionally, rules can be cultural rules (patriarchy, gender biases, gender roles, and gender stereotypes) that teachers and learners experience in their communities. All these might constrain both teachers and learners during the teaching and learning process. The community involves individuals and subgroups who share a similar general object (Engeström & Sannino, 2010).

In my study, the community consisted of learners who were taught by the teachers, teachers, and me (we all shared the same object which was being gender and culturally responsive). Critical friends were also part of the community by providing the stimulus for the CLWs during

phase two of the study. In the activity system, the division of labour refers to how tasks are shared among the community (Yamagata-Lynch, 2010). In this study, I looked at how teachers assigned roles to the learners during the lesson presentations. Similarly, the study also looked at the division of labour for the teachers during the presentation of exemplar lessons. For instance, while one teacher was teaching, the other teachers played the role of distributing the materials that were used during hands-on activities. These elements were materials and social resources that had the potential to enable and/or constrain human action in the activity system (Sewell, 1992).

Teachers and learners were the members of the community that constituted the primary activity system. Applying second-generation CHAT enabled me to critically look at each element of the primary activity system concerning gender and cultural responsiveness in the science classroom. Gender and cultural issues are contextually rooted in culture and history and these then influence perspectives, thoughts and practices. Thus, Engeström (2001, p. 134) explains that "individuals could no longer be understood without his or her cultural means and the society could no longer be understood without the agency of individuals who use and produce artifacts". To understand the primary activity system (home, cultural background), I posed questions to each element of the activity system to understand the underlying mechanism of gender and culturally responsiveness. Figure 3.2 shows the application of primary activity system to the education system.

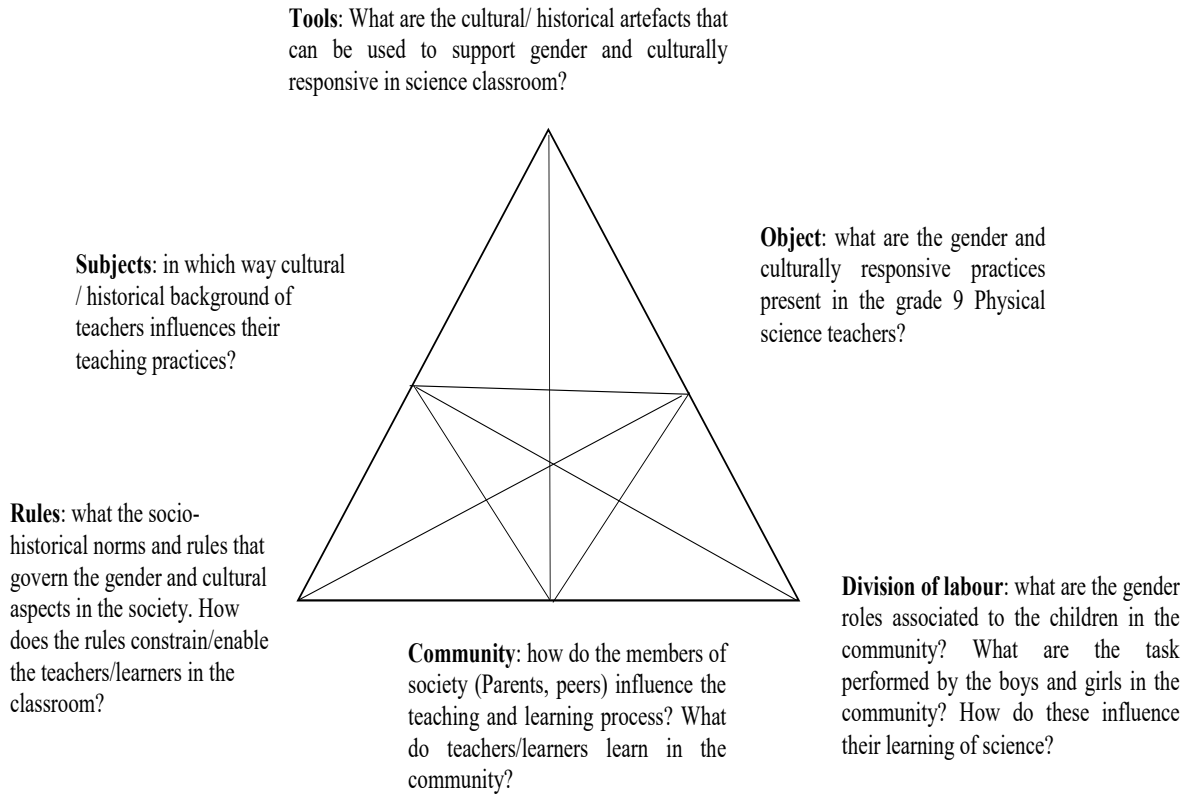


Figure 3.2: The application of primary activity system to education system (Adapted from Chikunda, p. 140)

The school can also serve as the secondary activity system in which learning takes place. Mukute and Lotz-Sisitka (2012) point out that learning takes place through shared activities that are tenaciously conducted around the common object based on the idea that learning is a social and cultural process that is based on historical achievements. Similarly, Batiibwe (2019) emphasises that the environmental surroundings and prior experiences influence the enactment of unconscious actions of the subject. In other words, teachers' actions are the product of their everyday experiences from their society. That is because society builds the teachers in the people they become. Thus, their culture influences and affects how they do acts in the classroom. Similarly, viewing the school as a secondary institution, learners may display attributes they had at home. Figure 3.3 shows the elements of the secondary activity system (school) how they are applicable to this study.

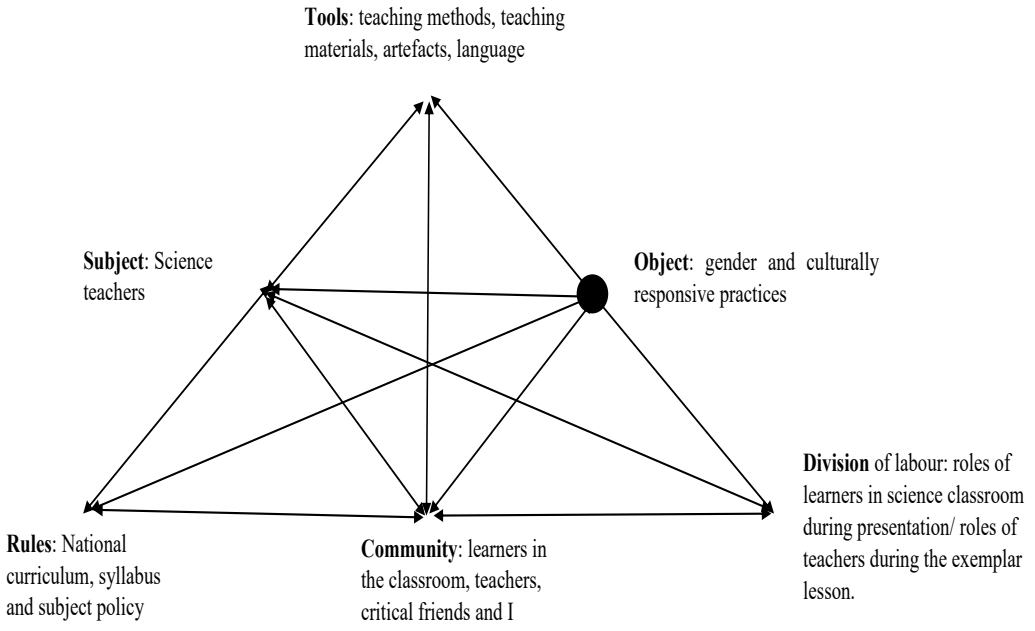


Figure 3.3: The structure of the second-generation activity theory (Adapted from Engeström, 1987, p. 78)

The school presents as the secondary activity system in which different tools, rules, division of labour, and community differ from the first activity system. In this study, the interacting activity systems represent the home and the school. The gender and cultural responsiveness of the teaching and learning process of being are influenced by the home (primary) and the school (secondary). Figure 3.4 shows two interacting activity systems that apply to the third generation of CHAT.

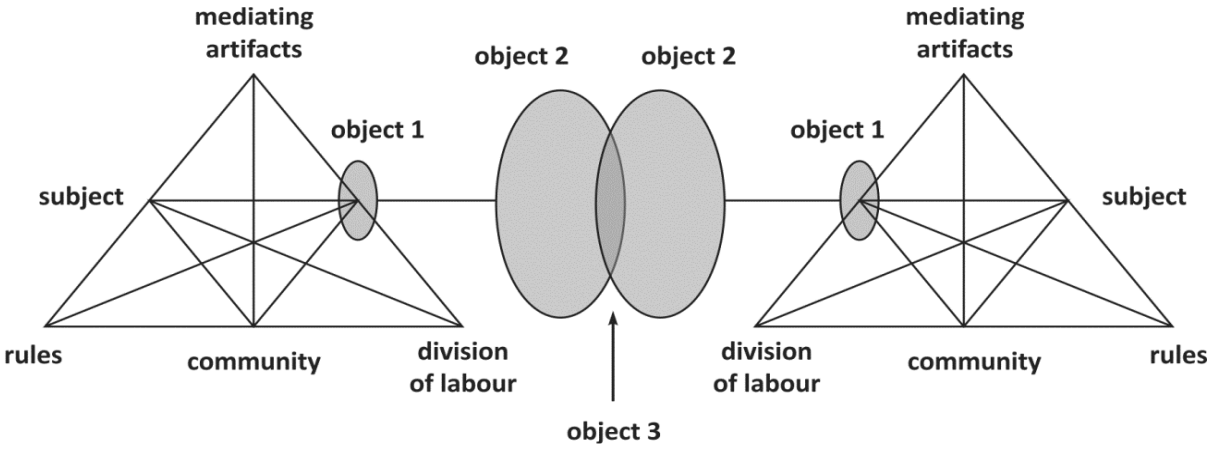


Figure 3.4: Series of interacting activities (Adopted from Engeström, 2001, p. 136)

To understand the nature of gender and culturally responsive practices, I needed to focus beyond the local activity system (the school). This enabled me to understand how it (the local system) has been influenced by other activity systems. It is with this thought that I focused on how the culture and history of both teachers and learners influenced their gender and cultural responsiveness in the science classroom. The third generation of CHAT was then adapted to analyse the contradictions between the overlapping activity systems (home and school). The shared common object was gender and culturally responsive practices for Grade 9 Physical Science teachers. Having discussed CHAT, I now look at its applicability to my study.

3.3.1 Applicability of CHAT to the study

I chose CHAT to frame my study and help to shed light on and explore gender and culturally responsive practices of Physical Science teachers in their science classrooms when mediating the learning of chemistry topics using acids and bases and combustion reactions as examples. It helped me to understand how teachers practice gender and cultural responsiveness in their classrooms and, in particular, to identify the underlying contradictions that enabled and/or constrained them. It also provided me with the methodological tools to analyse gender and cultural responsiveness during the CLWs. According to Roth and Lee (2007), CHAT is an academic theory that is useful in dealing with unsettled problematic situations encountered in both informal and formal working environments and educational activities. In other words, CHAT provides the conceptual tool to explore how the work of the teachers is positioned in its socio-historical contexts (Grant, 2017b). Hence, it is valuable in surfacing emerging innovative ideas about how to improve future practices (Foot, 2014). CHAT was then used to inform my intervention through the CLWs. I now look at the principles of CHAT.

3.3.2 CHAT principles

CHAT is categorised by five basic principles which form a matrix with four central questions (Engeström, 2001). To Engeström (2001), these central questions are: Who are the subjects of learning? Why do they learn? What do they learn? And how do they learn? These apply to the third activity system. I found these principles necessary to describe the current practice of gender and culturally responsive behavious in science classrooms when mediating the learning of chemistry topics, using acids and bases and combustion reactions as examples. This was central to this study. Additionally, it provided opportunities for analysing the activity systems,

namely the school activity system and the home activity system. Both have an influence on teachers' in gender and culturally responsive. Hence, contradictions arose between these activity systems. According to Engeström (2001), the first principle is that of a collective *artefact-mediated* and *object-oriented* activity system, which is identified as the prime unit of analysis. This is viewed in its network relations to other activity systems. In my study, teachers' gender and culturally responsive acts were understood when related to the cultural-historical practices of their context (Daniels, 2008). This enabled me to understand the science teachers' perspectives and pedagogical insights with various dimensions such as *culture* and *history* in mediating the learning of acids and bases as explained by Chikunda (2014).

The second principle is the *multi-voicedness* of the activity system. Engeström (2001) believes that an activity system is always a community of multiple points of view, traditions, and interests. Hence, the division of labour within the school creates different positions for the participants (Daniels, 2008). For instance, science teachers have the responsibility to teach, assess, and manage their classes while adhering to policies such as curriculum, and how to teach these learners specific topics based on their gender. However, this might bring tensions and innovations which demand actions of translation and negotiation within the activity system (Engeström, 2001). To understand the gender and culturally responsive practices of science teachers, I needed to consider their views and traditions. That allowed me to solicit views from different perspectives. This also afforded me an opportunity to understand the contradictions that constrained them from being gender and culturally responsive when mediating the learning of chemistry topics.

The third principle of CHAT is the *historicity* of the system. The activity system takes a long period to be shaped and transformed (Engeström, 2001). Teachers' difficulties, abilities, and experiences can only be understood against their history. For instance, the history of the teachers revolved around being the products of Bantu education during the apartheid era in Namibia. During this era, Physical Science could not be offered, because there were either no qualified teachers to teach it or there were no apparatus and books to make its teaching possible (Mwetulundila, 2000, p. 18). Girls were also not afforded the same opportunities for learning science as their male counterparts (see section 2.3). It is thus through this principle that one would ask questions such as "where do we come from, what are the tools and signs available

for different participants and how are they used to construct the object of the activity, what are the inner contradictions of the activity, what can and will be done?" (Sannino et al., 2009, p. 33). The conditions that enable and/or constrain teachers' gender-responsive practices can only be understood against their cultural-historical daily practices. This principle enabled me to understand how gender is viewed in the learning of science, as well as how the history of culture plays a role in the teaching and learning process, particularly in science classrooms.

The fourth principle is the central role of *contradictions* as a source of change and development. Engeström (2001) believes that contradictions are not the same as problems or conflicts. Instead, they are "historically accumulating structural tensions within and between activity systems" (Engeström, 2001, p. 137). This implies that when working with science teachers, they are expected to surface or unearth contradictions in their gender and cultural responsiveness while advocating for qualitative change in their teaching practices. Even though teachers are required by the policy to be gender responsive when mediating learning, it seems that there are *cultural* and *historically* based challenges that exist and continue to hinder their practices as was identified by Chikunda (2014). Engeström (1999) identifies four levels of contradictions:

1. primary contractions that occur within one element of a single activity system;
2. secondary contradictions that take place when two of the single activities conflict with one another;
3. tertiary contradictions occur when subjects face conflicting situations by adopting what is believed to be a newly advanced method for achieving the object; and
4. quaternary contradictions when the subjects encounter changes to their activity that result in conflicts with the adjacent activities.

Contradictions can lead to innovation and transformation in an activity system. This leads to the fifth principle which is the possibility of *expansive transformation* in an activity system (Engeström, 2001). To Engeström (2001), an activity system changes through relatively long cycles of qualitative transformations. He further argues that as contradictions of activity systems are intensified, some individual participants begin to question and diverge from its

established norms. Hence, Engeström (2001, p. 137) avers that "expansive transformation is accomplished when the *object* and *motive* of the activity system are re-conceptualised to embrace a radically wider horizon of possibilities than in the previous mode of activity". The participants address the identified contradictions and collectively transform their activities (Sannino et al., 2016). The contradictions that were identified in my study were addressed during the CLWs following an expansive learning cycle to find solutions. This resonated well with reflections as teachers were able to create self-awareness, evaluation of their teaching methods, problems encountered in their teaching, and then change mediating practices where necessary (Göker, 2016). Thus, solving contradictions or tensions that arise during mediation provides the learning opportunity, what Engeström (1999) called "expansive learning". In the following section, I deliberate on expansive learning.

3.3.3 Expansive learning

Sannino et al. (2016) defined expansive learning as a creative type of learning in which learners (teachers in this study) join forces literally to create something novel and essentially learn something that does not yet exist. It is used to support and accomplish organisational transformation (Engeström, 2001).

Expansive learning is a cyclical process that comprises the collective learning actions explained using the model shown in Figure 3.5. Engeström (2016) indicates that expansive learning is attained through a series of learning actions. The first learning action is questioning. This action involves participants critiquing or discarding some aspects of the acknowledged practice and existing wisdom (Virkkunen & Newnham, 2013). In the context of my study, the first action was to question the existing level of gender and cultural responsiveness in science classrooms when teaching acids and bases. It then proceeded to the action of analysing the contradictions. This was aimed at tracing the roots and evolution of the object as well as explaining the situation by constructing a picture of its inner systemic relations. This action was pursued to elucidate the cultural and historical roots of the problem situation (Engeström & Sannino, 2010) which helps to surface and enunciate those contradictions (Engeström & Sannino, 2016).

The third action is that of modelling whereby participants construct an explicit, simplified new set of ideas that explain and offer an amicable solution to the problem. This action is followed

by examining the model, which is aimed at establishing its dynamics, potential, and limitations. The fifth action is that of implementing the model by employing practical applications, enrichment, and conceptual extension. The sixth action is reflecting on the process, in which participants reflect and evaluate the process of the new model. The last action is that of consolidating its outcome into a new stable form of practice. At the end of each learning action, further data that served as mirror data or new stimulus is introduced to the cycle (Lotz- Sisitka et al., 2017). Unlike Engeström's (2000) model, in this study the reflections featured in all the learning actions of the expansive cycle. Figure 3.5 below illustrates the process of expansive learning.

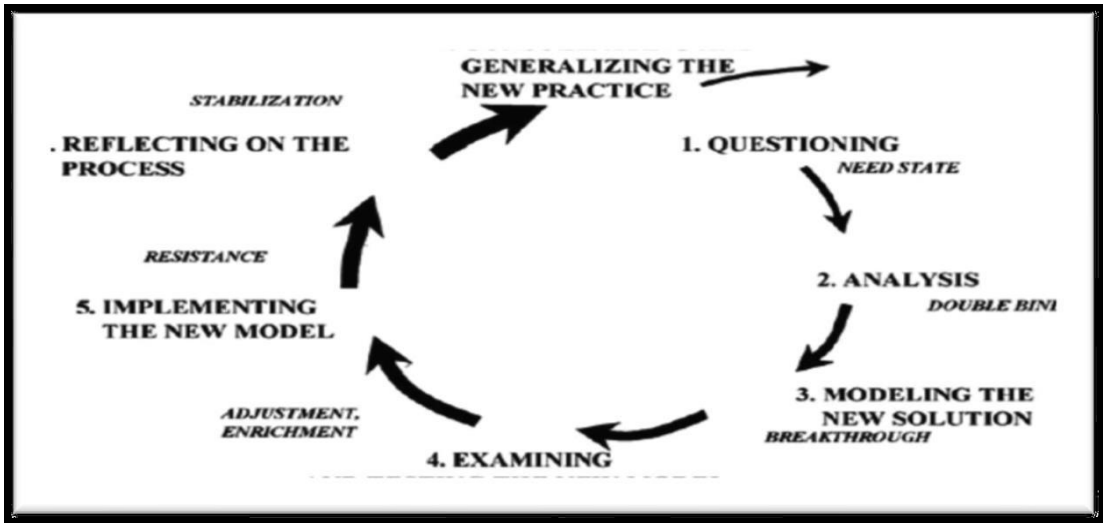


Figure 3.5: The expansive learning cycle or process (Adopted from Engeström, 2000, p. 970)

The process of expansive learning should be assumed as the construction of consecutively progressing contradictions (Engeström & Sannino, 2010). It creates new forms of work activity. This is because, with the transformation and alteration of participants' lives and organisational practices, innovative forms of activity and practices that do not exist are learnt. Expansive learning is carried out through developmental research work and I elaborate on this below.

3.3.4 Developmental work research

The developmental work activities were established as a "new kind of collaboration between a group of practitioners and the researcher" (Virkkunen & Newnham, 2013, p. 23). It is an interventionist methodology that uses participatory methodologies to apply CHAT, specifically

the theory of expansive learning, in the world of work, technology, and organisations (Engeström, 1999). It was also used as "a way of critiquing the existing historical and individual-centred approaches and the construction of an alternative based on the cultural-historical activity theory" (Virkkunen & Newnham, 2013, p. 23). Developmental work research is used around a chain of sessions called 'CLWs' in which researchers together with participants question tensions or contradictions within and between activity systems (Virkkunen & Newnham, 2013).

Expansive learning through change laboratory interventions puts into use the principles of double stimulation and ascending from the abstract to concrete (Engeström & Sannino, 2010; Sannino & Engeström, 2018). To Sannino (2015), double stimulation involves the mechanisms that human beings use that can purposefully alter their circumstances or find solutions to their problems. The participants are presented with critical incidents, problems, and troubles that exist in their workplace during the change laboratory (CL) sessions, and these act as first stimuli (Engeström & Sannino, 2010). In this study, participants were presented with data gathered from questionnaires, interviews, and observations for them to understand their practices in terms of gender and cultural responsiveness. Engeström and Sannino (2010) add that interventionists facilitate the analysis and resolution of the problem by introducing the conceptual tool as a second stimulus. During this stage, participants and I received the presentations from the critical friends.

Critical friends played a role in what Engeström and Sannino (2016) refer to as "break out of the paralysing conflict" (p. 9). It served as the second stimulus during the CLWs. According Engeström and Sannino (2016), the process of double stimulation offers significant support in setting up the tasks and materials needed during the engagement. In this way, critical friends provide agency for transformation. Agency enables the capability to structure the guiding purpose and recognise actions needed to achieve the goal (OECD, 2018). In other words, agency requires active contribution of the participants (Hopwood, 2022). This leads to what is termed as relational agency. Edwards (2005, p.172) defines relational agency as "a capacity to work with others to expand the object that one is working on and trying to transform by recognising and accessing the resources that others bring to bear as they interpret and respond to the object". This shows that individuals - in this case participants and I - interact and

collaborate to find solutions to how to be gender and culturally responsive with the support of the critical friends. Consequently, through relational agency we were provided with capacity to offer support and to ask for support from others (Edwards, 2005). In the end, the ZPD of the participants was enhanced as espoused by Vygotsky (1978). The key aspect to this is that our engagement during the CLWs included the critical friend who formed part of our community. Through this engagement we followed the expansive learning cycle with the help of the critical friend. We followed all the learning actions from questioning to consolidating the new practices.

Ascending from the abstract to the concrete is "the method of grasping the essence of an object by tracing and reproducing theoretically the logic of its development, of its historical formation through the emergence and resolutions of its inner contradictions" (Sannino & Engeström, 2018, p. 51). This learning stems from contradictions that need to be resolved through constructing a foundational relationship (Engeström & Sannino, 2010). Thus, it could lead to qualitative transformation both at the level of individual actions and of the collective system (Sannino et al., 2016). In this study, teachers developed a mediational tool that they could use in their teaching practices. Through joint collaboration, participants shared ideas on how to be gender and culturally responsive. That is, participants worked together collaboratively to transform their practices, and this was done during the formative intervention process of CLWs (Virkkunen & Newnham, 2013). In formative interventions, the researcher involves participants directly in the design process which originated with the problem of practices as faced by the participants in an activity system rather than the researcher's goal (Penuel, 2014). I now look at the Change Laboratory (CL).

3.3.5 Change laboratory

The CL method started in 1995 in Finland, developed by the University of Helsinki, before it spread to other countries (Engeström, 2006; Sannino et al., 2016). It is a formative intervention technique for developing work activities by the participants in collaboration with the researcher-interventionist (Virkkunen & Newnham, 2013). In terms of CHAT language, an intervention is defined as "a purposeful action by a human agent to create change" (Engeström, 2009, p. 325). CL is a research methodology that is used in organising the participation of participants which follows an expansive learning cycle (Lotz-Sisitka et al., 2017). In other

words, CL is a method used for designing "sessions whereby participants and researcher-interventionists use a set of representational devices designed for jointly analysing disturbances and contradictions in their activities and for developing new solutions" (Sannino et al., 2016, p. 4). That is, in the CL participants are engaged in the intervention and generate data to create opportunities for change in their practice.

This intervention enables participants to "analyze the history, contradictions, and zone of proximal development of their activity system, design a new model for it and take steps toward the implementation of the model" (Engeström, 2016, p. 30). Lotz-Sisitka et al. (2017) explain that CL involves creating data with communities on their present object of activity in identifying the history, tensions, and contradictions in the activity. In this way the CL provides an opportunity for expansive learning as a transformative agency, as outcomes in the learning process are not predetermined ahead of time (Foot, 2014). In other words, in CL the results are not predetermined by the researcher but outcomes are designed by the participants as they work out the expansive solutions (Virkkunen & Newnham, 2013). In this regard, these scholars further aver that during CL interventions practitioners collectively solve problems which results in a new understanding of the problem.

According to Virkkunen and Newnham (2013), the collaborative analysis and design work in the CL is maintained by a 3x3 set of surfaces for representing the work activity that helps the group to share and jointly process their observations and ideas (see Figure 3.6).

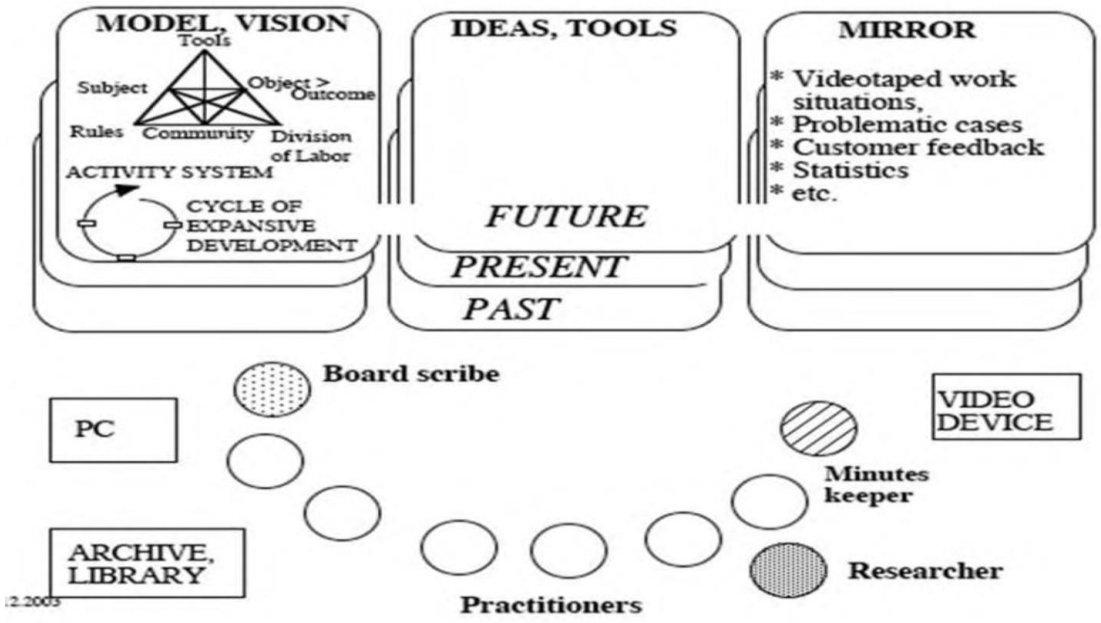


Figure 3.6: Prototypic layout and instrument of the CL space (Adopted from Virkkunen & Newnham, 2013, p. 16)

The surfaces are allocated horizontally into three columns, which permit the participants' work activity to be represented on different levels of abstraction and systemic integration. Virkkunen and Newnham (2013, p. 15) explain that in the "vertical dimension, the surfaces are divided into rows representing the past, present, and future of the activity".

The mirror surfaces of the right-hand column are used to provide the practitioners with a mirror reflection of their activity by presenting specimens of the current practice and first-hand data of their activity to be jointly examined. The mirror/present surfaces are used to represent and examine experiences from work practice, particularly problem situations, and disturbances, but also novel innovative solutions. The mirror of the past comprises data and observations concerning historical changes in the activity. The mirror of the future is used to represent and discuss follow-up data concerning participants' experiments with the new concept and tools, which they have created and in which they begin to form the future form of the activity. It can also be used to present data to anticipate changes in the object and structure of the activity. The model/vision surfaces in the left-hand column are reserved for modelling the past, present, and future structure of the activity and inner contradictions in it. The triangular model of the activity system is issued to analyse and model the systemic structure of the activity and interconnectedness within it (Virkkunen & Newnham, 2013, pp. 15-16)

In this study, the right-hand side (Present - the mirror) provided an analysis of the challenges and problems of gender and culturally responsive practices for Physical Science teachers. These explain the current situation of the participants in terms of gender and cultural responsiveness when they are mediating the learning of chemistry topics. These were obtained from questionnaires, interviews, and classroom observations. Similarly, the left-hand side (Model/vision) represents where CHAT and expansive learning were used during CLWs. It represents the mediational tool that was developed with the aim of transforming the teaching practices of the participants.

In this study, during CLW we used the sharing circles. During these circles, the participants are provided a safe space that is non-hierarchical thus embraces the views of all participants (Brown & Di Lallo, 2020). That is in sharing circles collaborative ideas on indigenous traditions are emphasised for the benefit of the people taking part (Chilisa, 2012). In the Africanised way, particularly in Aawambo this is done at the place called *Olupale/Oshoto* where everyone contributes to the discussion. Thus, this approach lessens power imbalances among the participants, hence building relationships and soliciting views from all (Brown & Di Lallo, 2020). It provided the opportunity to the participants to embrace their traditions but in the teaching context. I now look at the CLWs process.

3.3.6 Change laboratory workshops process

As proposed by Virkkunen and Newnham (2013), the CL process commences with discussions of the mirror data that discloses challenging and problematic aspects of the current activity. In this case, the participants observe and analyse the mirrored data and recount it to their particular experiences and interpretations (1. Mirror/present). Afterwards in the observations, investigations, and discussions of the current practice, participants deliberate and identify the most important problem areas that need additional exploration and possible solutions (2. Ideas/tools/present). Thereafter, for a better understanding of how the problem exists, the participants gather data and observations concerning changes that have taken place in the systemic structure of their activity and record them (3. Mirror/past). Consequently, the records are then scrutinised to identify the rate of change and to examine the causes of and connections between the observed changes. Through this exploration, the participants can identify ways for devising solutions to the current practice within their activity system (4. Ideas/ tool/ past). The

past form of the activity is then modelled by characterising the specific nature of the elements of the activity system at that time (5. Model/ vision/ past).

The model of the current activity system is then built by finding elements of the activity in which main changes have taken place and those in which there has been little change. The relationship between the changed and unchanged elements of the activity system is then analysed to identify contradictions and disturbances (6. Model/ present). To afford solutions to the identified tensions and contradictions, a vision of a new form of activity is developed (7. Model/vision/future) and new forms of action and tools within which participants may begin to experimentally realise the vision are decided upon (8. Ideas/tools/future). Follow-up data about the feasibility of the new tools and forms of action decided in step 8 above are then collected from the first experiments (9. Mirror/future) and identified problems in the data is used as a mirror for the current activity [1. Mirror/ present]. The CL process is then represented in Table 3.1.

Table 3.1: Change laboratory process

	MODEL/VISION	IDEAS/TOOL	MIRROR
FUTURE	7. Visioning the future structure of the activity system in which the current contradictions would be overcome.	8. Modelling the new tools and ways of working necessary for realising the vision. Designing first experiments with the new tools and new ways of working.	9. Follow-up data about feasibility of the designed new tools and ways of working as well as about needs for their future development.
PRESENT	6. Modelling the most important changes taking place in the elements of the activity system as well as the historicity evolved inner contradictions the changes have created with the activity system.	2. Shared concerns, and identified problem areas in the joint activity. Ideas for further analysis. Solutions, and ideas to identified problems.	1. Samples of problem situations in the participants' daily work with the object of the joint activity – gender and culturally responsive practices (for instance disturbances and ruptures in serving learners or in central processes of joint activity).
PAST	5. Modelling the central features of the past structures of the activity. Analysing the nature of the current phase of the transformation of the activity.	4. Identification of periods and turning points in the development of the activity (mediational tool).	3. Data concerning important historical changes in the activity system.

It is through these processes that new ideas were developed regarding the gender and culturally responsive practices for Physical Science teachers when mediating the learning of chemistry topics.

3.4 Relevance of the Two Theoretical Frameworks in My Study

As explained earlier in this chapter, I used Vygotsky's (1978) SCT and Engeström's (2001) CHAT. These two theories complement each other (see Figure 3.7). The SCT is a learning theory that underpinned the social interactions that took place during the classroom presentations as well as during the CLWs. CHAT focused on the wider socio-cultural structures in which the individuals were located.

The SCT and CHAT complement each other in understanding the gender and culturally responsive actions in the science classroom. CHAT being the extension of SCT, the cultural component in both frameworks might help me to understand the cultural contexts of teachers which might influence their mediating of chemistry topics using acids and bases and combustion reactions as examples. Teachers' cultural context influenced their teaching pedagogies. Furthermore, it enables the teachers to identify the underlying contradictions that enable and/or constrain the mediating of chemistry topics. This was done through social interaction (Vygotsky, 1978) during the CLWs (Virkkunen & Newnham, 2013). These social interactions (Vygotsky, 1978) and collaborative learning spaces of CL (Virkkunen & Newnham, 2013) provided the opportunity for the acquisition of knowledge on how to be gender and culturally responsive.

Moreover, the interaction of the members of the community plays the role on shaping the mediation the learning. This includes taking into consideration the gender and cultural aspects. The sharing of ideas during the CLWs thus enhance the ZPD of the teachers in being gender and culturally responsive leading to change and development. In this case the plurality of knowledge (multi-voicedness) (Engeström, 2001) of the teachers allow them to surface the contradictions within their activity system (classroom). This social interaction allows the teachers to trace the historicity of the gender and cultural responsiveness particularly in a patriarchal society. Figure 3.7 shows how SCT complements CHAT and how they are intertwined. All in all, the impact of the social, cultural and historical factors shapes the interactions and the development of the teachers. This means that both SCT and CHAT put emphasis on collaborative work in order to develop human capabilities.

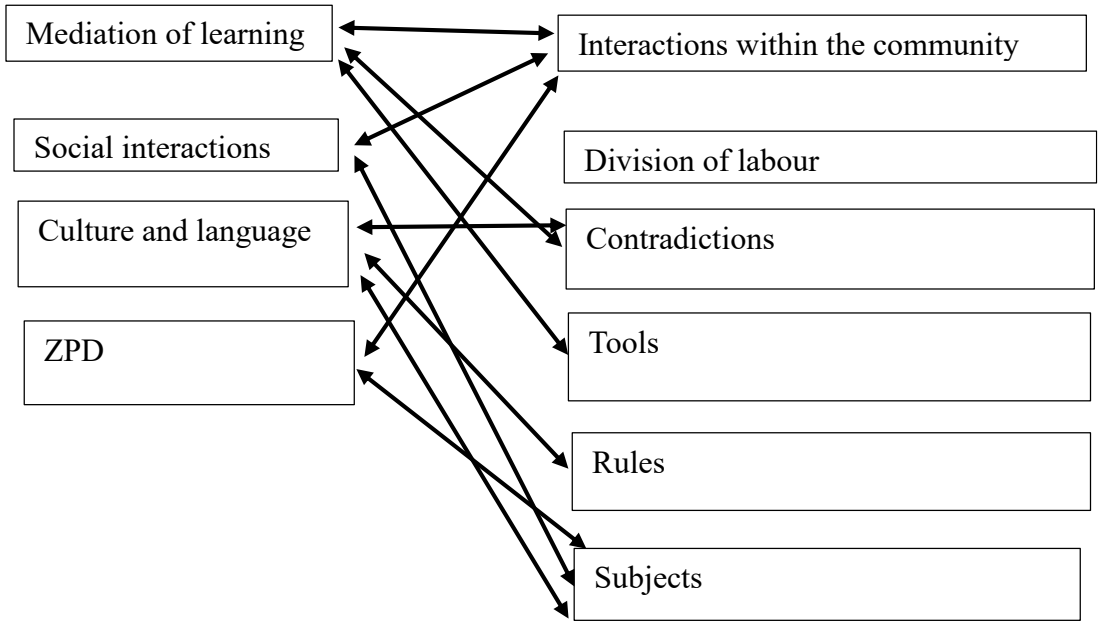


Figure 3.7: The relationship between SCT and CHAT

3.5 Chapter Summary

This chapter highlighted the theoretical and analytical frameworks that were used as lenses of the study. It started with the SCT which focuses on the four components, namely mediation of learning, culture and language, social interactions, and ZPD. The chapter highlighted how these components play a role in the development and learning of people. I also explained how I used each theoretical concept for data analysis and interpretation. The chapter also looked at CHAT, explaining the components of the triad. It also presented its applicability to this study. Furthermore, I discussed the CHAT principles that lead to expansive learning and explained the change laboratory and how the process of the CLW was conducted by the participants to transform their practices. I now look at the research methodology employed in this study.

CHAPTER FOUR: RESEARCH METHODOLOGY

> Methodology concerns how researchers go about obtaining knowledge about the world. This includes how they collect data depending on their views of what exists and what can be known (their ontology and epistemology), how they describe phenomena, and how they explain. (Bertram & Christiansen, 2020, p. 25)

4.1 Introduction

The central point of this study was to explore and expand Physical Science teachers' gender and culturally responsive practices in their science classrooms when mediating learning of chemistry topics using acids and bases and combustion reactions as examples for phase one and phase two respectively. This was to look at how aware teachers were when they were dealing with gender and cultural issues in their classrooms during science lessons as well as to find ways of how they could expand their gender and cultural responsiveness in dealing with gender and cultural aspects in their classrooms.

This chapter highlights how data were gathered as explained in the epigraph above. It explained how the participants and I worked in understanding and expanding gender and culturally responsive practices for science teachers when mediating the teaching and learning of chemistry topicsThat meant working alongside science teachers in designing a mediational tool that was gender and culturally responsive. This study adopted a formative interventionist approach aimed at generating solutions (Sannino et al., 2010). In this section, I discuss and substantiate the research paradigms underpinning the study as well as the research design employed. The chapter also highlights the research goal and research questions that the study sought to answer. It also looks at the research site and procedures for sampling, data gathering techniques, the research process, data analysis as well as validity and trustworthiness. The chapter ends with a discussion of the ethical aspects undertaken in the study and a chapter summary. I now look at the research paradigms.

4.2 Research Paradigm

A paradigm is a set of general philosophical assumptions about the nature of the world (ontology) and how we can understand it (epistemology) (Cohen et al., 2018; Maxwell, 2008). In support of this classification, Cohen et al. (2018) add that paradigms are means of viewing the world. This study was underpinned by two complementary paradigms, namely, the interpretivist and critical paradigms. Creswell (2014) explains that interpretivists believe that individuals seek understanding of the world they live and work in. It is through social interactions that people construct meaning and make sense based on their historical and cultural perspectives (Crotty, 1998; Vygotsky, 1978). Creswell (2014) further stated that in the interpretivist paradigm the research relies on the participants' views of the situation being studied. That is, participants share their experiences to understand their values, beliefs, and meaning of their social phenomena (Hussain et al., 2013). Thus, the subjective meaning is negotiated socially and historically (Creswell & Creswell, 2018). In other words, these scholars point out that meaning is formed through interactions with others and through historical and cultural norms in which individuals' lives operate.

Concurring, Cohen et al. (2018) aver that the interpretivist paradigm views the social world as an emergent social process that is shaped by the individuals concerned through experiences. Thus, the interpretivist paradigm has to do with people's understanding and experiences of an individual's behaviour and actions. Put differently, the interpretations are made with the purpose of understanding human agency, behaviour, attitudes, beliefs and perceptions (Bertram & Christiansen, 2020). With this view in mind, the interpretivist paradigm resonates well with this study. Participants were able to give their views of what was happening in their classrooms and what their perspectives and pedagogical insights were in terms of gender and cultural responsiveness when they were mediating chemistry topics in their science classrooms. It is through this paradigm that I hoped to understand the underlying enablers and/or constraints that were experienced by science teachers about gender and cultural aspects.

However, it can be acknowledged that this paradigm has its weaknesses. One of the criticisms is that it does not favour using approaches that offer objective or precise information (Thanh & Thanh, 2015). Thus, Bakkabulindi (2015) asserts that it has greater challenges in arriving at the truth as it focuses on descriptions at the expense of explanation. Hence, the surfacing of

contradictions through CHAT and focusing on the experiences of the participants that reflect what was happening in their everyday teaching addressed this limitation. In this study, I wanted a paradigm that enabled me to go beyond simple explanations of the phenomenon. Hence, I used the critical paradigm as well to complement the interpretivist paradigm.

According to Flick (2018), a critical paradigm focuses on scrutinising issues of power, control, and philosophy that are said to dictate our understanding of the social world. This scholar further explained that this paradigm was pursued to urge social sciences from its primarily intellectual seat into the realm of action, specifically emancipatory action. Holding similar sentiments is Asghar (2013) asserting that the critical paradigm goes beyond ordinary recordings of interpretations but endeavours to reform for a better world. Its objective is to recognise a society that is based on equality and democracy for all its members (Cohen et al., 2018).

In this paradigm, specific issues need to be addressed that speak to social issues such as empowerment, inequality, oppression, and dominance (Creswell & Creswell, 2018). Additionally, the relationship between the researcher and what is researched is not based on the power hierarchy as in the interpretivist paradigm; instead, it involves the transformation and emancipation of both the researcher and the participants (Chilisa, 2012). Thus, I believe that critical research and a formative intervention align well as both aim for a transformational agenda. In other words, these two approaches (formative intervention and a critical paradigm) emphasise bringing about some social change that will advantage those groups of individuals with rarer opportunities or choices open to them (Bertram & Christiansen, 2020).

Moreover, science teachers need to be empowered to ensure that all learners have access to science regardless of their gender, that is, to revisit and bring changes to curriculum content (chemistry topics in this study) to ensure that both boys and girls get assistance in increasing their academic learning (Paudel, n.d). In this regard, transformative research offers a voice to the participants in raising their consciousness and advancing their agenda for change to improve their practices, and it became the integrated voice of alteration and transformation (Creswell, 2014). The participants are involved in identifying and defining the problem, collecting and analysing the data as well as disseminating the findings, and using these findings

to inform their practices (Chilisa, 2012). The critical issue in the context of my study was to ensure that teachers were paying attention to all learners' needs and not paying attention to one gender, particularly girls who were previously disadvantaged in terms of participating in science. Thus, the study sought to liberate the disempowered, amend inequality and support individual freedoms within society (Cohen et al., 2018), and at the same time develop a mediational tool that teachers can use in mediating science. In other words, the essence of using the critical paradigm in my study was to seek social justice and equality in terms of gender and cultural responsiveness of Physical Science teachers and bring transformation into the activity system through the CL as a CHAT intervention method (see Section 3.3.5).

Thus, these two paradigms complemented each other in that the interpretivist paradigm offered the teachers involved in this study an opportunity to explain their situation. On the other hand, the critical paradigm enabled me to take an emancipatory stance, which created an empowering environment for the science teachers in being gender and culturally responsive when mediating science and making changes to their teaching practices. Hence, their ZPDs as espoused by Vygotsky (1978) on how to be gender and culturally responsive when teaching their lessons were developed. I now look at the philosophical assumptions on gender and culturally responsiveness.

4.3 Philosophical assumptions about the nature of reality and the theories (gender and culturally responsiveness)

The philosophical assumptions in this study drew on the ontological, epistemological and axiological aspects of how gender and culture are perceived in society. I drew from SCT and CHAT. The ontological assumptions from the interpretivist paradigm are that the world is multifaceted and dynamic and it is created, deduced and experienced by the lived people as they interact with one another in society (Aliyu et al., 2015). That means reality is socially and subjectively created through connotations and explanations dispersed by individuals and societies. Bertram and Christiansen (2020) posited that reality is out there and interpretivists seem to believe in that reality as the truth. Thus, there are diverse perspectives and interpretations. In terms of this study, teachers were interviewed to establish their nature of reality in their community regarding gender and cultural issues before they came to the school environment. That afforded me an opportunity to have an understanding of how gender and

culture are constructed and perceived in society by the science teachers and how they acquired knowledge.

In terms of knowledge acquisition, to the interpretivists, knowledge is created through many interpretations (Chilisa, 2012). That is, there are many realities. Hence, the researcher needs to consider various factors such as behaviour, ethnicity and gender based on the participants' experiences (Alharahsheh & Pius, 2020). Epistemological assumptions of SCT involve subjective standpoints. In other words, teachers cannot be separated from gender and cultural issues as they might be exposed to these in their society. For instance, how teachers view boys and girls in terms of learning science was critical to know. Hence, it was important for participants to explain their experiences. Epistemologically, SCT acknowledges that knowledge is constructed through social interactions (Vygotsky, 1978).

It could be surmised, therefore, that the interpretivist paradigm builds on multiple realities that are locally and specifically constructed. In this study, the society where teachers grew up shaped their reality of what it is to be gender and culturally responsive. Such reality then subsequently influences the gender roles of individuals in a society (Başar & Demirci, 2018). So, knowledge is not regarded as out there to be found (Bertram & Christiansen, 2020). Instead, it is socially constructed (Chilisa 2012) and it is through interpretations that the perceptions of people are understood (Bertram & Christiansen, 2020). To understand the gender and cultural responsiveness of teachers, we had dialogue and we had to reach consensus based on their individual experiences.

Within the interpretivist paradigm, the researcher must deal with ethics and values during the research process (Khatri, 2020). As a researcher, it is crucial to understand the context, culture and historical experiences of the participants. These influence how individuals act (Aliyu et al., 2015). In terms of this study, understanding teachers' contexts enabled me to identify what they valued regarding gender and cultural responsiveness in their classrooms.

The critical paradigm on the other hand believes that what we know is influenced by our own place in society (Bertram & Christiansen, 2020). These scholars further explain that reality requires unloading operational, historical and political aspects of reality in order to achieve an emancipatory stance. Thus, ontologically, it is crucial to examine power dynamics in the

creation of knowledge. In this regard, Chilisa (2012) emphasised that multiple realities are shaped by social, cultural and historical contexts. Therefore, dominant groups in the community have a major influence in what is believed to be actual and authentic knowledge. Hence, in this study, CHAT through Developmental Work Research (Chikunda, 2013), offered an opportunity for the participants and I to work together and analyse the nature of gender and CRP in the science classrooms.

In terms of knowledge creation, it is important to understand how knowledge can be used to empower marginalised groups. The emphasis of this study was to ensure that both boys and girls are offered equitable opportunities. Hence, in this study, we derived ways to work with the science teachers for them to be gender and culturally responsive. This means that understanding gender and cultural responsiveness allowed the teachers to acknowledge their challenges and analyse these dominant values in society to promote equality and equity for all learners.

This then supports the curriculum transformation intent for the study. Consequently, in understanding the gender and cultural responsiveness of the science teachers and then together constructing new ways, which as a result enhanced the empowerment and agency of the teachers. This was done during the CLWs to understand the contradictions that emanated from *social*, *political* and *historical* contexts that constrained teachers in being gender and culturally responsive. Subsequently, we found ways that promote social justice and equity for both boys and girls in our science classrooms through the development of the mediational tool. In this regard, Chilisa (2012) explained that epistemologically, knowledge is true if it can be turned into practice that benefits all the participants and this could be referred to as the mediational tool that was developed in this study. I now look at the research design.

4.4 Research design

Research design is a choice that comprises which approach should be used to examine the topic under study (Creswell, 2014). This is a strategy or approach derived from underlying philosophical assumptions to postulate the selection of participants, and the data gathering methods to be used as well as data analysis (Creswell et al., 2016). In other words, research design offers detailed direction for procedures to be followed in the study which includes

defining the questions of the study and identifying the data to be collected (Creswell & Creswell, 2018). It encompasses what, where, when, how much, and by what means an inquiry in a study will be accomplished. In this study, the learning outcome was not predetermined by me or the participants because it was a generative study that explored the gender and culturally responsive practices of science teachers. Considering this, in this study I employed a case study research design as discussed in the next section.

4.5 Qualitative Case Study and Expansive Learning

The study employed a qualitative case study. A case study explores the context of the phenomenon and describes it in detail (Cohen et al., 2018). It is an in-depth exploration of a bounded system built on extensive data collection (Creswell, 2012; Merriam & Tisdell, 2016), developing an in-depth analysis of the case (Creswell & Creswell 2018; Yin, 2018). This study took the form of a qualitative case study.

According to Plano-Clark and Creswell (2015), qualitative research is a type of research in which the researcher studies a problem that requires the exploration of a phenomenon. The researcher will rely on the views of the participants obtained through questioning (Cohen et al., 2018). As explained in section 3.3.3, the participants questioned the level of gender and culturally responsive practices in the teaching and learning process. These scholars further argued that a case study emphasises practices, interventions, and interpretations intending to improve the situation.

Thus, this study incorporates an emancipatory aim of enlightening and empowering individuals and organisations in the community setting. That means involving the participants in the study by collaborating in decision making and engaging the participants as equals to ensure their well-being (Plano-Clark & Creswell, 2015).

In this study, this was carried out during group discussions. This included presenting the information that was gathered from the teachers through questionnaires, interviews, and classroom observations. Consequently, we developed a mediational tool that was gender and culturally responsive for mediating science, particularly chemistry topics. As a result, I worked with the participants to devise a mediational tool that the teachers used in their science classrooms as a solution.

In this study I followed the expansive learning cycle through CLWs. As highlighted earlier, CLWs are aimed at providing a platform or space for research participants to work collectively and try to resolve contradictions (Virkkunen & Newnham, 2013). Thus, the key contribution of this study was the process of working alongside the teachers in a dynamic and explorative way in developing the mediational tool that was gender and culturally responsive and created an emancipatory environment for science teachers. In other words, this study adopted the PAR, following the expansive learning cycle through CL (see Sections 3.3.3 & 3.3.5).

I used a case study because the study explored the gender and cultural responsiveness of science teachers. Furthermore, it hoped to expand their gender and cultural responsiveness through the development of a mediational tool that the participants and I worked on as co-researchers as espoused by Plano-Clark and Creswell (2015). Thus, the case in this study was teachers' gender and culturally responsive practices when mediating the learning of acids and bases.

4.6 Research Goal and Research Questions

The goal of this study was to explore and expand Grade 9 Physical Science teachers' gender and culturally responsive practices in science classrooms when mediating learning of chemistry topics using acids and bases and combustion reactions as examples. The study also sought to develop a mediational tool that aids teachers in being gender and culturally responsive when mediating the learning of chemistry topics.

To achieve this goal, the following research questions were addressed:

1. What are Grade 9 Physical Science teachers' perspectives and pedagogical insights into gender and culturally responsive practices when mediating learning of acids and bases?
2. What are the underlying contradictions (if any) that enable and/or constrain gender and culturally responsive practices in Grade 9 Physical Science teachers' science classrooms?
3. What expansive learning and mediational tools can the study develop to support gender and culturally responsive practices in Physical Science teaching using acids and bases and combustion reactions as examples?

4. How do group discussions and reflections through CLWs influence (or not) the implementation of mediational tools when Grade 9 Physical Science teachers mediate the learning of their lessons?

4.7 Research Site and Sampling

Sampling is an important element of research as it involves the issue of defining the population on which the research will focus (Cohen et al., 2018). Similarly, it encompasses identifying the size of the population as well as identifying the individuals of the population (Creswell & Creswell, 2018). Cohen et al. (2018) explained that the quality of a piece of research depends on the appropriateness of methodology, instrumentation, and sampling strategy. While researchers in quantitative studies attempt to acquire samples that are representative of the whole target population, qualitative studies frequently use non-probability sampling methods that permit them to gain a deeper understanding of phenomena (Cohen et al., 2018). In this study, purposive sampling was used. According to Flick (2018), purposive sampling involves selecting instances that are rich in information, with a view to answering research questions.

In this study, purposive sampling was used to select people with the required characteristics. My target population was Grade 9 Physical Science teachers teaching at rural schools at both combined and secondary schools. The selection of this target population was done purposively because the goal of this study was to explore and expand their gender and culturally responsive practices when mediating the learning of chemistry topics. However, due to the nature of my study, I had neither the financial resources nor the human capacity to work with all teachers in the circuit or the whole region (Oshikoto). Thus, I focused on only six Grade 9 Physical Science teachers (five males and one female) from some of the schools in the Oshikoto Region. Teachers were selected from *rural* schools (combined and secondary) for convenience in terms of accessing the participants as well as for the participants to be within easy reach of the venue for CLWs (reducing the travelling costs). The selected participants' teaching experience varied from one year to 13 years.

Moreover, these teachers were selected because, in the Namibian context, Grade 9 is the last year where learners are taught Physical Science (a combination of chemistry and physics topics), and it is compulsory. Thereafter, learners can opt for a field of study for science

(chemistry or Physics or both) or opt for other fields of study in Grade 10. Hence, the final sample size for this study was six Physical Science teachers from six schools and it would therefore be difficult to generalise the results. I thus chose to explore the teachers' gender and culturally responsiveness as this might have an influence on the learners in choosing the field of study in the next grade.

4.8 Participants

In this study, I had six participants, and I gave each participant a code, T1 to T6. Below are the detailed profiles of each teacher.

Teacher 1

This participant was a male teacher. He has been teaching Grade 9 Physical Science for 13 years. He is also responsible for teaching Physical Science in Grade 8 and Design and Technology in Grades 5-7. This teacher did not receive any professional development in his teaching career on how to be gender and culturally responsive. He had been teaching at this school for seven years.

Teacher 2

This teacher was the only female participant. She had 12 years' teaching experience of teaching Physical Science in Grade 9. She was also responsible for teaching Natural Science and Health Education in Grade 4. This participant indicated that she also had not received any professional development regarding how to be gender and culturally responsive. She had been teaching at this specific school for 12 years.

Teacher 3

This participant was a male teacher. He had two years' experience of teaching Physical Science in Grade 9. He was also responsible for teaching Mathematics in Grade 9 and Physics in Grade 11. He indicated that he had done a course on comprehensive sexual education which also looked at how to treat learners equally and fairly when teaching. He had been teaching at this school for three years.

Teacher 4

This participant was a male teacher and had two years' teaching experience of teaching Physical Science for Grade 9. He was also responsible for teaching chemistry and Mathematics in Grade 10. This participant also indicated that he had not received any professional development on how to be gender and culturally responsive. He had been teaching at this school for three years.

Teacher 5

This participant was a male teacher with teaching experience of one year in teaching Physical Science in Grade 9. He was also responsible for teaching Mathematics in Grade 11 and Mathematics Advanced Subsidiary (AS). He also indicated that he had not received any professional development on how to be gender and culturally responsive. He had been teaching at this specific school for three years.

Teacher 6

This participant was a male teacher. He had been teaching Physical Science in Grade 9 for 13 years. He was also responsible for teaching Physics in Grade 10 and 11. He indicated that he had done a module on inclusive education in his teacher training. He had been a teacher at this school for four years.

All in all, this study sample +comprised both novice and experienced teachers. Since the empowering environment was created for all participants, there was no difference in the participation of novice or experienced teachers. They all expressed their views as we established an environment where we were all co-learners. Table 4.1 summarises the profiles of the participants.

Table 4.1: Participants' profiles

Teacher	Gender	Age group	Teaching experience in Physical Science Grade 9 (years)
T1	Male	40-49	13
T2	Female	40-49	12
T3	Male	20-29	2
T4	Male	20-29	2
T5	Male	20-29	1
T6	Male	30-39	13

4.9 Data Generation Methods

According to Creswell et al. (2016), data generation methods are tools that the researcher uses to generate data. It concerns instrumentation, and how data are collected and analysed (Cohen et al., 2018). In this study, data generation methods were divided into two phases, viz., phase one and phase two. In phase one data were gathered from questionnaires, semi-structured interviews, classroom observations (which were recorded on a videotape with the permission of the participants), and stimulated recall interviews. Additionally, in phase two I gathered data during CLWs through group discussions and reflections.

The questionnaires were administered first followed by semi-structured interviews for further exploration. Classroom lesson presentations for four teachers were observed followed by the stimulated recall interviews. The initial plan was to observe all six teachers; however, it came to my attention that two teachers had already taught the topic of acids and bases in semester 1. The teachers and I met for group discussions and reflections to develop the mediational tool

through CLWs. To ensure validity, all data generation schedules (questionnaires, semi-structured interviews, and observations) were adapted. The interview schedules were also piloted with the other students in our science education community of practice. According to Bertram and Christiansen (2020), piloting a study forms part of the initial juncture where the data-gathering instruments are tested with people who are analogous to real study participants. Piloting an instrument allows one to make changes to questions that are ambiguous and rephrase them to be clearer. This makes them understandable to the participants. The aim of using multiple data collection methods was that the constraints or deficits of one method may be complemented by one or more of the other methods. In the section below I discuss how each data generation method was used in each phase.

4.9.1 Phase one: Data generation methods and tools

Phase one was intended for contextual profiling. This was done to understand the teachers' perspectives and pedagogical insights in being gender and culturally responsive. I now explain in detail the methods employed in this phase, starting with the questionnaire.

4.9.1.1 Questionnaire

A questionnaire consists of a list of questions in a certain order which have to be answered by the participants on their own (Gay et al., 2012). The questionnaire focused on teachers' profiles in terms of experience in teaching Physical Science, specifically acids and bases, and their understanding of gender and culturally responsive practices. This helped me to understand their position regarding these concepts. Teachers completed the questionnaire in their own time, and I collected them upon completion. All the participants answered all the questions in the questionnaires. This means that none of the participants left any questions unanswered. This shows that the questions were well phrased well and clear. Only one participant (T3) understood gender responsive differently. However, after the follow up with the semi-structured interview, this participant explained it well. Hence, I concluded that this participant misunderstood the concept. The advantage of administering the questionnaire first was that it helped me formulate my semi-structured interviews in which I probed for clarity based on what the participants answered in the questionnaire. The questionnaire was adapted from Nhase (2019) (see Appendix F1).

4.9.1.2 Interviews

Interviews involve the researcher communicating with the participants and asking questions about the topic being investigated (Bairagi & Munot, 2019). Cohen et al. (2011) explain it further by pointing out that an interview goes beyond being just a data gathering procedure, by being a social encounter where data can be generated through both verbal and non-verbal cues. That is, the researcher can generate first-hand information that can be verbal or non-verbal. Cohen et al. (2018) echo similar thoughts stating that an interview is a conversation between the researcher and the participant, in which the researcher seeks to get information that is significant to their study. The advantage of carrying out an interview is that it allows the researcher to have control of the questioning (Creswell & Creswell, 2018). The interviews that were carried out were semi-structured and stimulated recall. These sets of interviews are described below in detail, starting with the semi-structured interviews.

- Semi-structured interviews

The first interviews (semi-structured interviews) were conducted after teachers had answered the questionnaires. The reason for this was to follow up on what teachers had answered in the questionnaires. Schultze and Avital (2011) point out that interview questions in a qualitative study can be both closed-ended and open-ended. According to Cohen et al. (2018), semi-structured interviews allow probing the views of the participants on a phenomenon. I adapted the format from Cetin-Dindar and Geban (2017) (see Appendix F2). These interviews allowed me to probe for more information that was generated from the questionnaires. Hence, this strengthened and validated the data generated from questionnaires. These interviews lasted between 15 to 20 minutes. All the interview sessions with the participants were audio recorded. The interviews were carried out in English, except for T2 and T3 who answered in both English and Oshiwambo. They opted to use both languages because they wanted to express themselves well or when they were asking for clarity when the question was asked. Since these were the first intense interactions with the participants, I observed that they were not free in expressing themselves compared to the stimulated recall interviews. For ethical reasons all the participants were informed about recording and provided their consent.

- Stimulated recall interview

The second interview (stimulated recall interview) was conducted after the classroom observations. This is a collaborative inquiry that is between the researcher and the participants with the dialogue focused on their practices through the video or audio recordings to help the participants recall the experiences of the event (Mackenzie & Kerr, 2012). This method offers the participants an opportunity to view themselves as a way of recalling their thoughts of events as they have occurred (Nguyen et al., 2013). I watched the videos with each teacher and then questions were asked based on what was observed in the video. This allowed me to ask for clarity based on the decisions that the teachers had taken during the lesson presentation. For thorough preparation, I watched the video first alone. This also enabled me to write down the guiding questions that I intended to ask the participants. For convenience, these stimulated recall interviews were conducted on different days and at each participant's school at a time that was convenient for each participant. Hence, some were conducted during the morning and some in the afternoon. The interviews lasted between 20 to 30 minutes. All the participants felt that it was a good thing to see themselves in action. For instance, T5 pointed out that there were many things that could happen in the classroom and the teacher could fail to pick them up, as in his class there was a learner who was lying on the table. Upon inquiry the teacher could not remember such a case.

4.9.1.3 Classroom observations

According to Bairagi and Munot (2019), observation requires the researcher to observe participants in their natural setting. Maxwell (2012) points out that observation affords a direct and powerful approach to learning regarding people's behaviour and the context in which this takes place. Moreover, observation necessitates the researcher to go to the research site to collect first-hand information from the participants (Wellington, 2015). This allows the researcher to make their own observation. Using observation provided rich contextual information and an opportunity for the researcher to document verbal, non-verbal, and physical information (Clark et al., 2009). Moreover, observations yield invaluable information that can complement interviews (Yin, 2018). In this way, the researcher took field notes at the research site about the behaviours and activities of the participants. The advantage of observation is that

it requires less active cooperation from the participants. It enables the researcher to see for themselves the context and site of the research where they are to gather information about a wide range of phenomena (Cohen et al., 2018). Furthermore, observation allows the researcher to notice unusual aspects and explore the topics that participants might find uncomfortable discussing (Creswell & Creswell, 2018).

In this study I gathered data through non-participatory observation and participatory observation in phase one and phase two respectively. According to Busetto et al. (2020), in non-participant observation the observer observes without taking part or trying to influence the setting through their presence. In other words, the researcher distances herself and acts as an outsider (Ciesielska et al., 2018). During phase one I was a non-participant observer. I observed how teachers were conducting their lessons. This afforded me an opportunity to see if they practised gender and cultural responsiveness in their science classrooms.

Only some participants were observed in the end. Of the six participants, only three participants were observed twice (T3, T4 & T6), T5 was observed only once and two participants (T1 & T2) were not observed at all. The first observation was done when each teacher was teaching theory. All these teachers were observed as they were introducing the topic of acids and bases. That meant the teacher discussed the topic and gave further explanations through summary or notes. The second observation was done when the teacher was doing the practical (hands-on practical activities) with the learners (Asheela et al., 2021). During the hands-on practical activities both teachers and learners brought the materials that were used. However, one participant (T5) was observed once only, when he was teaching theory. During this observation the teacher was teaching the reactions of acids. This participant could not be observed for the second time when he was carrying out the hands-on practical activities. The reason was that this participant (T5) did not inform me so that I could observe him. The two participants (T1 & T2) were not observed because by the time I started the data gathering process, they had already taught this topic. Hence, a total of seven (7) lessons were observed. The observation schedule was adapted from Nikodemus (2017) (see Appendix F3).

The focus was to look at how the teacher addressed the learners of different genders and what teaching methods the teacher used in the classroom related to gender issues, and how teachers

were assigning roles to the learners during lesson presentation. For instance, the language used as well as how teachers interacted and engaged with learners as espoused by SCT (Vygotsky, 1978). Additionally, the observation was done to look at what IK the teachers were using when mediating the learning of chemistry topics. It was also to observe whether the teachers were able to connect learners' everyday experiences with the science that was learnt in the classroom (Gwekwerere, 2016). The classroom observations lasted between 30 to 50 minutes. That depended on whether the teacher had a single or double lesson. In the Namibian curriculum, the subject can be taught as a single lesson (40 minutes) or a double lesson (80 minutes) in a day. The normal lesson duration is 40 minutes.

In phase two of the study, I took the position of a participant observer. According to Moser and Korstjens (2018), participant observation involves participating in and observing the people or the group. In other words, participant observation is a process of knowledge production through being and action (Shah, 2017). During this phase, I took part in observing with other participants how the teacher was implementing the mediational tool that was gender and culturally responsive. I now shift to phase two of the study.

4.9.2 Phase 2: Change Laboratory workshops (group discussions and reflections)

As explained in section 3.3.4, this study was a formative interventionist study in which the intervention took place during the CLWs conducted with the participants. As alluded to earlier, the CL involves participants working collaboratively with the researcher to transform their practice (Virkkunen & Newnham, 2013). According to Penuel (2014, p. 101), CL represents three aspects of formative intervention research: "(a) beginning with the analysis of a problem of practice, (b) double stimulation as a mediating device for generating potential solutions, and (c) expanding the collective agency of participants to generate and test novel concepts". Hence, during these CLWs, teachers reflected on their teaching practices through reflective journals (Mayana, 2020). To simplify this, it was during these working spaces that participants worked out the expansive solutions to the developmental contradictions within the elements of the activity system (Virkkunen & Newnham, 2013). Hence, this was done during CLWs through group discussions and reflections.

Reflections are personal accounts of the learning experience (McMillan & Schumacher, 2014). The data are realistic and echo the experiences of all participants. It is during the reflections that teachers discussed their teaching experiences. Reflections resonated well with CHAT since CHAT affords the framework for subjectivity (looking at oneself) and inter-subjectivity (interaction between subject and object) and the relationship encounters of subjectivity and objectivity (Roth & Lee, 2007). The process of reflection allowed the teachers to examine their actions as they took place and use observations to refine their practices (Bialka, 2017). Thus, the discussions looked at the factors that enabled and/or constrained their teaching of acids and bases and how they addressed gender and cultural issues when teaching the said topic. It was during the group discussions and reflections that the mediational tool was developed (see Figure 7.3). This method was used to support and expand teachers' gender and culturally responsive practices in mediating the learning of chemistry topics. As explained in the previous sections, acids and bases and combustion reactions were used as examples in phase one and phase two respectively. Eun (2008) suggested that the best way to improve teaching and learning is to engage teachers in workshops and this was done in the form of group discussions. Shabani (2016) supported the idea that teachers should be involved in activities that help them improve their professional development. Likewise, through group discussions, teachers collaborate to understand the problems in their teaching practices and then design an appropriate type of intervention that is related to learning; hence this developed their ZPD as espoused by Vygotsky (1978).

Consequently, and similarly to Nhase's (2019) study, group discussions and reflections established a learning space in which teachers were afforded opportunities to engage and participate in learning activities (Sedlacek & Sedova, 2017) as well as providing in-depth perspectives on improving individual and institutional practices (Chikunda, 2013). Lantolf et al. (2015) asserts that participation in cultural, linguistics and historically formed settings such as family life, group interactions, and institutional context enhance the developmental process. Similarly to a socio-cultural perspective, teachers were engaged in an all-encompassing variety of cooperative activities and then adopted the effects of working together to acquire new strategies and knowledge (Stott, 2016). This enhanced their social interactions and learning from one another as advocated resonating with Vygotsky's (1978) claim that learning takes place in a social context. Ayele et al. (2019) stress that the conditions for discussions are that

the participants must talk to one another, attend to dialogue, answer questions, suggest more than one point of view, and have the purpose of improving their knowledge, understanding or judgement of the item being discussed.

These group discussions and reflections were carried out during CLWs where the teachers discussed the contradictions in their teaching practices and developed a mediational tool. Additionally, an exemplar lesson was developed in which the mediation tool was implemented. During the CLWs, the participants sat in the sharing circles. According to Lavallee (2009) sharing circles are used to capture people's experiences. During this exercise all the participants are equal, and their ideas are shared through discussions. These sharing circles are similar to Aawambo sharing circles called *Olupale/oshoto*[2]. Since this was the learning space for all of us, the seating arrangement was done in an Africanised way similarly to Liveve (2022) and Simasiku (2022) whereby we sat around the table which is similar to *Olupale/oshoto* - Figure 4.2.

Figure 4.2: Aawambo traditional *Olupale/Oshoto*

[2] Olupale/oshoto is the traditional place, where family members sit around the fire to discuss important issues or to advise the younger ones.

This served as the sharing circle (Lavallee, 2009) and hence minimised the power gradients, that is, symbolising equal power among the participants (power gradient). In Aawambo culture, these circles symbolise the seriousness of the discussions. In the context of my study, the discussions revolved around gender and cultural aspects experienced in our science classrooms. As advocated by Engeström (2001), in expansive learning the participants are supported in accomplishing organisational transformation.

Since data were gathered using questionnaires, semi-structured interviews, classroom observation, stimulated recall interviews, CLWs, the research process was divided into two phases. In the next section, I discuss the research process. Table 4.2 summarises the data-gathering techniques for the research questions that they intended to answer.

Table 4.2: Data gathering methods, their purpose, and analysis

Phase	Methods	Research questions	Purpose	Data presentation & Analysis
1	Questionnaires	1	Participants' profiles and their thoughts on gender and culturally responsive practices.	Elements of conceptions and disposition
	Semi-structured interviews	1&2	To solicit participants' perspectives and pedagogical insights on gender and culturally responsive practices as well as to unearth any underlying contradictions (if any) that enable and/or constrain their gender and culturally responsive practices. These data were also used to validate data obtained from questionnaires.	Elements of conceptions and disposition (How do they understand gender and culturally responsive practices? What are their perceptions? What are the contradictions?)
	Classroom observation	1 & 2	To help me understand and observe how teachers are carrying out their lessons and how they are responding to gender and cultural issues in their science lessons. It was also used to validate data obtained from semi-structured interviews.	Elements of SCT, social interactions, language, mediation
	Stimulated recall interviews	1 & 2	To explain and clarify the methods used by teachers and why, as well as to find out why the teachers have acted in the way they have acted during the lesson presentation.	Elements of SCT (mediation, social interaction, language). Perspectives: conceptions and dispositions

2	Change laboratory (Group discussions and reflections)	3&4	To discuss the surfaced contradictions and tensions (if any) in their teaching practices and develop the mediational tool that is gender and culturally responsive to be used when mediating their science lessons. Additionally, it was used to discuss any challenges experienced by teachers in implementing the mediational tool and how to improve on it.	Elements of SCT: social interactions, culture, language, mediation, ZPD. Perspectives: conceptions and dispositions

4.10 Research Process

This formative interventionist study was carried out in two phases, viz., the contextual profiling phase and the intervention phase (CLWs).

4.10.1 Phase one: Contextual profiling (to answer research questions 1 and 2)

This exploration phase responded to the first two objectives of the study:

1. To determine Grade 9 Physical Science teachers' perspectives and pedagogical insights on gender and culturally responsive practices when mediating the learning of acids and bases;
2. To surface the underlying contradictions (if any) that enable and/or constrain gender and culturally responsive practices in Grade 9 Physical Science teachers' science classrooms.

In this phase as a starting point for the data gathering process, I conducted a detailed contextual profile of my fellow participants, and these served as mirror data (Virkkunen & Newnham, 2013). I started with profiling the participants through questionnaires followed by semi-structured questions. These methods were used to determine the teachers' perspectives and pedagogical insights in terms of their gender and culturally responsive practices when mediating chemistry learning. The topic of acids and bases was used as an example (See section 2.2). It was then followed by classroom observations whose aims were to observe teachers' gender and culturally responsive practices (or lack thereof)) and explore how teachers deal with learners in terms of their (learners') gender. It was also during the classroom observation that I looked at how the teacher closed the gap between learners' everyday science and the science they learn in the classroom. After observation, stimulated recall interviews were carried out while watching the videos to discuss what happened in the classrooms during the lesson presentations. This afforded me an opportunity to do follow-up questions regarding the actions carried out by teachers in the classroom.

4.10.2 Phase two: Intervention phase (to answer research questions 3 and 4)

The expansive phase responded to the last two objectives of the study aimed to develop mediation tools that supported expansive learning for gender and culturally responsive practices for Grade 9 Physical Science teachers when mediating the learning of chemistry topics. The objectives were:

- To support expansive learning and develop mediational tools for gender and culturally responsive practices in Physical Science teaching using acids and bases and combustion reactions as examples.
- To determine how the group discussions and reflections through CLWs influence (or fail to influence) the implementation of the mediational tool when Grade 9 Physical Science teachers mediate the learning of their lessons.

In this phase I used CLWs, guided by the expansive learning cycle, along with group discussions and reflections. The teachers and I discussed the factors that might have constrained them from being gender and culturally responsive and consequently developed a mediational tool that might assist them in being gender responsive when mediating any chemistry topic. Nhase (2019) asserts that these cooperative and shared reflective spaces have the potential to contribute to teacher change in their teaching practices. This might lead to learning and development (Vygotsky, 1978).

Additionally, the research participants worked together towards surfacing the contradictions and tension in developing new ideas or breaking away from a given frame of action and initiating new ideas to resolve the contradictions that surfaced (Sannino et al., 2016). This was done through a series of four CLWs. CLWs are meetings in which "participants and the researcher-interventionists use a set of representational devices designed for jointly analysing disturbances and contradictions in their activities and for developing new solutions" (Sannino et al., 2016, p. 4). Through these series of CLWs, the participants had an opportunity to attain new knowledge about gender and culturally responsive practices employing what Engeström (2001) called expansive learning. To remind the reader, this study was a formative interventionist study that supported creating a space for alteration. As Sannino et al. (2016) explains, it "aims at generative solutions" (p. 10) that may lead to transformation. This implies

that by generativity, my study did not aim merely to interpret data about gender and culturally responsive practices in schools but instead to further provide a platform for the participants to deeply explore possible solutions to the contradictions in the emergence of gender and culturally responsive practices in the schools. Thus, I engaged the participants in this intervention through CLWs. There were four CLWs as discussed below.

The Developmental Work Research (DWR) is functions around sessions called 'change laboratory workshops' in which the researcher and participants cooperatively question tensions and contradictions within and between different dimensions of the activity system (Sannino, 2011). As explained in section 3.3.4, CL workshops were the last tool employed for the data gathering process. The purpose of the CLWs was that they permitted research practitioners (researcher and participants) to investigate and explore the contradictions within existing practices to develop new knowledge and new forms of activity that are learnt as they are created (Engeström, 1999). This implied that this study did not aim solely at exploring gender and culturally responsive practices of Physical Science teachers, but also to create a platform where participants are engaged in the intervention through CLWs. There were four CLWs conducted. Through CLWs the study anticipated bringing about changes to gender and culturally responsive practices of Physical Science teachers when teaching chemistry topics.

Figure 4.3 shows the expansive learning methodology through the CLWs. This emanated from phase one. The participants questioned the existence of the gender and culturally responsiveness in the teaching of Physical Science. Hence, this included the perspectives of the participants regarding gender and culturally responsive practices.

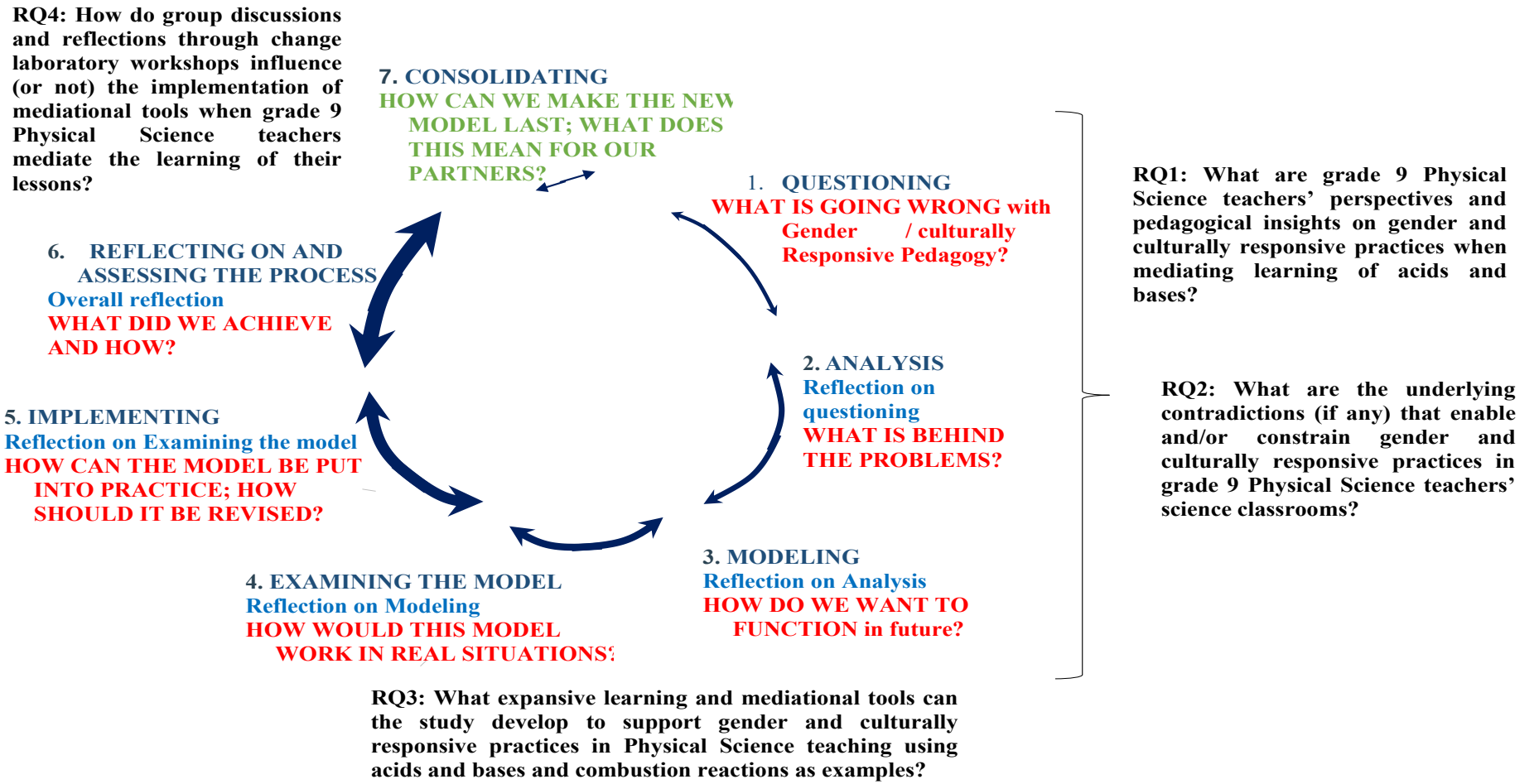


Figure 4.3: The expansive learning cycle or process (Adapted from Lotz-Sisitka et al, 2017, p. 902)

During the CLWs we received presentations from critical friends. Before I engage with what transpired during these CLWs, I would like to give the profiles of these critical friends. They were both from South Africa. In CLW 1, the critical friend was a PhD scholar and a school principal. He gave the presentation on the power of reflections. This focused on how teachers can engage learners through reflection, with the purpose of improving the teaching and learning process. In CLW 3, we received another presentation on the document analysis. The critical friend was a former PhD scholar and a lecturer at one of the universities in South Africa. He was also responsible for BEd (Honours) students in Namibia. These presentations proved to be of importance in our PLCs. I now discuss what transpired in each CLW.

4.10.2.1 Change laboratory workshop 1

The first CLW was conducted on 09 February 2023. The purpose of this workshop was to introduce the participants to one another. It was during this workshop that I explained the rationale of the study as well as its potential value. During this CLW we set the rules that guided us through all the CLWs. Furthermore, I presented mirror data from data generation methods from phase one. Hence it was during this CLW that the participants started with the first actions of the expansive learning cycle, namely questioning the nature of gender and culturally responsive practices in Physical Science lessons. During this workshop, a critical friend from South Africa made a presentation on the power of reflection to us. This workshop was necessary for this study because it afforded us an opportunity to understand the importance of reflection in the teaching and learning process. The participants indicated the importance of this presentation through the reflections. Consequently, reflexivity became part of all our workshops in following the expansive learning cycle (see Figure 4.3). This workshop lasted for two hours.

4.10.2.2 Change laboratory workshop 2

The second CLW was conducted on 16 February 2023. Before the presentation of the planned activity, the participants reflected on the previous workshop, discussing, for instance, what they had learnt, what they had tried and what it meant to their profession. One participant (T6) reflected that it had been a learning curve for him. He indicated that he had tried it with his

learners, and it had been successful. It was during this exercise (his own classroom) that he needed to be slow when explaining the concepts to learners (learners' reflecting).

During this workshop, the participants discussed the origins or causes of factors that constrain gender and culturally responsive practices (group discussions). We looked at the constructs taken from the NCBE syllabus and question papers (see Appendix G). These enabled us to discuss how we understood them and what do they meant in terms of gender and culturally responsive practices. It also afforded us an opportunity to critically analyse the materials that were used in the teaching and learning process and to see if they were gender and culturally responsive as well as to find substitutes for the materials that were gender biased. This addressed the second learning action of the expansive learning cycle which was analysing. This workshop lasted for two hours.

4.10.2.3 Change laboratory workshop 3

The third CLW was conducted on 02 March 2023. Similarly to previous workshops, the group started with the reflection of the previous workshop. For instance, T1 reflected that teachers do not really pay attention to gender and cultural aspects that are portrayed in the teaching and learning materials, for example in the question papers or textbooks. Some of the activities that are done in our communities are viewed as normal even though they have some gender stereotypes attached to them (see Appendix G). This resonates with Mthembu et al. (2023) that gender stereotypes in our communities are implicit and not easily recognised for them to be addressed.

The purpose of this workshop was to devise the mediational tool that is gender and culturally responsive. However, before engaged in the process of devising the tool, the participants and I received a presentation from another critical friend from South Africa on how to analyse documents. This was important as it offered an opportunity to this PLC on how to engage with curriculum and other policies in the teaching and learning domain. This included teaching and learning materials. Also, it served the role of looking in detail at the materials that we use in our classrooms. Even though in the previous workshop we looked at the excerpts from the curriculum and past year question papers, this presentation assisted us on how to engage with these documents from the planning stage.

The presentation looked at how to use the five Topic Specific Pedagogical Content Knowledge (TSPCK) components developed by Mavhunga and Rollnick (2013). These TSPCK components are learners' prior knowledge, curriculum saliency, what is difficult to understand, representations and conceptual teaching strategies. These helped us in the planning of the lesson as we had to consider these in the planning. For instance, we had to understand learners' socio-cultural background (Mavuru & Ramnarain, 2020; Vygotsky, 1978) and this served as prior knowledge. This presentation was of benefit as it allowed us to engage critically with the educational documents in order to eradicate all gender and cultural bias in our teaching and learning process. We also had to look at curriculum saliency (how the teachers can be assisted in being gender and culturally responsive). This afforded them an opportunity to deliver their lessons more effectively. The teachers needed to know what concepts were difficult to understand and how they could help learners (both boys and girls) based on their individual needs (Brown & Crippen, 2017; Mlama et al., 2005). This presentation looked at the materials that could be used by the teachers in presenting their lessons.

In the context of this study, this focused on the local materials that could be used in the teaching of these topics (acids and bases and combustion reactions). Lastly, on the TSPCK, we looked at the conceptual teaching strategies that the teachers could use. This was intended to ensure that all learners were afforded equal opportunities in the teaching and learning process (Bakshi, 2016; Dorji, 2020; Mavuru & Ramnarain, 2020). This presentation also assisted us in the development of mediational tool as we learnt what we needed to consider in the preparation of the lesson.

It was also during this workshop that the topic for the exemplary lesson was discussed. This was done in order to prepare the materials that we needed for the lesson presentation. The participants agreed to develop the exemplar lesson on the topic of combustion reaction. To remind the reader, the topic of acids and bases was used as an example in phase one. Hence, the third learning action of the expansive learning was addressed during this CLW. This workshop lasted for two and a half hours.

The participants suggested that, since we normally met in the afternoons, the lesson presentation would also be carried out in the afternoon. The reason was that these learners were based in the hostel making it easy to access them as opposed to day learners. One participant (T6) volunteered to teach this lesson. Since it was costly to travel to the venue, a WhatsApp group was opened to facilitate easy communication. Through this group we discussed how we were going to teach the lesson.

4.10.2.4 Change laboratory workshop 4

The fourth and last CLW was conducted on 15 March 2023. We started with reflections on the previous workshop. For instance, T3 acknowledged that, as teachers, we needed to work hard at removing all gender and cultural biases. This includes the planning as well as the presentation of the lessons.

The purpose was to present the lesson by implementing the developed mediational tool. We started by discussing again how to teach the lesson as it was explained during the WhatsApp group. This included the writing of the lesson plan (see Appendix H). The gathering started with the planning of the lesson (see Figure 4.4 below). As explained in the consent letter, anonymity was a challenge since this study aimed at devising a mediational tool that science teachers could use in being gender and culturally responsive (see Appendix B). During this discussion, we explained thoroughly how the developed mediational tool had to be implemented, including how to engage all the learners in the lesson, how to use their everyday knowledge and acknowledging their cultural experiences. The topic that was used for the exemplar lesson was combustion reaction (see section 2.2). After the preparation of the lesson one of the participants (T6) volunteered to teach the lesson while the other participants were observing. T6 had 13 years of experience in teaching Physical Science. Hence, he was confident in teaching this topic.

Figure 4.4.: Planning of the exemplar lesson

The participants resolved some of the contradictions by suggesting the solutions to challenges that are experienced in the science classroom regarding gender and cultural responsiveness and consequently co-developed the mediational tool that is gender and culturally responsive. During this workshop, the participants presented and reflected on the implementation of the mediational tool that was discussed during CLW 3. Thus, the aim was to expand the understanding of the participants regarding the implementation of the mediational tool. This addressed the fourth and fifth learning actions of expansive learning (see Figure 3.5).

After the presentation of the lesson, the participants and I met again to do the reflections on the lesson presented as well as the overall reflections on all the CLWs that were conducted. This workshop lasted for three hours. What is worth noting is that all the participants were present in all the CLWs. This demonstrated their sense of ownership of the study.

The study used the expansive learning methodology research design for the research questions (see Figure 4.3). The most important contribution of CLW to the study was the learning that took place through the collective and collaborative activities of developing the mediational tool that was gender and culturally responsive.

4.11 Data Presentation and Analysis

Data analysis involves organising, accounting for, and explaining data (Cohen et al., 2018). It requires researchers to make sense of data by consolidating, reducing and interpreting what people said and what the researcher has seen and read (Merriam, 2009). The decision on which procedures of data analysis to embark on is governed both by fitness for purpose and legitimacy (Cohen et al., 2018). In other words, data analysis concerns how we move from data to understanding and explaining the phenomenon in question (Cohen et al., 2018) and this is done by noting patterns, themes, and categories (Braun & Clarke, 2006). Based on what I have highlighted earlier in this study, data were analysed inductively and deductively. To Flick (2018), inductive analysis involves reasoning once all data are gathered to establish themes and patterns that emerge. This can be done through narrative stories (Nhase, 2019) and deducing the episodes from these stories (Sedlacek & Sedova, 2017). On the other hand, in deductive analysis themes are formulated from the elements of the theoretical framework (socio-cultural) and analytical framework (CHAT) as well as from the indicators of conceptions and dispositions (Atallah et al., 2010) (see Appendix E). The similarities in data generated and the emerging trends and patterns were used to formulate the analytical statements. I now look at how I analysed data from the explorative phase.

4.11.1 Explorative phase data analysis

For the data collected in this study, different methodological instruments were employed to complement and support them as postulated by both the research goal and questions in this research. These guided the process of breaking texts into pieces and coherently combining them. Data generated from these instruments, as explained in section 4.8, were categorised and analysed as per the research questions, namely research questions 1 and 2. Informed by the interpretive paradigm, the data gathered in this phase one was condensed using inductive categories derived from the data. The data were colour coded to identify the patterns. According to Creswell (2008), coding is all about making sense of the textual data and then grouping the coded data into a broad theme. The themes were then extracted by reading through the data numerous times and assigning the answers in various categories. I then re-read through the categorised responses to inductively classify and identify the sub-themes which were then

refined into themes. Throughout this cleaning process, some categories were refined, and some of the responses had to be shifted from one category to another for better fitting.

The raw data from questionnaires and semi-structured interviews were analysed to understand the participants' views and perceptions and pedagogical insights in gender and culturally responsiveness when mediating the learning of chemistry topics in Physical Science. Moreover, the raw data from the video-recorded lesson observations and stimulated recall interviews were used to understand the actions that took place when the participants taught in their classrooms. I wrote a narrative story for all the participants' data and deduced the episodes that were later transformed and classified into themes.

During this stage I also used the second-generation and third CHAT activity system to analyse the raw data generated from these techniques. The activity system was used as a lens to identify the tensions and contradictions between and within the elements of this system regarding being gender and culturally responsive in the teaching and learning process. Hence, these were also used as mirror data that informed the intervention (expansive) phase. Figure 4.5 shows the analysis process of explorative data in phase one.

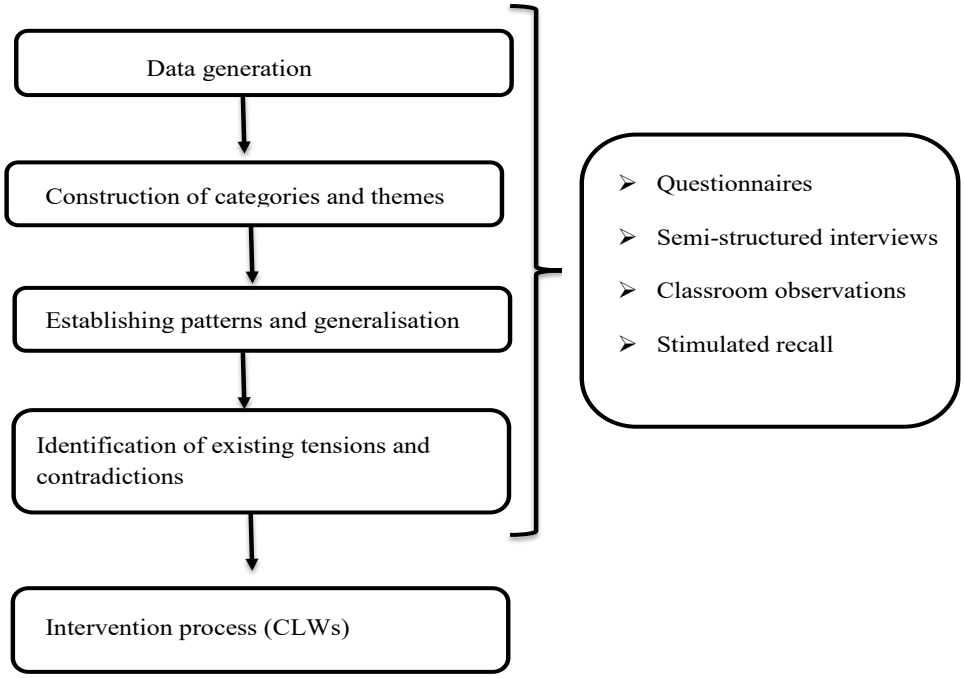


Figure 4.5: Inductive analysis process (Adapted from Chikunda, 2013, p. 204)

4.11.2 Expansive phase data analysis

Data analysis in phase two of this study applied discourse analysis both through the interpretive paradigm and CHAT tools. The main goal of this phase was to comprehend the expansive learning opportunities generated by this intervention. Consequently, this analysis drew on CHAT, concepts of ZPD, contradictions, expansive learning, transformation, envisioning, and resistance to understanding the change in the teachers' understanding and pedagogical insights of gender and cultural responsiveness when mediating the learning of science through CLWs. I employed CHAT as an analytical framework to explore gender and culturally responsive challenges and contradictions that teachers encounter in their teaching practice, that is, to identify contradictions or tensions in the activity system (Engeström, 2001; Lotz-Sisitka et al., 2017). I resumed the process by examining information obtained from the instruments used in phase one (first stimulus) as explained earlier, and then used this information as mirror data to inform my intervention phase. This was followed by the use of the expansive learning cycle, where participants analysed the origin of contradictions and then embarked on finding the solutions by developing a mediational tool that is gender and culturally responsive (see sections 4.9.2.1, 4.9.2.2, 4.9.2.3 & 4.9.2.4). Thus, they were able to transform their practices (Virkkunen & Newnham, 2013).

Next, I briefly outline how data were coded for all the data gathering methods.

4.11.3 Data coding

Respect for ethical issues was considered crucial in the study, so the data sets were coded for anonymity and confidentiality. Table 4.3 below illustrates the coding system to identify both the data generated and research participants as a source of raw data. Since various data gathering methods were employed in this study and for easy classification and identification of methods used, different data coding was used. These methods were questionnaires, semi-structured interview, classroom observation, stimulated recall interviews and CLWs.

Table 4.3: Data codes

Participant	Questionnaire code	Semi-structured interview code	Classroom observation code	Stimulated recall interview code	Change laboratory workshop code
Teacher 1	T1-Q	T1-SSI			T1-CLW
Teacher 2	T2-Q	T2-SSI			T2-CLW
Teacher 3	T3-Q	T3-SSI	T3-CO	T3-SRI	T3-CLW
Teacher 4	T4-Q	T4-SSI	T4-CO	T4-SRI	T4-CLW
Teacher 5	T5-Q	T5-SSI	T5-CO	T5-SRI	T5-CLW
Teacher 6	T6-Q	T6-SSI	T6-CO	T6-SRI	T6-CLW

4.12 Validity and Trustworthiness

Validity is one of the fundamental components of any research. Validity refers to the researcher checking for the precision of results by using certain measures such as triangulation, member checking and thick description among others (Creswell & Creswell, 2018). Additionally, honesty, depth, richness and scope of data achieved can be used to address the issue of validity (Cohen et al., 2018). These scholars pointed out that criteria for validity are credibility (accuracy of data and findings), transferability (generalisability), dependability (consistency) and confirmability (neutrality).

Different data gathering methods were employed namely questionnaires, classroom observations, interviews, group discussions, and reflections and this validated the data through triangulation. According to Flick (2018), triangulation entails gathering information using multiple sources or methods with the aim that the conclusion to the findings provides only

systematic bias, inadequacies or limitations of a specific method. In triangulation, evidences from different sources are used to build articulated justifications for themes (Creswell & Creswell, 2018). In this study, for instance, the interview schedule was piloted with fellow science education PhD scholars in our community of practice. This enabled to me to change the questions that were ambiguous.

Trustworthiness means that the research gathering methods work consistently in different contexts (Moon et al., 2016). The lessons were video-recorded and thereafter I watched these together with the teachers. Questionnaires, observation, and interview schedules were adapted to ensure their validity. Creswell and Creswell (2018) similarly who maintain that the use of existing instruments pronounces the established validity of scores achieved from the previous usage of such an instrument.

In the context of this study for assuring validity my work was presented within our community of practice in science education as well as at platforms such as research design courses, the research school, and during PhD week workshops. This enabled me to receive constructive feedback during these gatherings. My study was further presented at Namibian SAARMSTE Chapter colloquiums for validation purposes. Equally, group discussions and reflections through a reflective space (Nhase, 2019) contributed to validation and trustworthiness. Additionally, the interviews were recorded and then transcribed verbatim. Thereafter, the transcripts were given to the participants for validation purposes, a process known as member checking (Creswell & Creswell, 2018). I now look at the ethical considerations.

4.13 Ethical Considerations

According to Cohen et al. (2018), ethics deals with what is good or bad, right or wrong, and ethical research involves what researchers should or should not do in their research and research conduct. Thus, all ethical practices need to be engaged in all steps of the research process (Creswell, 2012), that is, before conducting the study, at the beginning of the study, during the collection of data, analysis of data, reporting, sharing, and storage of data (Creswell 2014). For this Cohen et al. (2018) emphasise that a code of ethical practice enables the researcher to be aware of the obligations to their participants and those obligations address non-maleficence, loyalty, and beneficence. Hence Creswell (2014), point out that the researcher

needs to protect their participants, develop trust with them and promote the truthfulness of the research. Similarly, ethically the researcher must respect the participants and use non-discriminatory language (Creswell, 2012).

Before I started the research process in this study, I obtained an ethics clearance certificate from the university after I had submitted my research proposal. This included the application for ethical clearance from the Rhodes University *Education Faculty's Research Ethics Committee.* Moreover, I sought and obtained permission to conduct the research from the Director of Education for the Oshikoto Region, the school principals of my participants as well as the participants themselves. Even though the research focus was not on learners, it was importantt to engage with their parents as the observed lessons were going to be video-recorded, hence assent was obtained from these parents. This constitutes *transparency* and *honesty* during the research process.

Additionally, before the beginning of the research process, all the research procedures were explained to the participants. This included the research process and what was expected from the participants. They were informed about their voluntarily participation in the study and that they had the right to withdraw from participating in the study at any time. They were also informed that, since this was an intervention study, the issue of anonymity would be a challenge. This was because the mediational tool that was developed would be shared with other Physical Science teachers. I then used the codes that were allocated to the participants to protect their identities. This followed the advice of Creswell (2014) that it is required for the researcher to protect the privacy of the participants. This is because qualitative data analysis often concerns individual cases and unique instances and may include personal and sensitive matters (Cohen et al., 2018). Since the teachers were not familiar with the expansive learning cycle, the workshops were introduced in the form of presentations from the critical friends. This was done to address the ignorance of the teachers and hence respect them through creating an empowering environment.

For *accountability* and *responsibility* I had to guarantee my participants that the information they provided would be treated as confidential and would not be shared on any other platforms where it was not supposed to be shared. Also, I did not misuse my position as a principal or

PhD scholar in this study for my personal gain and any conflict of interest was disclosed. All the codes of ethics were observed during the entire research process. Lastly, on ethical considerations, I practised *integrity, academic professionalism and researcher positionality.* This was to ensure that this was my own work in my own words and indicating where I had drawn from other people's work, I have referenced as per the *Department* of Education's referencing guide. There are no untruths, manipulations and misreporting of data.

4.14 Chapter Summary

This chapter explained in detail the methodological choices made in this study. It started by giving an overview of the two research paradigms that underpinned the study, namely the interpretivist and the critical paradigms. These paradigms were used as complementary philosophical lenses that informed the study. The chapter discussed the case study approach in a form of PAR especially in my phase two of this study. It also highlighted the research goal and research questions. It further explained the research site and sampling of the research participants. The chapter went on to discuss the research process, which was divided into two phases; the explorative phase which focused on contextual profiling, and the intervention phase. The data that emerged from the instruments informed and guided the presentation, analysis of data, and expansive learning process as presented in chapters five, six and seven. The chapter also highlighted how I have ensured the validity and trustworthiness of data gathered as well as ethical consideration. In the next chapter I present, analyse and discuss the data gathered from questionnaires and semi-structured interviews.

CHAPTER FIVE: GENDER AND CULTURALLY RESPONSIVE PRACTICES: PERPECTIVES AND INSIGHTS

> Culture is important so that it fits children into the school, and therefore provides them with a sense of **recognition that they count in the school culture**, and that this sense of recognition then supports the student to learn the target curriculum. (Harrison & Skrebneva, 2020, p. 19, my emphasis)

5.1 Introduction

In the previous chapter, I provided the reader with the detailed methodological choices that underpinned the study. To remind the reader, this study aimed to explore and expand Physical Science teachers' gender and culturally responsive practices in their science classrooms when mediating learning of chemistry topics using acids and bases as an example. To have a better understanding of the participants' experiences and pedagogical insights, questionnaires and semi-structured interviews were used in the first phase of this study with the six participants involved in this study. To analyse the data generated from these tools, I used the second generation of CHAT to surface the contradictions that arose within and between the elements of the activity system. This then led to the intervention in phase two (see section 4.9.2). In this chapter, I thus present, analyse and discuss data to address the following two research questions. These questions were dedicated to questioning and analysing (expansive learning actions) the nature of the gender and culturally responsive practices of the teachers.

- What are Grade 9 Physical Science teachers' perspectives and pedagogical insights on gender and culturally responsive practices when mediating learning of acids and bases?

- What are the underlying contradictions (if any) that enable and/or constrain gender and culturally responsive practices in Grade 9 Physical Science teachers' science classrooms?

The questionnaires, as previously explained in section 4.8.1 assisted me in building the teachers' profiles in terms of experience in teaching Physical Science, using acids and bases as an example. This included their understanding of gender and culturally responsive practices when mediating the learning of chemistry topics. Thus, this helped me to understand these teachers' positions regarding these concepts. Moreover, the supporting data from the questionnaires informed how I constructed my semi-structured interview questions. That is, the semi-structured interviews helped to triangulate and to corroborate data from the questionnaires (see section 4.8.2). These individual semi-structured interviews were used to generate data from all six participants. As stated in section 4.8.1, these interviews lasted for about 15 to 20 minutes, and this differed from participant to participant based on how they were expressing themselves during the interviews.

This section begins by summarising the data generated from the questionnaires and the semi-structured interviews. As I analysed the data, I found out from their responses that their perceptions and understanding of the concept varied. Table 5.1 shows the connection and alignment of the themes that emerged from both questionnaires and interviews and the literature related to gender and CRP and the SCT that informed this study. Hence, the literature and the theoretical and analytical frameworks helped me in discussing the findings in this chapter. The voices of participants from both questionnaires and interviews were used to support the discussions.

I have presented this chapter in accordance with each theme and discussions drawn from the data collected from teacher 1 (T1) to teacher 6 (T6). In organising this chapter, with the help of literature on gender and CRP and the SCT, I developed various categories to organise and synthesise the data. This assisted to make sense of the data, i.e., seeing if the data responded to and answered each research question from both the questionnaires and the interviews. The presentation of data is followed by a thick discussion of the data summary from all themes. While the theories discussed in Chapter Three are well brought to bear on the data, Vygotsky's

SCT (1978) and CHAT's second generation were used in analysing and interpreting data in this chapter. The main findings discussed relate to the perspectives and pedagogical insights of the teachers on being gender and culturally responsive are summarised in Table 5.2. The data and results are synthesised using the literature and theories in this study. Lastly, the summary in this chapter presents the results and findings from the overall chapter.

Table 5.1: Themes emerging from questionnaires and interviews

Themes	**Theory**	
	Literature	**Conceptual/Theoretical Framework**
Views and experiences of teaching boys and girls	Abraha et al. (2020); Bakshi (2016); Chikunda (2014); Mlama et al. (2005); Kahamba et al. (2017); Vygotsky (1978)	Participants' views and experiences in teaching boys and girls in their science classrooms. Social interactions in the science classroom.
Understanding of gender and culturally responsive practices in teaching and learning science	Attalah et al. (2010); Gullberg et al. (2018); Bottiani et al. (2018); Miller (2020); Mensah (2021); Vygotsky (1978); Mavuru (2022)	The participants' views on gender and culturally responsive practices when mediating the learning of science in their classroom. The participants' perspectives (conceptions and dispositions) on being gender and culturally responsive. Participants link cultural experiences of learners, connecting learners' culture to learning of science Addressing cultural misconceptions in the teaching of science.
Surfacing contradictions embedded in science teaching and constrain teachers' gender and culturally responsiveness	Chikunda (2014); Engeström (2001); Engeström and Sannino (2010); Sannino et al. (2009).	Teachers' perspectives and pedagogical insights concerning cultural and historical dimensions in mediating the teaching and learning of science (historicity). Underlying contradictions that constrain teachers in being gender and culturally responsive. Teachers' views in terms of tensions and innovations within the activity system (multi-voicedness).
Gender and culturally responsive practices and professional development	Admiraal et al. (2021); Gess-Newsome et al. (2019); Ngcoza and Southwood (2019)	Professional learning communities and PCK in the teaching and learning process. Benefits of PLCs and PCK.

Table 5.2: Themes emerging from questionnaires and interviews with socio-cultural components and CHAT

Themes	**Socio-cultural/CHAT components**
Views and experiences of teaching boys and girls	Experiences of teaching boys and girls (participation of learners in the class). Interaction of the components of the activity system (subject, object, tools, division of labour, community and rules). How teachers mediate the learning of science to ensure gender equality and gender equity for both boys and girls.
Understanding of gender and culturally responsive practices in teaching and learning science	Approaches to being gender responsive and addressing bias. Social interaction in the science classroom to enact gender and cultural responsiveness. How teachers make learning compatible with the socio-cultural context of the learners. Acknowledging learners' culture in their science teaching and connecting it to the curriculum. Opportunities provided to learners from diverse ethnic backgrounds. Implications of gender socialisation. Addressing cultural beliefs and misconceptions in teaching and learning science.
Surfacing contradictions embedded in the science education activity in being gender and culturally responsive	Teachers' perspectives and pedagogical insights concerning cultural and historical dimensions in mediating the teaching and learning of science. Underlying contradictions that constrain teachers in being gender and culturally responsive. Teachers' views in terms of tensions and innovations within the activity system.
Gender and culturally responsive practices in relation to teachers' professional learning communities	Participants' need of professional development regarding gender and culturally responsive practices.

Table 5.2 shows the themes that emerged from questionnaires and interviews with socio-cultural components and CHAT. This was done through colour coding of data (see Appendix I). I now discuss these themes with supporting excerpts from questionnaires and semi-structured interviews.

5.2 Teachers' Perspectives and Pedagogical Insights on Gender and Culturally Responsiveness Practices

The data presented, interpreted and discussed in this section are gathered from questionnaires and semi-structured interviews. I used the codes as indicated in Table 4.3. The manual colour coding was employed to highlight the concepts that were related to the purpose of the study. This allowed me to generate the themes. For instance, the data sets that were related to the understanding of gender and culturally responsive practices were coloured pink, the indicators of gender and culturally responsive practices were coloured green, and the contradictions such as gender and cultural stereotypes were coloured red. While colour coding the data, I also annotated the transcriptions with the related literature (see Appendix I). All the similar colour-coded excerpts were collated to generate the sub-themes and main themes.

The analysis of data revealed the different perspectives and pedagogical insights of the participants regarding gender and culturally responsive practices. The first theme is on the views and experiences of teaching boys and girls. The second theme discusses the teachers' knowledge, perceptions and understanding of gender and culturally responsive practices in the teaching and learning of science. The third theme deliberates on the surfaced contradictions that are embedded in science education. The fourth theme highlights PLCs regarding gender and culturally responsive practices. In addition, in the discussion of these themes I use verbatim excerpts from the participants' responses to support my discussions. These are presented, interpreted and discussed below.

5.2.1 Views and experiences of teaching boys and girls

In terms of views and experiences of teaching boys and girls, the findings revealed that the teachers seemed to experience the differences between teaching boys and girls in their classrooms in terms of learners' participation. For instance, when asked about the participation of learners in the class, most of the participants indicated that in most cases the boys participate

more than the girls and only T2 indicated a balance in the participation of boys and girls. However, T6 expressed that, even though the boys participate more in science lessons, girls tend to perform better than boys. T4 also expressed that it "*depend(s), because sometimes boys are more participating than girls but otherwise again girls participate more than the boys so is vice versa thing"* (T4-SSI). T6 added that *"I am teaching Physical Science and in terms sometimes and some topics that the boys would like to dominate the girl and also the performance seems girls are doing better, they are more committed"* (T6-SSI).

The excerpts above indicate that teachers seemed to understand the roles of the learners in science lessons highlighting that the lack of participation of a certain gender may lead to them not being fully engaged in the presentation. These findings resonate with Dorji's (2020) findings that teaching and learning become inclusive and interactive when the participation of both boys and girls is balanced. Hence, it is vital that teachers are gender responsive and facilitate the different learning trends of both boys and girls (Zahro et al., 2020). This allows both boys and girls to be actively involved in the teaching and learning process as reiterated by Dorji (2020).

Moreover, the study also revealed that even though there is low participation from girls in science lessons, these teachers attempt to apply gender equity and equality in their science lessons, thus enabling them to try to ensure that both boys and girls take part in the lesson. In this regard, T5 expressed that "*all learners are treated equally irrespective of their gender. All learners have equal chances of asking and answering questions"* (T5-Q). T4 added that *"every learner regardless of gender has to participate in Physical Science"* (T4-Q*)*. Similarly, T3 expressed that:

> I try by explaining what they don't understand and give more examples that, giving examples you give the same for all either for all for the whole class all boys and girls just to boost their performance or understanding (T3-SSI).

The above excerpts indicate that these teachers seem to be trying to be gender responsive and address all learners in their classrooms. This has affinity with Mlama et al.'s (2005) findings that suggests that the teacher should enhance classroom participation by ensuring that both boys and girls do answer the questions asked in class. Moreover, evident in these excerpts is that learners' participation in the lesson enhances the social interactions among the learners and

teachers as espoused by Vygotsky (1978). Hence, these teachers seem to be employing some of the methodologies to ensure that their learners are participating. These echoed similar sentiments suggested by Abraha et al. (2021) that for better participation for both boys and girls, teachers should ensure that they use gender responsive methodologies.

Furthermore, the interaction of the components of the activity system (subject, object, tools and rules) allows the teachers to socially interact with the learners as advocated by Vygotsky (1978) as well as follow the rules as espoused by the subject policy and the MOEAC's national curriculum (2018). In addition, this enables the elements of the activity system such as how the subject (Physical Science teachers) interacts with the community (learners) using the rules (NCBE). This is similar to what was suggested by Sannino et al. (2016), that the rules should mediate the interaction between the subject and the community and between the subject and the object.

5.2.2 Teachers' perceptions and understanding of gender and culturally responsive practices

The findings revealed that all the participants who were interviewed expressed an understanding of being gender and culturally responsive. They all acknowledged that they are practising gender and culturally responsive practices in their classrooms. For instance, T2 expressed that "*by using gender-neutral language. By avoiding stereotyping learners. Asking learners to participate regardless of* gender. *Encourage boys and girls to sit together" (*T2-Q*).*

In support of this, T3 also expressed:

> … and they came from different background not to say culture and you make effort to make sure that these people, these learners they receive equal treatment and equal distribution or benefits, for example, other benefits, its treatment it should be the same for all of them (T3-SSI).

These findings also revealed that in promoting social interaction in the science classroom and enacting gender and cultural responsiveness, learners are always encouraged to work with their peers. The excerpt above resonates well with Kahamba et al. (2017) who accentuated that teachers' day-to-day interactions with learners offer a unique opportunity to either support the status quo in classrooms or make a transformation that will affect the learners' achievements. For instance, T2 expressed that

> I make sure that all of them participate equally by including them all in the activities, even the sitting the way they are arranged. Sitting arrangement it is mm it is like oya mixathana (Translated: they are mixed). iiyaa maar ngwee nee otoya kwatele kumwe nenge oto ya kwatele komeho, oyo yakwate komeho ya mix kutya kehe gumwe na gumeko (Translated: you direct them, for them to take the lead and let everyone to take part) (T2-SSI).

The study also revealed that the teachers do make teaching and learning compatible with the socio-cultural contexts of the learners. This means that the teachers acknowledged learners' culture in their science teaching, connecting it with the curriculum. Hence, they provided opportunities to learners from diverse ethnic backgrounds. For instance, T1 pointed out:

> You have to carry the background of the learners so what they believe and what also you believe or you observe. I used to ask them at least to come up with some what they have learnt, so from their community... so on, a teacher should listen to all the ideas coming from different learners especially boys and girls and from the learners who are from different background when they are sticking more on their myths (T1-SSI).

T2 further elaborated that

> All of us we have to participate and you can also create a room for the learners to hear their background on what are they saying about that one. So that you can at least emphasise on their negative … what they are going to give they are giving answers but they are reflecting on their background what they know which is not even stipulated in the basic competencies. So if you are ready to I mean if you know this one you can help your learner (T2-SSI).

T5 echoed that *"having an awareness of one's own cultural identity and views about differences plus the ability to learn. This stand a reason to promote gender-culturally responsive"* (T5-Q). Correspondingly, T5 expressed similar sentiments on acknowledging knowledge from learners' communities:

> We call an elder or grandmother or mother then they come and explain to us how ombike is done. Remember ombike is done through the process of fractional distillation yes, we call them in and explain to the kids the knowledge they have then how everything is being done. From the kuku explain the process of ombike you show them pictures, then from there you move on a real lesson to explain the fractional distillation in the lesson. So we call in such kind of experts that we have around the community (T5-SSI).

These responses indicate that these teachers seemed to be aware of how the diverse socio-cultural contexts of the learners play a role in the teaching and learning of learners (Mavuru & Ramnarain, 2020). This finding is similar to what Harrison and Skrebneva (2020) suggested,

that teachers should recognise the important influence that culture has on learning and make their teaching processes compatible with the socio-cultural contexts as pointed out in the epigraph above. This is because culture shapes the learners (Vygotsky, 1978). Teachers should ensure that they have provided opportunities to all learners from diverse ethnic backgrounds to have free and personal cultural expressions so that their voices and experiences can be amalgamated into the teaching and learning process regularly (Gay, 2018). However, this is only possible when teachers understand the role of culture and uphold collective approaches to learning among learners and communities to use students' distinctive cultural backgrounds as a foundation for learning (Jett et al., 2016).

The study also revealed that there are gender socialisation implications. Some learners still believe in gender stereotypes from their communities. Moreover, there are cultural beliefs as well as misconceptions when it comes to teaching and learning science. For instance, T6 pointed out that

> Challenges that are experienced is to get good examples or scenarios that are not so gender biased. That is one of the challenges just to get the examples. If you are talking about somebody is playing maybe like soccer obvious that soccer part is familiar with the boys leaving it to male gender. Now obvious the teacher sometimes is even difficult you end up saying like a boy because a set-up itself getting those activities (T6-SSI).

On the issue of misconceptions, T1 explained that

> These learners can tell you that so you don't need to put on red shirt or any to carry anything which is red during the rainy season. So this one it can cause or you might find yourself being stricken by the lightning (T1-SSI).

Similarly, T5 also added that

> there are few also who tend to say they memorise the concept from the community when you bring in the fractional distillation you have and then ask some few questions you remember if your terminologies in Physical Science they tend to write what the community member was presenting instead of writing what they are supposed to write what we learn in the syllabus (T5-SSI).

These findings corroborate with Bottiani et al.'s (2018), that only a few teachers are well equipped to link cultural differences ensuring that all learners have chances to learn and thrive. This leads to science teachers struggling with enacting culturally responsive pedagogies

(Brown & Crippen, 2017). This indicated that teachers also face challenges in being gender and culturally responsive, even though some scholars encouraged teachers to engage with science in everyday activities and design informal settings that learners cross and also connect to school science (Panuel, 2017). Similarly, schools as secondary institutions tend to display attributes they had at home. Thus, this is the reason Parker et al. (2017) suggested that teachers need to understand learners' culture and their background and use such awareness to help learners' learning and cultural competence. This is because teachers are responsible for learning about cultural and social issues, societal contexts, imbalances of power and educational and social disparities, and how they affect the academic achievements of learners (Kayaalp, 2019), thus addressing any misconceptions or cultural beliefs that are associated with learning of science.

5.2.3 Surfacing contradictions embedded in science teaching

The study revealed that the teachers involved in this study seemed to experience a difference in teaching both boys and girls, particularly T3, T4 and T6. Some viewed gender and cultural responsiveness from the social justice perspective. This is because there are those who have been previously disadvantaged especially the girls (Heijnen-Maathuis, 2008). For instance, T3 expressed that "*treating learners equally in the classroom it make the learners to feel comfortable and be able to and free to give their ideas and to participate".* Some viewed being gender and culturally responsive as a way of addressing previous inequalities and social disadvantages in the teaching and learning of science. Echoing similar sentiments was T5 who explained that "*giving the girls a chance to be the head of the group or group work or project, you are giving them confidence to be able to give their opinions and feel like they are valued and are part of the class"*. These sentiments illustrated the teachers' perspectives and pedagogical insights concerning being gender and culturally responsive and how it is beneficial to the learners.

The thread that ran through most of the participants' responses is that they experience the difference in teaching and learning of both boys and girls with the boys being active in taking part in the teaching and learning process and girls being less confident in partaking in science activities. This seemed to concur with the findings of previous studies which revealed that learners – especially girls – tended to have their participation influenced and affected by socio-

cultural factors (Iwu & Azoro, 2017). This is also embedded in the historicity of learning science. Girls are often regarded as not being good in some STEM subjects (Cheryan et al., 2017) while males are associated with being good in science (Archer et al., 2012). For this reason, T1 expressed that *"previous years teachers use to pay attention to the boys than the girls".* This indicated the historical dimension in mediating the teaching and learning of science to different genders and revealed the historicity of science education in Namibia, where girls experienced unfairness and inequalities in the learning of science. Essentially, the tension is traceable in the historicity of science teaching (Engeström & Sannino, 2011) which evolved into inner contradictions in teaching (Virkkunen & Newnham, 2013).

Subsequently, these underlying contradictions constrain teachers in being gender and culturally responsive when mediating the teaching and learning of science. This also includes cultural beliefs regarding the learning of science by girls. For example, T3 pointed out that "*I don't know so but they just... because they perceive that science subject are tough especially like chemistry. They just believe that it is difficult for them."* Teachers viewed these as the tensions or contradictions in their classrooms (activity system).

Clearly, gender stereotypes are still prevalent in the community. For instance, T1 indicated that:

> From the previous experience, girls were labelled that they are not good in science. For as a teacher now I try to give them examples of female teachers who are teaching Physical Science. This comes from the history of learning science. You know previous years, teachers use to pay attention to the boys than the girls and this one makes male teachers to be the teachers of science.

This excerpt resonates with McGuire et al. (2020) who argued that these gender stereotypes begin to emerge at a young age. Hence, they negatively affect the academic achievement of the learners, particularly the girls (Ertl et al., 2017). It is then the responsibility of the teachers to attend to all these aspects of gender biases and discrimination against a specific gender (Sinnes & Løken, 2014). To this extent, some participants emphasised ensuring that learners are treated equally and are given the needed motivation. For instance, T1 expressed that:

> Mostly what teachers, we need only to motivate learners and also to pave the way on how to become successful individuals in also science and just to take it simple that learners, they are all equal when it comes there (T1-SSI).

T2 also echoed similar sentiments:

> There you are kind of building the future generation … when they are going to be leaders, science doctors and so on. If you benefit is mostly for the learners to understand gender, nda hala kutya uunona sho shaa watameke oku longwa petameko like mos uunona to wii including minima activities. Shoo tau kaya pombada otashiya benefit naashi ta aka kala aaleli naashi ta ka kala aalongiskola nani otaye ke shi longitha in future (Translated: once learners are taught at the beginning, involving them all in the activities, they will benefit in future as they will be able to apply all these in the future) (T2-SSI).

The insights from these statements indicated that, through motivation, learners are able to make sense of why they can study science. This finding is congruent with the idea of Satiya (2021) that teachers are significant to teaching and learning, thus their consideration and cognisance of gender responsiveness are substantial to the effective involvement of both boys and girls in the learning process. Thus, motivating and treating learners equally paves the way for these learners in terms of being gender and culturally oriented. Table 5.3 shows the understanding of gender and cultural responsiveness in the multi-layered activity system.

Table 5.3: Gender and cultural responsiveness in multi-layered activity system

Tools	Gender stereotypes are embedded in the learning of science. The cultural backgrounds of the teachers and the learners influence the teaching and learning methods in the classroom. Gender roles allocated to the learners.
Subjects	Grade 9 Physical Science teachers; some do not receive professional development in being gender and culturally responsive. Some do not know if they are gender and culturally responsive. How the role of culture or patriarchy in teachers influences their teaching practices. Tensions between what is learnt in the community and what is expected in the classroom.
Community	Learners' low self-confidence in learning science. Low motivation in taking part in science practical demonstrations. Gender roles played by learners in the community, how these influence their science learning.
Rules	NCBE and subject policy require teachers to be gender and culturally responsive. Lack of professional development on how to enact gender and cultural responsive. Cultural rules that enable/or constrain the teachers in being gender and culturally responsive in the science classroom.

Division of labour	Learners allowed to partake in activities; have low self-confidence and lack of participation, particularly the girls. How does the division of labour in the community for boys and girls plays a role in their learning of science.
Object	Being gender and culturally responsive.
Anticipated outcome	Teachers to be gender and culturally responsive in addressing the needs of both boys and girls in the science class. Teachers to be certain that they are applying gender and cultural responsiveness in their lessons. Teachers to acknowledge the patriarchy in their society and address these in their classes. Transformative agency in their learning activities.

According to Engeström and Sannino (2011), contradictions are understood as structural tensions within any activity system and accumulate over a long period, hence, they are traceable to the history of the object. Figure 5.1 shows the tensions within the activity system as the science teachers experienced them.

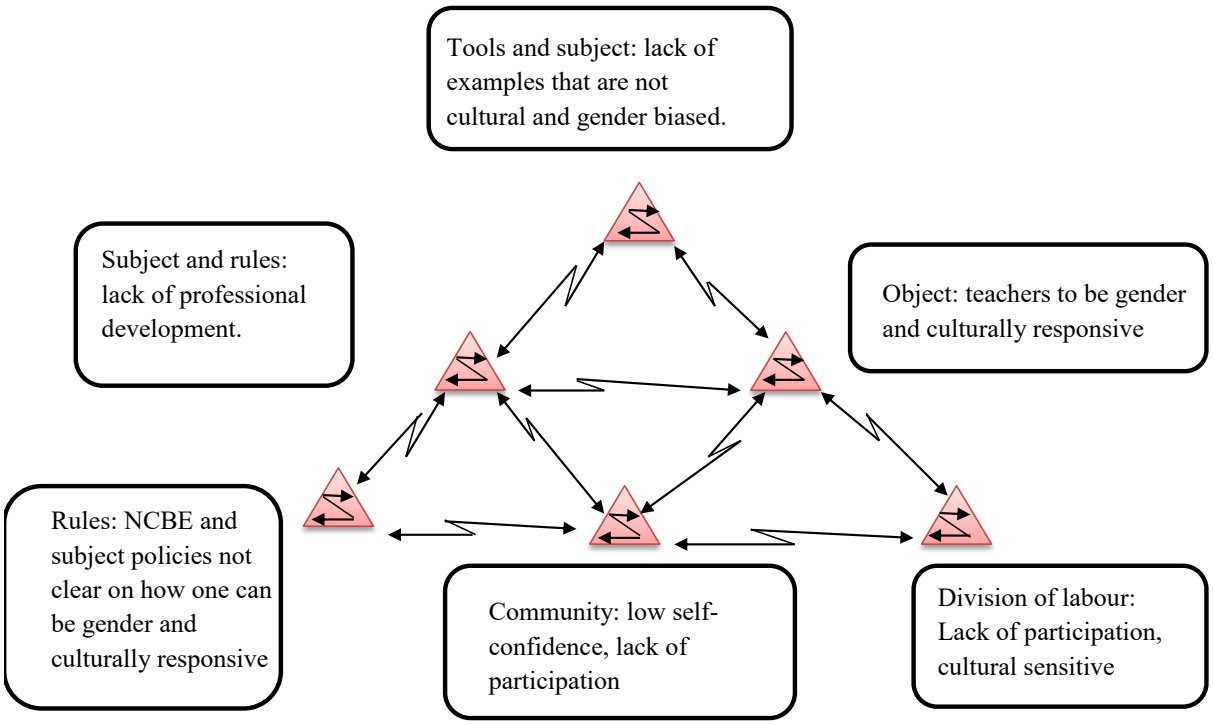


Figure 5.1: Tensions embedded in the science teaching activity (Adapted from Mutanho, 2021, p. 129)

Figure 5.1 illustrates the primary and secondary contradictions that are embedded in the science activity system. As suggested by Engeström (1999), these are tensions within the single activity system, and these were tensions identified by the science teachers. As stated by Engeström and Sannino (2011), contradictions are not directly apparent. However, they are observed when they manifest as tensions within and between different elements of the activity system – in this case, the science activity system. These constrain them from being gender and culturally responsive when mediating their learning.

5.2.3.1 Rules

In this study, the rules are the Namibian curriculum, the Physical Science syllabus and the national subject policy for Physical Science. These documents advocate that teachers need to be aware of gender stereotypes and that the focus should be more on girls who were previously disadvantaged. These documents do not explain exactly how teachers can be gender and culturally responsive. For instance, T6 expressed that *"I did the module on inclusive education in one course but sometimes I am not sure that what I am doing is what I am supposed to do"* (T6-SSI).

The assumption is that teachers are expected to be innovative on how to be gender and culturally responsive. However, the outcome of this study tended to reveal a different view in that the teachers lacked pedagogical knowledge on how to be gender and culturally responsive. Thus, tensions arose in their teaching and learning process. Similarly, the teachers have rules from their society, for instance, what is expected to be done by boys or girls and make decisions based on those (Ellemers, 2018). They are expected to live by those rules (Lips, 2016) but come up with ways of how to deal with gender and cultural biases in the science classroom. The literature revealed that teachers and learners are likely to display gender biases as these may be influenced by socio-cultural factors (Ceci et al., 2014; Richards et al., 2007). This constitutes the *subject vs. rules* tension.

5.2.3.2 Object

In CHAT, the object of the intervention is regarded as the motive behind the activity (Engeström & Sannino, 2011). In this study, the object of the study was the teachers' gender and culturally

responsive practices when mediating the learning of chemistry. The first noticeable contradiction was that teachers' practices are influenced by the society where they come from. In communities, boys and girls are treated differently in terms of gender roles and assigned responsibilities. As explained in section 3.3, both teachers and learners are part of a society, hence, teaching and learning might be influenced by what they learnt from their society.

T6 explained that *"it is difficult to use some examples from the community. For instance if you say in this community people use this and that learners may regard it as a myth, or it is not good thing to be associated with*" (T6-SSI). Thus, Mogari (2017) emphasised that what is learnt in the community can be acted out in the classroom causing tension with what is expected per the curriculum. Teachers then have to work out how to navigate through this tension.

The second contradiction is the documents used (syllabus, subject policy) – even though they require teachers to be gender and culturally responsive, little support is given to the teachers in interpreting these documents. For instance, T2 pointed out that "*I try to be gender and culturally responsive, but I am not really sure"* (T2-SSI). This resonates with Bottiani et al. (2018) that not all teachers are well equipped to link cultural differences to teaching to ensure equity. As a result, they may struggle with that (Brown & Crisppen, 2016). This is the gap that this study attempted to address.

5.2.3.3 Subject

The data revealed that there are primary contradictions within the subject. In this study, the subject was the Grade 9 Physical Science teachers. Teachers' insights and perspectives are situated in and derived from their social, cultural and historical backgrounds (Vygotsky 1978). As much as they are expected to be gender and culturally responsive in their classes, the tension arises as a result of their backgrounds (gender stereotype on learning of science, patriarchal society). For instance T2 expressed that *"I am trying to include everyone, but girls still feel like Physical Science is difficult and they prefer boys to prepare everything and for them is just to write"* (T1-SSI). This resonates with Abraha et al. (2021) that learners are exposed to those stereotypes at a young age and therefore accept them as normal.

5.2.3.4 Tools

In CHAT, tools can be artefacts that can act as psychological or technical tools (Yamagata-Lynch, 2010). Psychological tools have cultural foundations, and those tools can be both explicit and implicit (Amory & Hardman, 2014). That is, to make meaning in this study, teachers had to be aware that they have to be gender and culturally responsive. However, they expressed that there was a lack of tools that they could use in their classes. For instance, T3 pointed out that "*you will say something, and it may affect either boys or girls and they will start complaining that sir you are favouring boys or girls"* (T3-SSI). This calls for teachers' agency in order to work with others (Edwards, 2005). Engagement of teachers enabled them to identify tools that they could use such as teaching methods that are gender and culturally responsive.

5.2.3.5 Community

The community consists of teachers, learners and me. As explained in section 2.3, all parts that make up a community are part of the primary activity which is home. The person's life is influenced and affected by their socio-cultural background (Iwu & Azoro, 2017). This determines how it influences the teaching and learning process (see Figure 3.2). For example, T6 expressed that "*in our classes, there is cultural diversity whereby learners are coming from different background and now we have to be culturally sensitive not to segregate the learners"* (T6-SSI). Thus, Chikunda and Chikunda (2016) emphasised that the progress of learners is affected by both home and school experiences. In other words, teachers and learners equally are socialised in mainly patriarchal edifices that nurture gender inequality, economically, socially and culturally (Chikunda, 2013). As a result of the environment they grew up in, some learners developed a lack of confidence.

5.2.3.6 Division of labour

On division of labour, the analysis was on how the teachers allocate roles to the learners in their science classrooms. It was noted that the allocation was influenced by their socio-cultural backgrounds. For instance, T4 expressed:

> Sometimes when I am explaining some topics, I refer to girls that topics, and... there is some work that can be done by boys and some done by girls at home. And these works differ, boys tend to do heavy works compared to the girls (T4-SSI).

In this case, patriarchal norms led to the teacher and therefore the subject failing to be gender and culturally responsive. As pointed out by Engeström (2001, p. 137), contradictions are "historically accumulating structural tensions within and between activity systems". In this case. The subject is influenced by these patriarchal values in the division of labour when mediating the learning of science. As explained in section 2.4, it is these gender socialisation stereotypes that lead to masculinity and femininity (Iwu & Azoro, 2017). Similarly, teachers experienced low confidence among learners, particularly the girls, in the science classroom. This could be the result of how science was previously viewed in relation to gender. Thus, learners who are exposed to the representation of gender stereotypes, adopt and internalise these representations as true and natural (Abraha et al., 2021). I now discuss gender and cultural responsiveness in relation to teachers' PLC.

5.2.4 Gender and cultural responsiveness concerning teachers' professional learning communities

This study also revealed that some teachers received professional development on how to be gender and culturally responsive in some modules in their teacher training. For instance, T3 pointed out that *"I have done a course where we were taught about comprehensive sexual education where we were taught how to teach all learners equally and not to favour some"* (T3-SSI).

However, some teachers (T1, T2 & T4) expressed that they do not get support on how to be gender and culturally responsive, hence, they called for workshops on this topic to be carried out yearly. For instance, T2 expressed:

> Oshima shono ando osha pumbiwa oku kala hashi ningwa keshe omumvo. Opo ngaa natse kutya not like some of the things we still don't know them. Shaashi iinima mbika otashivulika teti onda base mo gender maar nani inandi includingamo lela kaya (Translated: This needs to be conducted every year, because there might be some things that we don't know. We might be saying we are being inclusive but in reality we might not be) (T2-SSI).

These excerpts agree with Hoaglund et al. (2014) that teachers need to understand how to work with learners who do not know how to learn, and that teachers have to be provided with such

opportunities. Hence, this opportunity can be provided through PLCs. In this study, taking part in PLCs provided the teachers with an environment that encourages professional development, collaboration and innovation as suggested by Brown et al. (2018).

5.3 Chapter Summary

This chapter was devoted to exploring the teachers' perspectives and pedagogical insights when mediating the teaching and learning of chemistry topics. It also explored the understanding of teachers' gender and culturally responsive practices in their science classrooms. The chapter discussed the experiences of teachers when teaching boys and girls in their science classrooms. Some teachers indicated that in most cases, the boys participate and have confidence in taking part in science experiments while girls show lower self-confidence. The chapter also looked at the teachers' understanding in terms of being gender and culturally responsive when mediating their lessons. It also pointed out the contradictions and tensions that surfaced in the activity system. For instance, the contradictions included the lack of examples that are gender and culturally responsive, the lack of professional development and how to be gender and culturally responsive. I now look at the presentation, analysis and discussions of data gathered from classroom observations and stimulated recall interviews. This chapter is devoted to analysing the underlying contradictions that constrained the teachers in being gender and culturally responsive.

CHAPTER SIX: GENDER AND CULTURALLY RESPONSIVENESS PRACTICES DURING TEACHING AND LEARNING

> "The distinctive feature of observation as a research process is that it offers an investigator the opportunity to gather first-hand, 'live' data *in situ* from naturally occurring social situations rather than, for example, reported data". (Wellington, 2015, p. 247)

6.1 Introduction

Classroom observations played an important role in this study. They did not only inform me about the participants' understandings of gender and culturally responsive practices, but they also gave me an in-depth analysis of the classroom interaction between teachers and learners (Vygotsky, 1978). It afforded me too an opportunity to observe how the teachers enacted or not gender and culturally responsiveness. Hence, they provided me with first-hand information as explained in the epigraph above.

In this chapter, I present, analyse and discuss data gathered from classroom observations and stimulated recall interviews in answering research question 2. In addition, in this chapter I also triangulate data gathered from questionnaires and semi-structured questions. The research question 2 is:

> What are the underlying contradictions (if any) that enable and/or constrain gender and culturally responsive practices in Grade 9 Physical Science teachers' science classrooms?

As explained earlier (see sections 4.8.1, 4.8.2 & 4.9.1), to achieve the first part of phase one, I gave the participants the questionnaires followed by the semi-structured interviews. For clarity, I planned to observe and videotape the lessons of the six participants teaching the topic of acids and bases. However, I could not observe two participants (T1 & T2). The reason given was that they had already taught this topic in semester one instead of semester two as they had the

incorrect version of the scheme of work[3]. I thus observed three participants (T3, T4 & T6) twice. For the first lesson, they introduced the topic of acids and bases. For the second one, they did the hands-on practical activities. I could only observe the fourth participant (T5) once, for the first lesson. I could not observe this participant for the second time while doing the hands-on practical activities because this participant decided to do the teaching without me. In total, I observed seven lessons. These lessons were analysed using the constructs of the SCT and CHAT. That is, these constructs were used as analytical frameworks in analysing the data that emerged from classroom observations and stimulated recall interviews.

In order to analyse data from this phase, I first wrote narrative stories in order to identify episodes (Nhase, 2019) for each videotaped lesson and then the transcriptions of each lesson. From these episodes, I then categorised the data into themes through colour-coding. I now shift into explaining in detail the classroom observations and stimulated recall interviews.

6.2 Enactment of Gender and Culturally Responsive Practices in Science Classrooms

In the next section, I present a summary of the lessons I observed from each participant and the stimulated recall interviews that were done when watching the videos together with each teacher. The lessons lasted between 30 and 50 minutes. All seven lessons were videotaped which I videotaped. Here, I acknowledge a missed opportunity during this data gathering technique. I had one camera which was mostly focused on the teacher and I should have had another camera which recorded the whole classroom engagement. I watched the videos and analysed them using concepts from the SCT and CHAT. In all the classrooms, the learners were seated in rows facing the teacher. Figure 6.1 shows the seating arrangement of the learners in the classrooms for all the observed teachers.

[3] In the Namibian education system, each subject has a scheme of work that guides the teachers when each topic should be taught.

Figure 6.1: The classroom arrangement of the observed teachers

As explained above, T3, T4 and T6 were observed as they introduced the topic of acids and bases and T5 was observed teaching the reactions of acids. Table 6.1 shows the general and specific objectives of the topic of acids and bases that were taught by the participants. To remind the reader, I only observed one lesson for T5 because he decided to teach the second lesson without informing me. Acids and bases were used as an example during this phase (see section 2.2).

Table 6.1: The general and specific objectives from the Namibian Physical Science Syllabus (2015, p. 36-37)

T3, T4 & T6	**T5**
Lesson 1 **General objectives**: know the nature and effects of acids and alkalis on indicators Specific objectives: ➢ identify and name examples of acids in everyday life, discuss that acids are common in foods, particularly fruits, and that they have a sour taste ➢ identify and name examples of bases used in everyday life, recognise that bases are common in cleaning materials and that they have a bitter taste and a soapy feel when rubbed between fingers	Lesson 1 **General objectives:** understand neutralisation as a reaction between bases and acids; know the pH scale and be able to relate the pH of strong and weak acids and alkalis and the pH of pure water Specific objectives: ➢ describe the reaction of a base and an acid and predict the products formed ➢ discuss the acidity of soils and the use of lime to neutralise acidic soil ➢ write down word equations for the reactions involving bases ➢ describe the reaction of an acid on a carbonate and carry out a test for the carbon dioxide evolved

	➢ write down word equations for the reactions involving acids
Lesson 2: Specific objectives ➢ relate the pH scale from 0 to less than 7 to the measure of acid strength or hydrogen ion involved ➢ relate the pH scale from more than 7 to 14 to the measure of the alkaline character of an aqueous solution (an alkali is a base that is soluble in water) ➢ outline that an indicator is a chemical that changes colour when an acid or an alkali is added to it, that indicators can be used to detect acids and alkalis ➢ outline the properties of acids such as their effect on indicators such as litmus and universal indicator (liquid or paper) ➢ outline the properties of alkalis such as their effect on indicators such as litmus and universal indicator (liquid or paper)	

I now give a brief summary of what transpired during the classroom observations for each participant for both lessons 1 and 2.

6.2.1 T3's lessons

The first lesson was on the introduction of the topic of acid and bases. The aim was to engage the learners on the examples of acids and bases that can be found in everyday materials such as food, fruits and cleaning materials. This resonates with Simasiku et al.'s (2017) study that the integration of local knowledge in the lessons may serve as the initial point in teaching science concepts. The teachers gave the definition and the examples of acids and bases. This was intended to introduce this topic since it was taught in this grade for the first time. For this lesson, this particular teacher and the learners did not bring any materials to the class in teaching this topic**.** As explained in section 2.2, these topics provided an opportunity to use easily accessible resources (Asheela et al., 2021) and connect science to the socio-cultural

backgrounds of learners (Mavuru & Ramnarain, 2017). At the same time, I observed the gendered classroom interactions, as some of the activities are culturally regarded as for a specific gender.

The teacher also gave examples of acids and bases that can be found in the laboratory. This was aimed at allowing the learners to see the connection between everyday (home) science and school science. As highlighted by Gay (2010), teachers need to connect teaching and learning experiences of learners and resources to allow their learners an opportunity to be engaged in the teaching and learning process (Vygotsky, 1978). The difference between weak and strong acids and weak and strong bases were also highlighted. The purpose was for the learners to understand the differences between acids and bases in terms of their pH values. In the questioning process, both boys and girls were given an opportunity to answer the questions. However, what I observed is that this specific participant tended to mention the names of boys when giving them a chance which was not the case with the girls. It could be inferred that mentioning the names of one gender only could negatively affect the other gender. Thus, Kahamba et al. (2017) emphasised that the language used in the classroom could cause inequality. For this reason, teachers are encouraged to use language that is gender neutral in order to accommodate all learners.

In lesson two, which focused on grading, the teacher presented the learners with different materials. During this exercise, only the learners who were carrying out that activity were present. This activity was carried out in a storeroom. The reason was that the extra classroom they were supposed to use was being used for an oral examination[4] for Grade 11 learners. The learners had to classify these materials as either acids, bases or neutral through testing. The learners used litmus paper when testing the materials. The materials tested were dishwashing liquid, bleach (JIK), fabric softener, vinegar and milk. When learners were testing the materials, they also had to complete the worksheet based on their observations. This group of learners consisted of three boys and three girls. According to the explanation given by the teacher

[4] In the Namibian curriculum the Grade 11 learners have to conduct the oral examination during the month of September/October.

regarding the composition of the learners in the groups, learners grouped themselves like that (equal number of boys and girls). Based on the observation made, the girls were more actively involved in carrying out the hands-on practical compared to the boys. The teacher explained that it could be that the girls were familiar with the materials that were used during the experiment. Most of the materials used were those that are normally used during the chores of the girls such as cooking and washing. It could be surmised that the use of familiar materials that are easily accessible resources (Asheela et al., 2021) influenced this. The teacher gave the instructions to the learners and encouraged them to follow the instructions that were on the question paper. Figure 6.2 shows the learners carrying out the hands-on practical activity.

Figure 6.2: T3's learners carrying out hands-on practical activities during lesson 2

As it is shown in Figure 6.2, the girls are the ones manipulating the equipment while the boys are observing. This is in contrast with Chikunda (2013), who found that only boys manipulated equipment while the girls were reduced to secretaries. In cases like this, gender responsiveness should come into effect. This required the teacher to invite the non-participant learners, in this case the boys, to be more engaged in the discussion. During the hands-on practical, the learners divided the responsibilities among themselves. This is the division of labour as per CHAT as the tasks were divided among the participants (Yamagata-Lynch, 2010). While one learner was pouring the substance into the container, the other learners were dipping in the litmus paper which was used for testing. I now look at the classroom observations for T4.

6.2.2 T4's lessons

The first lesson for T4 was also the introduction of the topic on acid and bases. The teacher started the lesson by asking the learners to bring forward the materials that they were tasked to bring. The purpose was to show the learners that in there are examples of acids and bases in their communities. This is similar to what Kuhlane (2011) suggested, that the use of everyday knowledge in the classroom localises science and helps to contextualise it within the learners' socio-cultural contexts. Similarly to T3, T4 also acknowledged the importance of using the everyday knowledge of the learners as reiterated by Kuhlane (2011). As the learners were bringing the materials to him, he asked what they were, as illustrated in the vignette below:

> Teacher: I sent you to bring items from home.
>
> Learners: Yes.
>
> Teacher: May I please have them? Please bring them. What is this?
>
> Learner: Othewa (washing powder).
>
> Teacher: This one?
>
> Learner: Is a coke.

In this instance, the teacher requested the materials that were easily accessible to the learners (Asheela et al., 2021; Shinana et al., 2021). As a result, he was able to mediate the learning of acids and bases in his classroom using the materials from the learners' environment. This resonates with what Morales (2021) noted, that mediation occurs through three processes such as through cultural artefacts and activities, scientific concepts and through social interactions (Vygotsky, 1978).

T4 also gave a definition of acids and bases that acids are substances that have a sour taste and bases are substances that have a bitter taste. He also asked the learners to give the examples of materials that they thought were either acids or bases. As he was writing the names of the materials, he asked the learners to state these names in their vernacular language and what they were used for. Examples of materials that learners brought were an orange*, oshikundu*, vinegar, cool drink (coke), washing powder, an apple and toothpaste among others. The purpose was to

invite the learners into the discussion so that he could establish if they were able to connect this to the school science as espoused by Mensah (2021).

For the second lesson, T4 brought some materials as well as the materials that were brought by the learners. The teacher together with the learners wrote the names of the materials on the chalkboard. Figure 6.3 shows the teacher with the materials that were brought to the class. He then handed out the worksheets to the learners to classify whether these materials were acids, bases or neutral. What I observed here is that none of the materials that were brought to class were tested in order to identify which were acids or bases or neutral. My inferences could be that the teacher might not know how to incorporate these materials in the teaching. This resonates with Ogunniyi (2007a), that teachers might not know how to integrate IK in their lessons. This might be a result of how they were trained. For the acids and bases that could be found in the laboratory, the teacher still asked the learners where these acids could be found in everyday life, for example, sulphuric acid that could be found in car batteries. From the everyday materials, the teacher used the acids that could be found in everyday life, for instance, in sour milk there is lactic acid. The teacher was connecting the curriculum to home experiences as suggested by Mavuru and Ramnarain (2017), thus being culturally responsive.

Figure 6.3: Teacher showing the materials and learners identifying the name of the materials

Even though the learners were tasked to bring materials from their environment, only a few learners brought some. Most of the learners who brought the materials were the girls. To this, T4 explained that

> Maybe they don't know, they are not interested in participation of the class. Few boys do participate compared to the girls. I don't know nee because is the difference between the number of girls and the number of boys in the class (T4-SRI).

From the excerpt above, it could be inferred that the lack of interest of the learners could be one of the factors constraining science teachers becoming gender and culturally responsive. Hence, this calls for teachers to find ways to motivate the learners to have an interest in the subject. It is for this reason that for teachers to be gender and culturally responsive as is suggested by Mlama et al. (2005), requires that they pay attention to all learners' needs. As it is explained in Chapter One, in gender responsive classrooms, teachers should find ways to attend to the needs of both boys and girls. T4 expressed, however, that he had not been given any training on how to be gender responsive and sometimes failed to engage all the learners in the discussion.

Similarly to T3, T4 also experienced low participation from the boys during the lesson presentations. He expressed that: *"Sometimes boys are more participating than girls but otherwise again girls participate more than the boys. The girls usually participate more on the chemistry part"* (T4-SRI). The teacher explained that it seems boys are not interested in participating, hence, only a few brought materials to the class. This shows that there are contradictions. Even though boys are usually associated with science (Archer et al., 2012), in this case, it was the girls who showed interest in science, which shows the importance of gender responsiveness. I now move to explaining what transpired during the classroom observation for T5.

6.2.3 T5's lessons

I only observed one lesson for T5 as explained in section 6.2. The lesson was on the reactions of acids with different substances. These substances were metals, such metal carbonate and bases. T5 started the lesson by writing the summary for the reaction of acids and bases as shown in Figure 6.4. He then explained his summary. His explanations also included questioning the learners. From the observation, T5 demonstrated being gender responsive. This was demonstrated by giving chances to different learners. For instance, he asked: *"What will be the product when sulphuric acid reacts with magnesium? Not you, not you and yes"* [teachers giving chance to the learners who have not participated before in the lesson] (T5- CO). From

the excerpt above, it could be deduced that T5 tried to be gender responsive since he afforded his learners (both girls and boys) opportunities to participate in the lesson. This echoes Dorji (2020), that in a gender-responsive classroom, teachers do not sideline less self-confident learners. Instead, teachers have to motivate both boys and girls to participate which leads to equal opportunities and allows learners to be engaged in the lesson. In terms of cultural responsiveness, T5 used examples of substances that produce carbon dioxide such as *oshikundu*. The teacher used an example that was familiar to the learners (Mavuru & Ramnarain, 2020). This helped the learners identify the activities that are done in their immediate environment that are related to science in the classroom.

Figure 6.4: T5 writing the summary on the reactions of acids

In this lesson, the teacher worked with the learners to explain the reactions of acids through questions. I now look at the classroom observations for T6.

6.2.4 T6's lessons

T6's first lesson was also on the introduction of acids and bases. He requested the learners hand in the materials that they brought from home. Similarly to T4, only a few learners brought materials to class such as toothpaste, orange juice and dishwashing liquid. The teacher also explained to the learners that the only way to identify if the substance was an acid or base was through testing. He then presented the materials that he also brought to the class that could be found in the local environment, such as washing powder and oranges. The teacher emphasised that learners need to know the everyday materials that can be found in their immediate

environment. He then requested the learners to name those materials such as oranges, dishwashing liquid and toothpaste among others and decide whether they were acids or bases based on the properties. Hence, the teacher used an opportunity to mediate the learning using artefacts from the environment as advocated by Vygotsky (1978). In other words, he used the socio-cultural context of the learners and made it compatible with the teaching and learning process (Harrison & Skrebneva, 2020; Mavuru & Ramnarain, 2020). In addition, the teachers also highlighted the acids and bases that could be found in the laboratory and emphasised that these are more concentrated and dangerous compared to the acids and bases that can be found in the local environment.

In T6's second lesson the learners carried out the practical experiments using the materials that they had brought to the school. Some of the materials that were brought were eggs, orange juice, toothpaste and many more (see Figure 6.5). The learners were divided into different groups with at least four learners per group. However, these groups were not equal in terms of composition. There was one group that consisted of nine learners, while others consisted of four to seven learners. Some had a mixture of both boys and girls while others consisted of boys or girls only. The learners grouped themselves according to the instruction, which was that the group should comprise at least four learners.

Figure 6.5: Some of the local materials that were brought by the learners

The learners were tasked to test different substances (see Figure 6.5) and then write down the colour changes in the worksheets. There were different indicators to test for the acidic and base nature of the substances, namely litmus papers (blue and red) and the universal indicator. However, during this experiment, the learners only used the universal indicator to determine whether the substance was acidic, neutral or base. There was no litmus paper at the school. After completing the activity, the learners and teacher wrote down the correct answers when classifying the type of substance (acid or base) by looking at the colour of the universal indicator. From the observation, the teacher moved around the class assisting the learners and giving them further instructions and identifying science concepts. For instance, the teacher requested learners to write the colour change of the universal indicator and learners deduced whether the substance was acidic, neutral or base.

Figure 6.6: Learners carrying out the experiments using easily accessible resources

As shown in Figure 6.6, there was variation in the participation of the learners in different groups, for example, pictures 1 and 2 from the right shows the boys observing while other learners are carrying out the experiments. Table 6.2 compares the lesson 1 and 2 of T3 to T6.

Table 6.2: Compares and contrast classroom observation for observed participants

	T3	**T4**	**T5**	**T6**
Lesson 1	Introduced the topic of acid and bases. No materials were brought to the lesson. Called the names of learners particularly boys.	Introduced the topic of acids and bases. Both teacher and learners (mostly girls) brought materials from immediate environment.	Taught the topic on the reactions of acids and bases. No materials were brought to the class. Both boys and girls were involved in the presentation.	Introduced the topic of acids and bases. Both teacher and learners brought the materials from the immediate environment. Girls were more active compared to the boys.
Lesson 2	Only the teacher brought the materials for the experiment. Learners carried out a hands-on practical in a group. The teacher observed while the learners were conducting the experiment. Testing done using litmus papers (red and blue). Girls were more active during the hands-on practical activity. Learners completed the worksheet in a group. No feedback was done.	Both teacher and learners brought the materials to the class. No testing of materials was done. Learners completed the worksheet individually. Teacher and learners did the feedback on the completed worksheet.		Both teacher and learners brought the materials to the class. Learners carried out hands-on practicals in groups. They tested materials using universal indicators. Teacher moved around the class giving instructions to the learners in different groups. Differentiation in the participation of the learners. Some groups boys were more active, in some girls were more active. Learners completed the worksheet in their groups. Teacher and learners did the feedback on the completed worksheet.

Table 6.2 illustrated the differences and similarities regarding the lessons conducted by the four teachers. For lesson one, T3, T4 and T6 introduced the topic of acids and bases while T5 taught the topic on the reactions of acids and bases. As is illustrated in the table, during the lessons for T4 and T6, both teachers and learners brought the materials to the class which could be classified as acids or bases. However, for T3, no materials were brought to the class. Similarly, T5 also did not use any local materials in his lesson. In terms of gender responsive, T3 tended to call boys by their names which was not the case with the girls. In T4 class, the girls were the one who brought most of the materials. As for T6's class, both boys and girls brought these materials.

In lesson two, all teachers had easily accessible materials in their classrooms. In terms of gender responsive, during the hands-on practical activities in T3's class, the girls were more active compared to the boys. This means there was unequal distribution in the division of labour. In T6's class, there was variation in the carrying out of the hands-on practical activities. In some groups, girls were more active than boys and in others, boys were more active. For both T3 and T6, learners were tasked to complete the worksheets while testing the materials. However, for T4, learners completed the worksheet without doing any hands-on practical work. Also for T4 and T6, after the completion of worksheets they gave feedback while T3 gave no feedback. I now discuss the data from classroom observations of these teachers.

6.3 Teachers' Knowledge and Enactment of Gender and Culturally Responsive Practices

As explained in section 6.1, the observed and videotaped lessons helped me in understanding how these teachers mediated their lessons while paying attention (or not) to gender and cultural aspects. On the other hand, the stimulated recall interviews were aimed at probing for clarity on the teachers' instructional strategies and actions during the classroom observations. Before I conducted the stimulated recall interviews, however, I watched the videos, transcribed them and wrote narrative stories (Nhase, 2019). Watching of videos was done more than once in order to familiarise myself with these lesson presentations, focusing on aspects such as the interaction between teacher and learners as well as the expressions of the teacher. Additionally, it allowed me to draw up the guiding stimulated recall interview questions for each participant. For convenience, these stimulated recall interviews were conducted on different days and at

each participant's school at a time that was convenient for each participant. Hence, some were conducted during the morning and some in the afternoon. We began watching the videos of each lesson one by one starting with lesson 1. These videos afforded the participants an opportunity to remember the events and decisions that they took as alluded to by Nguyen et al. (2013).

In this discussion, data from both classroom observations and stimulated recall interviews were used. The following themes were derived from the classroom observation and stimulated recall interviews. Hence, the excerpts are used to support the claims made from both classroom observation and stimulated recall interviews.

6.3.1 Teachers' knowledge of gendered and cultural social interactions in the science classroom

The findings from the classroom observations revealed that boys were not fully involved in the lessons for most of the participants' presentations. For example, T3 indicated that "*learners were not willing to participate in the hands-on practical, particularly the boys"* (T3-SRI). Herein lies the importance of gender responsive pedagogies. Even though science is associated with masculinity, in this case the boys were the ones who needed assistance in being involved in the lesson rather than the girls who were previously disadvantaged (see section 2.2). This resonates with Stott (2016), that cognitive development is a result of associations in the construction of knowledge. Thus, teachers need to ensure that they use strategies and interventions in their classrooms during the mediation of learning that offer equal participation to both boys and girls in their day-to-day interactions (Bakshi, 2016).

When I enquired from T3 what could be the reasons that the boys were not willing to participate, he replied that *"I thought maybe because I mixed them with the girls or maybe they don't understand what they supposed to do"* (T3-SRI). This shows that the teacher understood that there were factors that could hinder the participation of learners in the lesson. This indicated that teachers need support on how to address this tension which calls for transformation agency. This requires the support of others as proposed by Edwards (2005).

Another factor that seemed to constrain these teachers was language barriers. For instance, when I made a follow-up question on the issue of teaching, T4 commented:

Researcher (R): Why most of your teachings are in vernacular?

T4: For them to understand because most of them they have poor communication. For them to understand you have to swap English with Oshindonga.

From the excerpt above, it could be deduced that the language that was used for teaching and learning could be a reason that learners were not interacting with one another as they were supposed to do. Teachers are expected to use the language that learners understand better in order to accommodate them all, therefore, the teacher "smuggled" in the vernacular language as pointed out by Probyn (2009). This responded to the learners' cultural backgrounds as they were able to connect it to what they were learning in the classroom. However, Mlama et al. (2005) expressed that the teachers should use the language that is encouraging and inclusive of all learners which is accepted in class as being gender responsive. Also, the language that is used during the teaching and learning process plays a major role in the mediation of learning. This resonates with Samuels (2018), that the language that is used in a social setting either promotes or discourages active participation and thus leads to the social interactions as advocated by Vygotsky (1978). Social mediation, composed through dialogical cooperation, generates sophisticated forms of human mental functions as suggested by Shabani (2016). In this instance, the teacher used the language that the learners understood better in order to mediate the learning. The teacher motivated the learners by inviting them to take part in the discussion and used the language that was free from biases and stereotypes. I now look at the teachers' enactment of gender and cultural responsiveness during these lesson presentations.

6.3.2 Teachers' enactment of gender and cultural responsiveness when mediating lessons

The study revealed that these teachers seem to understand being gender and culturally responsive, for example, from the composition of the learners in the group when they were carrying out the hands-on practical activities. Some teachers such as T3 attempted to have a balanced number of boys and girls in the groups. From the lessons observed, some participants demonstrated that they could practice gender responsiveness in their classrooms. For instance, during the stimulated recall interview, T3 indicated that the groups that were formed consisted of both boys and girls. He pointed out that the learners selected their own groups, hence there was the balance of both boys and girls in the group. He reflected:

R: During that, that investigation where the learners were answering, how did you come up with those groups? Like the composition of the learners in the particular group?

T3-SRI: I just told them that, they were 30 in the class, they must form that, I need six groups each class. So I did not say who and who should be in that group, I just told them to choose their groups. That's why they end up in those groups. Grouping themselves some with boys some with girls. I did not find any group with only boys or only girls.

From this extract, it could be surmised that even the learners understood how to be gender responsive before the teacher could arrange them. This means that each learner had equal chance of partaking in the activity and this is similar to what is required in the division of labour in terms of CHAT. However, the teacher did not allow the learners to test their own materials as indicated in the vignette below.

R: The materials that are being used by learners where do they come from?

SRI -T3: In the first practical that we did I asked the learners to bring some of the materials like washing powder, oranges etc. in the second practical that I am grading I gave these materials to the learners. I choose my own materials and I did not tell them. I only put them on the table and ask them to classify them as acids or bases.

R: When you ask the learners to bring the materials, did they all bring the materials?

T3-SRI: No, I only chose some to bring, because if I ask them all to bring then it will be a lot of them in the class.

R: OK. These ones that you have selected it was based on what criteria?

T3-SRI: Mmm not really. I only choose some of the acid and bases that were not part of the practical.

From the vignette above, it could be hypothesised that the teacher did not make it possible for learners to participate in the lesson. That is, learners could not use the materials that they had brought from their homes during the mediation of learning. This is congruent with Vanner's (2019) assertion that school learners might be subjected to discrimination through unequal opportunities. In this regard, Morales (2021) is of the opinion that mediation occurs through the cultural artefacts and activities through interactions. Hence, teachers need to provide equal opportunities to all learners in their science classrooms (Gullberg et al., 2017). For this to happen, however, teachers need to know how to do that. Thus, Ross (2017) opined that teachers' approaches to their teaching affects learners' learning. This suggests that teachers'

conceptions and understanding of their subject area have a substantial influence on their teaching pedagogies, their educational decisions and their approaches to the relevant curriculum as suggested by Li and Chen (2018).

The study revealed that these teachers attempted to bridge the gap between home and school science through connecting these worldviews. To achieve this, most of them requested learners to bring materials from home. For instance, T6 explained, *"I send the learners to bring the materials from their homes and the aim was to see if they can able to identify household materials as acids and base"* (T6-SRI). This resonates with Mensah (2021), that in being culturally responsive in the class, the teacher needs to connect learners' home experiences to the curriculum. These teachers (T3, T4 & T6) also used easily accessible resources as advocated by Asheela et al. (2021). This means that the learners' everyday knowledge was considered during the lessons. For instance, during T4's second lesson, he asked the learners to name the materials as they call them at home in their vernacular language as shown in the vignette below for T4-CO.

> T4-CO: Oshike shino? (What is this?)
>
> Learners (L): Is a cool drink.
>
> T4-CO: Shino? (This one?)
>
> Learners: Milk.
>
> T4-CO: Milk in Oshiwambo is what?
>
> Learners: Omahini.

This shows that the teacher tried to engage all learners in the discussion by using their cultural examples, hence affording them an opportunity to know about the substances from home and how they could be used in the classroom in order to understand science concepts. During the stimulated recall interview, T4 commented:

> R: So like the first one I see that you have started the lesson by asking the learners to bring the substance they can get from home. Why do you need those substances?
>
> T4-SRI: I need to use them in the class for lesson presentation. To classify which one is an acid and which one is a base according to the properties of acids and bases.

R: Why do they have to take it from home?

T4-SRI: Because they need to know that acids and bases are substance which are around us.

R: Mm ok why did you ask for the specific substance like milk?

T4-SRI: Milk? Aa because I did ask that because it is also a substance which is home and according to the properties of acid, acid is sour so maybe for those who, who are what, take milk maybe they will realise that, iyaa that sour, I mean that milk is sour in taste.

T6 also echoed similar sentiments:

> I asked the learners to bring the materials from home and the aim was just to find out if they are able to identify these materials as acids and bases and also to know that acids and bases can be also found in our immediate environments (T6-SRI).

From the above excerpts, it seems that these teachers attempted to use the materials that were familiar to these learners. This is similar to what Harrison and Skrebneva (2020) and Mavuru and Ramnarain (2020) suggested, that teaching should take into account learners' socio-cultural backgrounds. To this, Gay (2018) emphasised that understanding how culture operates in the classroom dynamics and building a learning atmosphere that offers cultural and ethnic miscellany might lead to high academic accomplishment for all learners. Through the use of these materials, learning of science is contextualised, hence learners make sense of what they are learning in their science classroom (Mavuru, 2022).

6.3.3 Teachers' professional development in being gender and culturally responsive

The study revealed that even though learners brought the materials to school, T4 did not use these materials. For example, the materials that were brought to T4's class were not tested. During the stimulated recall interview he pointed out that *"those materials I was supposed to test with the learners but we just used the properties that we learnt in the class"*.

This statement indicates the contradictions between the subject and the tools. The teacher had the materials for mediating the learning and yet he did not understand how to use these materials as required by the curriculum. This is similar to what Makhure and Otulaja (2017) explained, that while acknowledging that the use of easily accessible resources would be appropriate and benefit the learners, it is crucial that teachers know how to use these resources in making science relevant to the learners. Herein lies the importance of understanding the

materials used in the classroom through the professional development of teachers' PCK. In delivering the lessons, teachers need to know how to deliver such lessons (Shulman, 1987). This shows the importance of expansive learning as teachers have to address this identified contradiction and collectively transform their practices (Sannino et al., 2016). Through PLCs, teachers could find ways to use materials that can be found in the environment, thus being culturally responsive. This resonates well with Shulman (1987) that teachers need PCK in order to present the content and instruction to suit the interest and capabilities of the learners. The main challenge, though, might be the teachers' PCK in using everyday materials when delivering lessons. This serves as a contradiction when enacting gender and culturally responsiveness and hence is an avenue for professional development for teachers. This is what Shabani (2016) advocated, that through collaborative engagement and discussion group members are allowed to support one another in remedying the instructional problems. This raises the importance of the CLWs in this study.

6.4 Chapter Summary

In this chapter, I presented and discussed the data sets that were generated from classroom observations and stimulated recall interviews. For better understanding, I explained what transpired in each science classroom presentation with the observed participants. This included when they taught the topic theoretically and when they carried out the hands-on practical activities. Also, I brought forward the participants' justifications of what happened during the lesson presentations by doing stimulated recall interviews. I also looked at the social interactions in the classroom during the lesson presentations.

Furthermore, I observed the enactment of gender and culturally responsiveness practices in the classrooms using the indicators of gender responsiveness by Mlama et al. (2005). This also led to further exploration of the professional development of science teachers regarding gender and cultural responsiveness.

It emerged that teachers are aware of how to be gender and culturally responsive. However, the contradictions that constrain them in their teaching still persist in their classrooms. These include low participation of the boys, language barriers in the expression of learners and how

to enact cultural responsiveness using everyday materials. I now look at the contradictions that surfaced and the CLWs that were conducted in addressing the surfaced contradictions

CHAPTER SEVEN: SURFACING OF CONTRADICTIONS, EXPANSIVE LEARNING AND CHANGE LABORATORY

> The analysis of contradictions in an activity system provides an understanding of its development trajectory. Contradictions can be seen as the places in an activity system from which innovation emerge. (Foot, 2014, p. 337)

7.1 Introduction

Chapters five and six were aimed at the contextual profiling phase, exploring teachers' gender and culturally responsive practices when mediating the learning of chemistry topics using acids and bases as an example. That is, presenting the mirror data that surfaced contradictions in the teaching and learning process. These chapters presented, analysed and discussed the findings gathered in phase one. In this chapter, I present, analyse and discuss the data gathered during the intervention phase through the CLWs which responds to the following research questions:

- What expansive learning and mediational tools can the study develop to support gender and culturally responsive practices in Physical Science teaching using acids and bases as an example?
- How do group discussions and reflections through CLWs influence (or not) the implementation of mediational tools when Grade 9 Physical Science teachers mediate the learning of their lessons?

I now discuss how I prepared the CLWs and what transpired during each session.

7.2 Preparation of CLWs

Being in a learning space, it was vital for me as an intervention-researcher to prepare for the CLWs **(**Virkkunen & Newnham, 2013). It should also be noted that one cannot pre-determine the outcome of the workshops; however, preparation has to be done in advance (Sannino et al., 2016).

Acknowledging the need for ethics in research prior to the beginning of the workshops, I asked permission from the participants to take videos, audio-recordings and photographs of all our CLW sessions. These helped me during data analysis to have a collection of rich data concerning the actions and social interactions involved in the cycles of expansive learning (Engeström, 2016). Data were captured during the informal group discussions and reflections. All the CLWs were conducted in the afternoons so that we did not interrupt the normal teaching time particularly for the host participant.

Before I started the workshops, I requested a venue which was convenient for all participants. I also prepared note pads and pens to be used during the workshops and the overhead projector for PowerPoint presentations. In addition, I prepared some audio speakers as some presentations on the power of reflection and document analysis would be done by two critical friends from South Africa via Zoom. I also created enough space on my phone to videotape the sessions and requested a friend to video record all our sessions so that I could focus on participating during all the presentations.

7.3 Presentations, Analysis and Discussions of the CLWs

In the following section, I present, analyse and discuss what transpired during the CLW sessions. For each session conducted, there were always double stimulations (Sannino et al., 2016) that allowed and stimulated the engagement of participants. Table 7.1 shows the summary of the CLWs that were conducted. A total of four CLWs were carried out with durations ranging from two to three hours.

Table 7.1: Summary of CLWs

Date	CLW	Duration	Purpose	Learning action of the EL cycle
09.02.2023	1	2 hours	To present mirror data that were gathered from phase one. During this workshop we received the presentation on the power of reflection from a critical friend.	Questioning
16.02.2023	2	2 hours	To accord the participants an opportunity to analyse the surfaced contradictions. This	Analysing

			included the historicity of these contradictions. Also looked at various aspects of curriculum and the assessment of the learners. These constructs enabled us to critically analyse gender and cultural issues as they are presented in the teaching and learning materials.	
02.03.2023	3	2 hours 30 minutes	Discussion on how to address the contradictions identified. The participants also received another presentation on how to analyse the documents. This helped in the development of the mediational tool on how to be gender and culturally responsive when mediating teaching and learning. It was also during this workshop that we discussed the topic that would be presented to the learners using the mediational tool.	Modelling the new solution
15.03.2023	4	3 hours	The purpose of this workshop was to plan the lesson and present it to the learners. Thereafter, we met as a group to reflect on the presentation of the lesson in which the developed mediational tool was implemented.	Examining the model, implementing the model and reflecting on the model

I now discuss what transpired in each CLW workshop.

7.3.1 Change laboratory workshop 1

As explained in Sections 4.8.4 and 4.9.2, the aim of this workshop was to present the mirror data that were gathered in phase one. These mirror data from this phase consisted of underlying contradictions that constrained these teachers from being gender and culturally responsive when mediating the learning of chemistry topics. Such contradictions included lack of participation of learners, low confidence and a lack of examples that are not gender and culturally biased (see Figure 5.1). As explained by Engeström and Sannino (2010), these are troubles or problems that exist in the workplace. All six participants were present for this session.

The presentation of mirror data was used as the first stimuli of the CLWs. According to Sannino et al. (2016), first stimuli are data that trigger expansive learning as participants respond by questioning data as the first learning action. This stimulus is presented as the identified problem

(Sannino & Engeström, 2018). Mirror data were the contradictions that surfaced as identified by the participants. These contradictions seem to constrain teachers in being gender and culturally responsive when mediating their learning of science. In other words, the participants were tasked to think critically about these challenges and find expansive solutions that constitute formative interventions. As suggested by Sannino et al. (2016), in these formative interventions a collective design effort is seen as a part of the expansive learning process that includes participatory analyses and implementations.

Before I presented the mirror data, however, a critical friend from South Africa who is part of our community of practice presented the topic of the importance of reflections in research. This presentation was necessary in this study because it afforded us an opportunity to understand the importance of reflection in the teaching and learning process. Herein lies the importance of Ubuntu (Seehawer, 2023) and his presentation culminated in being a double stimulus for our discussions and reflections in particular. The critical friend afforded us an opportunity to share the success of integrating reflections in the teaching and learning process. Thus, his presentation served as a form of professional development in our learning space and at the same time enabled me to be a co-learner during this research process. In other words, this critical friend established a learning space whereby teachers were afforded opportunities to engage and participate in learning activities as advocated by Sedlacek and Sedova (2017). In terms of CHAT, the community of this learning space was not limited to only those who were part of the study (participants, learners and me), but instead it also included the critical friend who provided the tools to critically analyse our teaching and learning processes. In addition, it offered emancipatory environment (Chilisa, 2012) and capacity building for the teachers to be able to reflect on their gender and cultural responsiveness. Thus, this led to participants' active contributions (Hopwood, 2022).

The striking significance of CHAT in this study was that it allowed me to deeply explore the underlying constraints in teachers' teaching practices as shown in Figure 3.3. Hence, in this workshop, I had an opportunity to probe for ideas from the participants as advocated by Sannino et al. (2016), according to whom the researcher-interventionist's role is to intervene by provoking and supporting the process of questioning. For thorough engagement, I provided the guiding questions to direct the discussions. These workshops were conducted in the African

way of sharing circles (Lavallee, 2009). This is similar to the setting of *Olupale/Oshoto* (see Figure 4.2). Sharing circles allowed the participants to discuss issues regarding gender and cultural responsiveness. All participants were afforded equal opportunities to discuss the issues pertaining to the teaching of science. Thus, there was a shared understanding of troubles during the lessons such as the one presented in Figure 5.1. Figure 7.1 shows the teachers having a discussion during the CLW 1. This echoes the sentiments of Ayele et al. (2019), that the conditions for discussions are that the participants must talk to one another, attend to, answer, and suggest more than one point of view, and have the purpose of enlightening their knowledge, understanding or judgement of the item being discussed. These social mediation sessions together with dialogical cooperation generate higher forms of human mental functioning as reiterated by Shabani (2016), hence developing transformation agency in response to tensions experienced by the teachers.

Figure 7.1: Sharing circles during CLWs

These guiding questions are shown in the excerpt from the PowerPoint presentation in Figure 7.2.

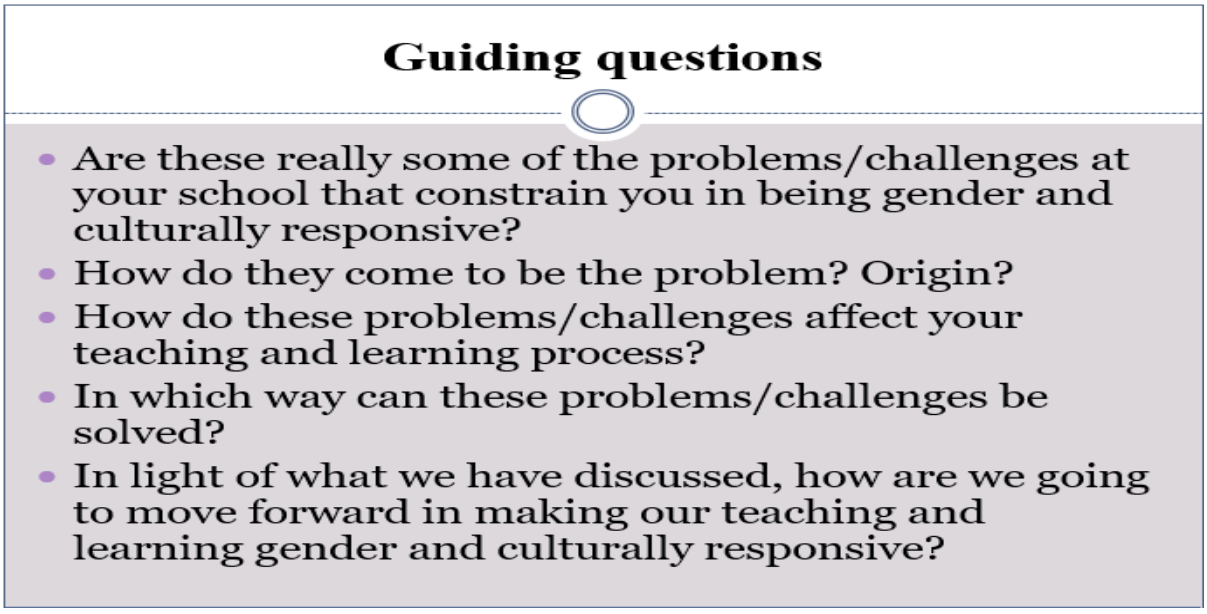


Figure 7.2: The guiding questions for CLWs 1

From the historical origin of these contradictions, some participants indicated that most of their learners are not exposed to see the connection between school science and everyday science. In this regard, T6 expressed:

> These cause of this is lack of exposure, for instance during the classroom presentation, we have used the toothpaste but there are some learners that cannot be able to connect these from home to school science (T6-CLW).

This conforms to Fomunyam and Ferrera's (2017) idea that it is important for the teacher to tap into the varied social and cultural heritage of the learners to identify approaches to assist them with their everyday experiences (Gwekwerere, 2016; Koç & Köybaşi, 2016). Similarly, T2 echoed that

> Our learners are also not exposed to different careers. They need to see that each individual is able to do a certain work. Not only like truck drivers are males and nurses are females only and so on. They need to see that everyone is capable (T2-CLW).

From this excerpt, it could be surmised that historical aspects emerged in terms of gender stereotypes when it comes to different gender roles as allocated to individuals. This resonates

with Iwu and Azoro (2017) that these gender socialisation stereotypes lead to those characteristics of masculinity or femininity. This shows that learners are exposed to patriarchal norms which influence their lives (Cho & Jang, 2021). However, teachers have the responsibility of exposing their learners to different careers and this means being gender responsive. In other words, teachers' professional obligations and positive relationships with other stakeholders should be reflected in the teaching and learning process as suggested by Johnston et al. (2018). This then addresses some of the gender stereotypes in the classroom, offering opportunities to the learners in terms of career preferences.

Apart from the contradictions that emerged from phase one, some emerged through the discussions, such as lack of exposure, language barriers and lack of motivation. For instance, T1 pointed out that "*learners would like to participate, however, due to language barriers they shy away from doing so"* (T1-CLW).

T4 added that *"social cultural background also plays a major role since some of these things that learners meet in the class they are not familiar with them"* (T4-CLW). This finding has an affinity with Başar and Demirci (2018), that socio-cultural background plays a role in determining the gender roles of the learners. Thus, what learners and teachers learn from home or the community contrasts with those that happen in schools as emphasised by Mogari (2017). It is for this reason that Kayaalp (2019) suggests that for successful implementation of teaching and learning, teachers need to be responsible for learning about cultural and social issues, societal contexts, imbalances of power and educational and social disparities and how these affect the academic achievements of learners. This suggests that there is a need to ensure that learners benefit from the lesson presentations and this means that teachers need to connect the learners' socio-cultural background to what they are learning in the classroom (Mavuru, 2022).

T2 shared that learners' lack of motivation in relation to career aspirations contribute to their lack of learning of science. "*Learners are not motivated and teachers need to play that part in their classroom. So that they help all the learners regardless of gender"* (T2-CLW). T2 shared similar sentiments with Satiya (2021), that teachers are fundamental to teaching and learning. Thus, their contemplation of and acquaintance with gender responsiveness are significant to

the effective involvement of both boys and girls during the learning process. T1 further expressed that

> When we look at the issue of language barriers, we need also to understand our education system that requires the learners to use English in classes. As teachers, what we can do is to motivate them and find ways on how better we can teach these learners so that they can learn science well (T1-CLW).

From this excerpt, it could be deduced that there are policies that are put in place, but that still cause tensions within the activity system (classroom). In the context of this study, there is tension between the rules and the community (the curriculum and the learners). The curriculum requires the learners to use English as a medium of instruction. However, the learners struggle to use the language during the teaching and learning process and therefore their participation was low. This excerpt seems to highlight the contradictions among these members. This finding concurs with Engeström (2001), that there are contradictions that can be encountered in the activity system, and these are primary contradictions.

7.3.2 Change laboratory workshop 2

In contrast to the expansive learning cycle as shown in Figure 3.5 where reflection is almost towards the end of the cycle, in this study, reflections were part of every workshop. That is essentially why I invited a critical friend to do a presentation on reflective journals. The participants reflected on the previous workshop and expressed what they had learnt. Similarly, in CLW 2, the participants reflected on what they had tried out in their classrooms based on what was discussed in the previous workshop. Hence, these reflections acted as further stimulus to the discussion. For instance, T6 pointed out that

> I have introduced the reflections to my learners. I started with asking them how my teaching of Physical Science was. One learner responded that the teaching was ok, but I am too fast in the explanation of the concept (T6-CLW).

From the excerpt above, it could be hypothesised that the participants, after being exposed to the CLW, explored in their own classrooms, hence expanding their teaching practices. This is similar to what Stott (2016) suggested, that learning takes place in a broader social system and development is achieved by drawing on the interpretations of the individuals as they participate in the activities. Thus, the development of the individual relies on the transmitted experiences

of others (Daneshfar & Moharami, 2018). In addition, people learn as they co-operate with others to achieve the goal related to the shared practice. This showed me that after the presentation at the workshop on the power of reflection in the classroom they had tried to implement it. This helped them to interact with the learners and provide specific learners with the needed attention to improve the mediation of their lessons.

The purpose of this workshop was to analyse documents, that is, the Physical Science syllabus and Curriculum for Basic Education. Also, we looked at some of the question papers that were used for assessment over the previous years. In addition, we used the excerpts from the curriculum and the previous question papers to look at gender and cultural aspects (see Appendix G). These were what learners would know from their communities that were associated with gender roles. As explained by Engeström (2001), contradictions have the potential to be sources of change and development. Consistent with this assertion, these excerpts were used to engage the participants on how to deal with gender and cultural issues. This resonates with what the NCBE (2016) advocates, that teachers need to be sensitive and address any gender issues that might arise in the classroom. Thus, it is the responsibility of the teacher to find ways to explain these to learners. Contradictions therefore are not the same as problems or conflicts but must be seen as ways of development. In this regard, T1 pointed out that

> By looking at these pictures nee (see Appendix G), I have never thought about it in my class that it could carry some gender associated stereotypes. I see it as normal, but now, I can see that our teaching really need to address these things. While the diagram is showing the man operating on the crane, as a teacher we need also to emphasise that, it is not just a man who can do that specific job but females too (T1-CLW).

This implies that, as teachers, we see these kinds of concepts in our teaching, and we view them as normal and thus there is no need to change them. This finding resonates with Chapin et al. (2020) that most of the LTSMs used in the classrooms consist of gender stereotypes and gender blindness and at times teachers might not be aware of these features. Echoing similar sentiments is Stephens (2019), who stated that the dispositions of teachers are affected by their life experiences before entering the classroom. Hence, teachers need to know how culture operates subtly in the classroom and strive to build conducive learning environments for learners (Gay, 2018). This would enable them to understand how gender operates in the

structural levels of society (Gullberg et al., 2017). Thus, this study revealed that teachers are not paying attention when it comes to gender and cultural aspects in their own classes. This includes how they plan, present and assess their learners. This shows that home as a primary activity has an influence on the teaching and learning process even during assessment. It is then the responsibility of the teachers to thoroughly prepare their lessons in order to identify materials that are gender biased and find ways to counter them with appropriate strategies. I now discuss what transpired during CLW 3.

7.3.3 Change laboratory workshop 3

As explained in section 7.3, in each CLW we started with reflecting on the constructs that we had looked at in the previous workshop (see Appendix G). The purpose of this workshop was to develop a mediational tool that was gender and culturally responsive. Before this workshop, my critical friend from South Africa, who is also part of our community of practice, presented a workshop on document analysis. This included how to analyse the teaching and learning materials that are used in the classroom. This presentation played a role in looking in detail at the materials that we use in our classroom and analysing them in terms of gender and cultural aspects. The presentation looked at how to use the five Topic Specific PCK components by Mavhunga and Rollnick (2013). These five TSPCK components are: learners' prior knowledge, curriculum saliency, what is difficult to understand, representations and conceptual teaching strategies. These helped us to plan the lesson as we had considered these in the planning. All in all, this presentation afforded us an opportunity to take into consideration all the aspects of gender and culture from the planning to the teaching and then assessment during the lesson.

It was during this workshop that the mediational tool was developed so that it could be implemented into the exemplar lesson. The participants suggested that, since we normally meet in the afternoons, the lesson presentation should also be carried out in the afternoon. The reason was that these learners were based in the hostel and that made it easy to access them as opposed to the day learners. One participant volunteered to teach this lesson.

From the discussions, the following mediation tool was developed. The exemplar lesson was on the topic of combustion reaction. To remind the reader, this study aimed to expand teachers' gender and culturally responsive practices when mediating the learning of chemistry topics.

Thus, a chemistry topic was used in this exemplar lesson, similar to acids and bases as was used in phase one (see section 2.2).

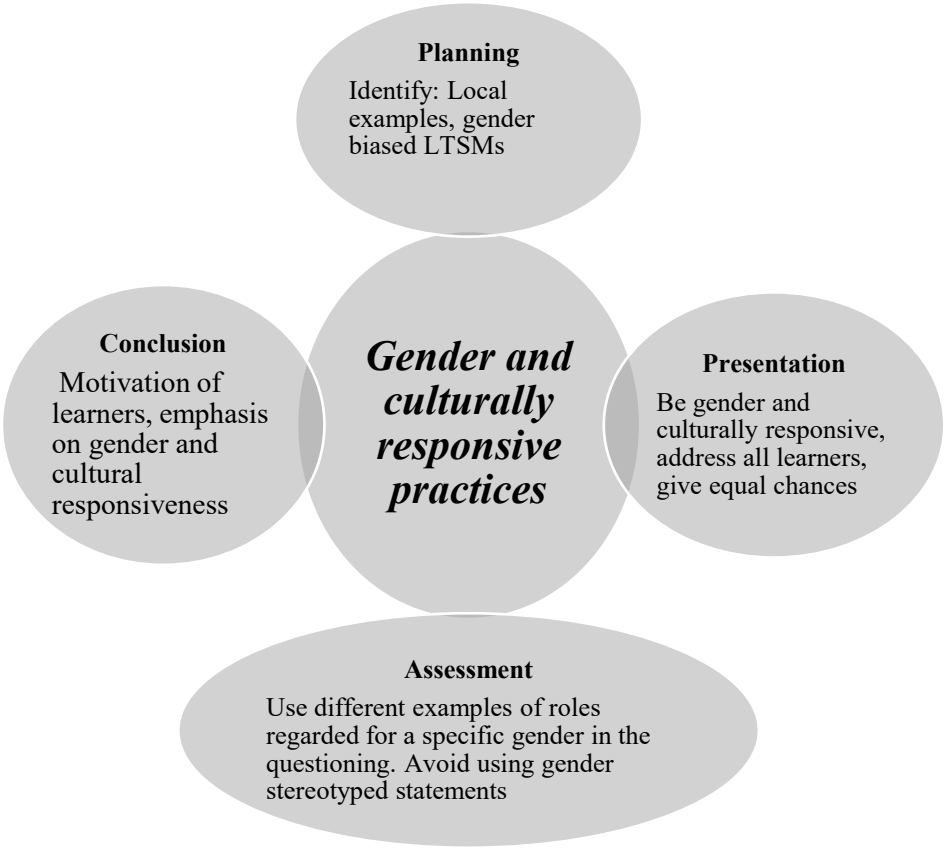


Figure 7.3: The gender and culturally mediational tool (Haimene, 2023; see Appendix K)

Figure 7.3 shows the mediational tool that the group developed and derived from Mlama et al. (2005). From the developed mediational tool, the teachers were expected to analyse the materials that they would use in their classrooms. The aim was to identify any gender and cultural stereotypes. This also included identifying the materials that could be found in the immediate environment of the learners which was done in the planning stage as shown in Figure 7.3 under planning. T5 alluded that

> Some of these things we take them for granted. I could not even tell that, the learners are able to think critically when it comes to these things. As teachers we need to work hard so that in future the learners are not exposed to these biases but they can be able to see that, every career can be done by everyone whether is a boy or a girl (T5-CLW).

In the lesson presentations, teachers needed to involve all the learners in the discussions. This meant that they had to alternate chances between the learners. Regarding the experiment, groups should consist of team leaders of both genders. Similarly, during the experiment, learners of different genders should be assigned the role of writing what is observed which prevented only the girls being given the role of secretary. The teacher should also use examples that come from the local environment or that are familiar to the learners in explaining the concepts. In other words, during lesson presentation, the teacher should ensure that all learners are given an equal opportunity to participate in the lesson. This includes inviting the non-participant learners to participate.

In summary, the teachers should use the chance to motivate the learners by providing career paths that learners might take. Being a gender responsive class, the teachers should use the opportunity to expose the learners to different careers, showing them careers that are regarded as for a specific gender being done by the opposite gender. To this, T2 emphasised:

> In our teaching we need to use examples of the people that succeeded in the professions that are meant to be for other genders. For example a scientist who is a woman or a Chef who is a man. In our culture we only have those assigned roles to specific gender. Then as teachers we need to remove those stereotypes. This will motivate the learners (T2-CLW).

Equally, in the assessment, the teacher needs to consider using other genders in the questioning regarding gender roles so as to create awareness that every person can do a specific task and not only those who are 'culturally assigned' to do it. For instance, girls can drive trucks the same as boys can fetch water. I now discuss the CLW 4.

7.3.4 Change laboratory workshop 4

This workshop was aimed at presenting the exemplar lesson to the identified class. Since there was more than one class group, the host teacher, who was also a participant, would teach the other class group later using the materials that were developed by the group. The participants resolved some of the contradictions by suggesting the solutions to challenges that were experienced in the science classroom regarding gender and culturally responsive practices and consequently used the mediational tool that was gender and culturally responsive (see Figure 7.3). After the lesson presentation (see section 4.9.2.4), the group met for the reflections on the presentation of the exemplar lesson. During this workshop, the participants presented and

reflected on the implementation of the mediational tool that was discussed during CLW 3. The group discussion and reflections contributed to the professional development of the teachers. For instance, T3 pointed out:

> Like the colleagues have experienced in the first meeting, I also experienced the low confidence among my learners. However, after being introduced to reflection journals for the learners, I have experienced a change. Some learners volunteered to do the reflection. The good part was that these learners were reflecting in the language that they can express themselves better. It helped me in making adjustment to my teaching (T3-CLW).

From the final reflection, T4 reflected:

> We indeed need to be exposed to these kinds of workshops. Sometimes the person is just focused on the teaching and forgetting that, we have different learners with different abilities. But also, we need to understand where we come from. Our communities will not change if they are not aware of these things. A girl will remain given specific duties because is a girl same as with the boys (T4-CLW).

From this reflection, it could be deduced that these teachers do need professional development now and then in order to expand their ZPD in terms of gender and culturally responsive pedagogies. This finding echoes the sentiments of Calvert (2016), that through teacher agency, the teachers are capacitated to act tenaciously and productively for their growth and the growth of their colleagues. I now present the overview of the exemplar lesson in the next section.

7.4 Overview of the Exemplar Lesson

The exemplar lesson was based on the topic of combustion reactions. This is one of the chemistry topics in Grade 9 Physical Science. This topic was chosen as it requires the learners to use their everyday knowledge (see section 2.2). The group met and planned the lesson and T6 volunteered to present the lesson while the rest of the participants observed and assisted learners particularly during the hands-on practical activity.

T6 started the lesson by asking the learners to give examples of things that learners can burn at home.

> Teacher: Now I want to learn from you, tell me what are the things that we burn at home?
>
> Learner (boy): We burn firewood to make fire

Teacher: Ok, you can end there, some people burn firewood, what about you?

Learner (girl): We burn papers.

Teacher: Good, someone else? Oo only few people burn?

Learner (boy): We burn rubbish.

Teacher: Ok thank you, girls at the back there
Learner (girl): We burn food.

Teacher: Do we burn food?

Learners (in a group): No.

Teacher: Right, we are talking about burning of firewood, burning of rubbish, paper. All these are regarded as fuel. The chemical name of burning is called combustion. Burning that takes place in their environment.

This was aimed at soliciting the learners' prior knowledge (Mavhunga & Rollnick, 2013). This approach seems to corroborate with Nyika (2019), who argues that prior knowledge of learners should be the foundation of learning new ideas or explaining the ideas. Hence, in this case, the teacher built on this foundation. The teacher also tried to connect everyday science to school science. This resonates with Mavuru and Ramnarain (2020) who suggest that the socio-cultural background of learners assists in contextualising science, thus making science relevant to the learners. It then makes the lesson learner centred (Abah et al., 2015). That is, learners were able to socially interact with the teacher and with their peers (Vygotsky, 1978). Moreover, from the excerpt above, T6 seemed to pay some attention to both boys and girls through inviting different genders to take part in the discussion. This echoes similar sentiments as Abraha et al. (2020), that gender responsiveness allows teachers to develop and use gender responsive methodologies to ensure that there is equal participation of both boys and girls in the learning process. In this lesson, the teacher gave opportunities to both boys and girls.

However, there were some contradictions in the examples of combustion reactions. For instance:

Teacher: All those examples that you mentioned can be regarded as combustion reaction. In our syllabus the examples given are like burning match. Do you know those?

Learners (all) Yes.

Teacher: Burning candle and burning fire.

Learner (boy): But sir, how do we burn fire?

Teacher: You know, that is the language that used in the class and we don't have to direct translate the phrases. What it meant here is that we burn firewood to produce fire.

From the vignette above, the learners could not make sense of how they could burn fire. This means that there was a tension between the language used at home and the language used in the classroom. Through teacher agency, the participants were shown how to deal with cases such as this. This resonates with Shulman (1987), that in order to address misconceptions or alternative conceptions the teacher needs to understand the subject matter intensely and flexibly. This allows the teacher to assist learners in creating cognitive maps to address the misconceptions that the learners might encounter. These can be termed as contradictions between the community and the rules.

After the lesson presentation, the learners were presented with the hands-on practical activity on combustion reaction (see Appendix K). The learners worked in groups of about four learners consisting of both boys and girls. Figure 7.4 below shows learners completing the task doing hands-on practical activities using easily accessible resources (Asheela et al., 2021; Shinana et al., 2021). This allowed the learners to use materials they are familiar with when learning combustion, thus connecting home science to school science (Mensah, 2021).

Figure 7.4: Learners conducting hands-on practical activities using easilly accessible resources

The learners used candles to observe how combustion takes places where two were enclosed in beakers of different sizes and one was left burning in the open air. The missed opportunity here was that the learners were not given an opportunity to first predict what would happen before engaging in the experiment. During the hands-on practical activity, all learners were encouraged to take part in the discussion. As a result, social interactions as espoused by Vygotsky (1978) were promoted. Both boys and girls were afforded an opportunity to manipulate and explore the equipment. Also, in different groups, different genders performed the role of secretaries and not only the girls as is often the case.

All in all, the teacher followed the procedure as discussed in the mediational tool (see Figure 7.3). This began with planning the lesson that is, identifying the examples that are from the local environment and familiar to the learners. The examples used in the lesson were intended to make science meaningful to all learners (Mavuru, 2022). In addition, the lesson was planned considering the context of the learners, inviting them to take part in the discussion to give examples of materials that they use at home. In the teaching process, the teacher engaged all the learners in the discussion and invited both boys and girls to participate. This finding coheres with Dorji's (2020) sentiments that in a gender responsive classroom, teachers do not sideline less assertive learners; instead, they motivate both boys and girls to participate which leads to equal opportunities for both genders. Hence, the teacher constantly took note of the gender that was not participating and included them. During the assessment, the groups consisted of both boys and girls as shown in Figure 7.4 above. I now look at the benefits of CLWs in the PLC.

7.5 Benefits of CLWs in the PLC

The participants in this study revealed that these workshops were beneficial. This resonates with Brown et al. (2018) that in PLCs, teachers are offered professional development, the opportunity to collaborate and be innovative. This indicated that it was beneficial to all the participants as they all attended each workshop. For instance, we were supposed to have the fourth workshop on 9 March 2023; however, there were two participants who had other commitments on the same day and thus they requested for the postponement of this workshop. Concerning the overall reflections only five participants (T1, T2, T3, T4 & T6) were able to hand in their reflections. T5 could not hand in his reflections due to personal reasons. Their

reflections were categorised into two groups which were their perspectives on attending the workshops and the other one on their recommendations as highlighted in Table 7.2.

Table 7.2: Teachers' perspectives and recommendations after CLWs

Participant	Perspective	Recommendation
T1	These workshops influenced me in a positive way for teaching Physical Science. I got many ways on how to motivate learners of all genders. I learnt that we need to pay attention to our assessment especially the question papers to avoid gender stereotypes when it comes to some job regarded as for specific gender.	I therefore recommend these workshops for all teachers from different fields. Also, they need to be extended to majority of Physical Science teachers so that young generations are taught about equality in teaching of Physical Science.
T2	My participation in these workshops influenced my teaching when it comes to gender and cultural aspects. Now all my learners are involved in the lesson. My teaching also includes materials and examples from the learners' cultural background. I have gained experience on the reflective journals. It helped me in giving chances to learners to give their views. During these workshops, the facilitator created a friendly environment of all participants, ideas and views of all were considered and respected at all times.	I recommend these workshops to all Physical Science teachers because not all teachers consider gender and cultural aspects when teaching. Considering gender and culture in teaching helps learners to reconnect what they know with what they do not know. It also help them to understand the content of the lesson well.
T3	My participation in these workshop has influenced my teaching very much to an extent of considering all learners equally, treating them fair and giving them equal chances of participating in the class. It also influenced me in such a way that I have to consider learners' prior knowledge in each topic.	These workshops to be beneficial, maybe the number of participants should be increased. By this way majority of Physical Science teachers can get a chance to experience and practice how to consider gender and cultural aspects in their teaching.

T4	My participation in these workshops influenced me in the positive way. I now started to involve all gender equally and respond to gender and cultural aspects in my teaching.	I am recommending for more participants to attend these workshops as it is more informative.
T6	It empowered me to use methods that are gender inclusive. Also, know the cultural background of all learners so that the examples to all cultures are applied in teaching of Physical Science. These workshops also made me to empower both male and female learners to participate equally in Physical Science. Learning how to apply reflective journals to learners was the one that I have find to be useful in teaching and learning.	I would like us to have more sessions of various topics in Physical Science so that we can know how to consider gender and cultural aspects in all topics of Physical Science. Also, we need to extend these to all Physical Science teachers so that they can learn and acquire skills and knowledge on how to plan for lessons and assessment activities that are not gender exclusive or discriminating and also that are cultural inclusive and embracing cultural diversity.

Table 7.2 illustrated the reflections and recommendation done by the participants after taking part in the CLWs. With these reflections, teachers were able to create self-awareness, evaluation of their teaching methods, and problems encountered in their teaching, and change mediating practices where necessary as espoused by Göker (2016). The provision of the three surfaces shown in Figure 3.6, made it easy in showing the mirror data to the participants. That refers to the emerging ideas as well as sharing the conceptual tool in analysing and reforming the teaching practices in terms of gender and culturally responsiveness, thereby creating an empowering environment for teachers. In other words, this opportunity provided a lens to interrogate our teaching practices and examine the historical and present issues in relation to gender and culture. Thus, developing transformation agency.

The relationship and shared support through the CLWs proved to be an influential factor in supporting one another for transforming the teaching practices. This resonates with the epigraph above. Thus, development of the mediational tool for being gender and culturally responsive provided space for change and development. That is, the social interaction among the teachers during CLWs lead to the development. This development is situated in the activity system (CLWs) and the activities that were carried out have a clear goal to address the joint problem. In other words, CLWs served as collaborative problem-solving activities. This led to all participants being actively involved in the task and sharing the ideas (Eun, 2019). The striking significance of these CLWs was the transformation from phase one to phase two through African perspective. Teachers are afforded an opportunity to express themselves on how to be gender and culturally responsive. Similarly acknowledging how our socio-cultural background influence our ways of doing things.

7.6 Chapter Summary

This chapter presented, analysed and discussed data sets that were gathered during the intervention phase through the four CLWs. Firstly, I explained how I prepared for the workshops, and this included organising all the materials that were needed for the CLWs. Secondly, I discussed what transpired in each workshop. In the first workshop, I presented the mirror data that were gathered in phase one and that served as the first stimuli. It was also during this workshop that my critical friend made a presentation on the power of journal reflections.

In the second workshop we looked at the curriculum, syllabus and other teaching and learning materials in terms of gender and cultural responsiveness. That consisted of extracting constructs from these documents and discussing what they meant to us as teachers in terms of gender and cultural responsiveness. This was aimed at expanding our professional development by analysing the materials that teachers work with in their own classrooms. This included teaching practices and the assessments that learners are given. The third workshop was aimed at devising the mediational tool that was gender and culturally responsive. The tool emphasised that teachers need to pay attention to the planning, teaching and learning process, the assessment and the conclusion of each lesson. It was also during this workshop that we received the presentation on how to analyse the teaching and learning materials. The purpose was to identify any gender or cultural stereotypes. The fourth workshop was aimed at presenting an exemplar lesson, focusing on the components of the devised mediational tool. Lastly, the chapter summarised the benefits of the CLWs as per the reflections of the participants. I now move to the next chapter that summarises the findings of the study.

CHAPTER EIGHT: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

> Teachers have the power to select course content, facilitate discussion, and reward learning - all of which can affect the classroom climate. In order to make sure that the climate is conducive to learning and to the success of all students, teachers should consider the elements that affect classroom climate when planning a course. After taking steps before and at the onset of the course to develop an inclusive classroom climate, teachers should continue to assess the class dynamic to help sustain an inclusive climate. (Ayele et al., 2019, p. 18)

8.1 Introduction

The broader aim of this study was to explore and expand gender and cultural responsiveness for Grade 9 Physical Science teachers when mediating the learning of chemistry topics. The chapter provides a synthesis of the study by providing key findings. It comprises major findings that emerged from chapters five to seven. The chapter starts with the overview of the whole research process. It presents the summary findings of the two phases, guided by the research questions. It also outlines the new knowledge that emerged from the research, the implications of the study, the recommendations, and the limitations of this study. The chapter further provides suggestions on areas for further research, my personal reflections on the research journey and finally the conclusions drawn from this study.

8.2 An Overview of the Study

As discussed in the preceding chapters, the main aim of this study was to explore and expand gender and culturally responsive practices for Grade 9 Physical Science teachers when mediating the learning of chemistry topics. Topics from chemistry, namely acids and bases and combustion reaction were used as examples for classroom observation and as an exemplar lesson respectively. This study was carried out during a time when gender and cultural aspects play a role in the teaching and learning process. Teachers are expected to pay attention to learners' needs (Mlama et al., 2005) and consider learners' socio-cultural backgrounds in making teaching and learning meaningful (Harrison & Skrebneva, 2020; Mavuru &

Ramnarain, 2020). Hence, this study was of great importance for capacity building of teachers in addressing and overcoming the constraints that they experienced in their teaching practice in relation to gender and culturally responsive pedagogies. Through our professional learning community teachers were afforded an opportunity to work collaboratively. This enabled them to perform their tasks as explained in the epigraph above. Thus, the purpose was to emancipate the teachers and transform their teaching practices. To accomplish this, the study sought to respond to the following research questions:

1. What are Grade 9 Physical Science teachers' perspectives and pedagogical insights on gender and culturally responsive practices when mediating learning of acids and bases?
2. What are the underlying contradictions (if any) that enable and/or constrain gender and culturally responsive practices in Grade 9 Physical Science teachers' science classrooms?
3. What expansive learning and mediational tools can the study develop to support gender and culturally responsive practices in Physical Science teaching using acids and bases as an example?
4. How do group discussions and reflections through CLWs influence (or not) the implementation of mediational tools when Grade 9 Physical Science teachers mediate the learning of their lessons?

As mentioned earlier, this study was comprised of two phases, the exploratory and expansive phases. The exploratory phase focused on the experiences and pedagogical insights of teachers with regard to gender and culturally responsive practices. This phase was also aimed at surfacing contradictions that constrain teachers from being gender and culturally responsive (see Figure 5.1). Data for this phase were generated through questionnaires, semi-structured interviews, classroom observations and stimulated recall interviews. These findings were then presented in chapter five (questionnaires and semi-structured interviews) and chapter six (classroom observation and stimulated recall interviews) and this phase was devoted to answer research questions 1 and 2.

The identified contradictions were then presented as the area of change and development and hence informed the expansive phase. The purpose of this phase was to expand teachers' gender and culturally responsive practices through transformative agency (Sannino et al., 2016). Through the formative interventions using CLWs, the teachers were afforded an opportunity to bring and discuss problems, and share ideas and issues surrounding gender and culturally responsiveness in their science classrooms. These contradictions precipitated change and development. Engaging the teachers in CLWs enhanced their ZPD espoused by Vygotsky (1978) in terms of gender and culturally responsive pedagogies. Through the CLWs, the teachers were enabled to interact socially (Vygotsky, 1978) and address the issues pertaining to gender and culturally responsive practices in science classrooms. This phase was devoted to answer research questions 3 and 4. I now summarise the key findings of each phase.

8.3 Key Findings of the Study

The following findings emerged from phase one and phase two and they are discussed below.

8.3.1 Findings from the exploratory phase

The exploratory phase was aimed at understanding teachers' perspectives and pedagogical insights in terms of gender and cultural responsiveness. It also aimed to surface contradictions that constrain teachers from being gender and culturally responsive. The findings revealed that some teachers seemed to have an understanding of gender and culturally responsive practices. They also indicated that they attempted to be gender and culturally responsive when mediating their lessons. This were done through involving all the learners in the discussions (Abraha et al., 2021) and using artefacts from the immediate environment of the learners in considering their socio-cultural background (Mavuru & Ramnarain, 2020).

However, they also indicated that there are contradictions that constrain them in being gender and culturally responsive when mediating their lessons. For instance, there are a lack of examples that are not gender and culturally biased, language barriers and poor participation among learners. In addition, the teachers also indicated that there is a need for professional development. This resonates with Antinluoma et al. (2018), that for teachers to advance in their practice, they need to be engaged in professional activities. It could be argued that being involved in these activities strengthens their teaching skills in being gender responsive as

espoused by Mlama et al. (2005). For example, they need to be given refresher workshops on how to be gender and culturally responsive as the curriculum is not explicit about this. This means that they are unsure if they are interpreting the curriculum correctly. Thus, teachers could not really articulate whether they are being gender and culturally responsive in their classrooms. A platform must thus be provided for those who might not know how to be gender and culturally responsive as suggested by Mhewa et al. (2021).

Moreover, the analysis also showed that there is low confidence among the learners which leads to most learners' lack of participation in the science classroom. The language barriers also play a role in the low confidence of the learners as they find it difficult to express themselves in the language that is used as the medium of instruction. All these tensions have implications for the quality of gender and cultural responsiveness. Some of these tensions arise from following societal patriarchal norms. These include gender roles and gender stereotypes that learners associate with from home. Equally, teachers are also members of this society hence their teaching perspectives and insights are also influenced by their experiences.

8.3.2 Findings from the expansive phase

As mentioned earlier (see section 4.9.2), this study sought to contribute towards teachers' gender and cultural responsiveness in the mediation of learning. The nexus between mediation of learning and gender and cultural responsiveness facilitated the analysis of issues that pertain to quality education. These issues centre on gender and culture in the teaching and learning process which is why this study approached these issues from the socio-cultural perspective (Vygotsky, 1978). Thus, SCT provided the lens for exploring the gender and cultural responsiveness of the science teachers.

The CLWs through the expansive learning process also sought to advance the gender and cultural responsiveness of science teachers when mediating learning. They provided a platform for the teachers to evaluate their teaching practices leading to transformative agency (Sannino et al., 2016). The CHAT provided me with the epistemological landscape of this study when examining the primary contradictions within the activity system that constrain the elements in achieving the object of the activity system (Engeström & Sannino, 2010); for instance, the tensions between the subject and the tools, the subject and the rules and between the tools and

the community (language barriers). It also helped examine the tensions between the primary and secondary activity systems.

The study revealed that a professional learning community plays a major role in the teaching and learning process. It allows the teachers to come together and deliberate on the issues pertaining to the teaching and learning process (Admiraal et al., 2021). To this end, all the participants involved in this study indicated that coming together gave them a different perspective when it comes to their teaching. This ranged from the methods used in the class, the language, the assessment and also affording the learners opportunities through reflections, so that the teachers could improve on their methodologies. The workshops conducted during this phase made an impact on the teachers' teaching methods. The participants thus suggested that this kind of engagement should be extended to other teachers for better implementation of the curriculum. Consequently, they enhanced their ZPDs through social interactions as believed by Vygotsky (1978). The participants revealed that, as teachers, they need to be constantly engaged in the interpretation of the curriculum so that they can correctly enact what is required. Thus, the participation of these teachers in these workshops proved to be beneficial as it influenced their teaching positively.

8.4 New Knowledge

In this study, my focus was on the Grade 9 Physical Science teachers and significant new knowledge emerged from this study. The first contribution from this study was that before engaging the participants in the CLWs they seemed unmotivated. However, by engaging critical friends who gave presentations, they became motivated to participate in the workshops. This meant that the CLWs seemed to work better when bringing in external members. This fostered ownership and agency among the participants to participate in these workshops through collaboratively working in their PLC. This emerged as a transformation from being an outsider to being an insider during the research process.

In terms of CHAT, the members of a community are usually those who share the same objective. However, in this study, the community was extended beyond the teachers who were part of the study to include the external critical friends who were not part of the study but who

were knowledgeable about reflective journals and document analysis. They provided the much needed first double stimulus for the CLWs that were conducted.

In addition, in this study, unlike in Engeström (2000)'s study, the reflections were part of all the learning actions of the expansive learning cycle (see Figure 4.3). This extended the expansive learning cycle which was almost at the end of the cycle. This provided an opportunity for the participants to reflect on what transpired in the previous learning action and what they had used in their own practices. This is my contribution to theory in this study.

The engagement of the teachers through CLWs afforded them an opportunity to co-develop a mediational tool that teachers should consider if they wanted to be gender and culturally responsive as shown in Figure 7.3. This mediational tool was tried in the classrooms and we reflected on it in order to improve it. Lastly, the CLWs were informed by the principle of Ubuntu (Seehawer, 2023), meaning that these workshops were carried out in learning circles in order to minimise power relations among the participants. The workshops were conducted in the African way through sharing circles that resembled *Olupale* for Aawambo people (see Figure 4.2 & Figure 7.1). Hence, all participants worked and learnt together as co-learners.

8.5 Implications of the Study

Firstly, the practice of being gender and culturally responsive seemed to be little understood by the teachers. This finding highlights that there is a need for teachers to be thoroughly engaged in the discussions on how to be gender and culturally responsive when mediating the learning of their lessons. The study also created a platform for the teachers to discuss how to address the issues that they were experiencing in their classrooms. I further suggest that science teachers need to be involved in PLCs for them to be aware of gender and cultural issues in their science classrooms and find ways to address those issues collectively.

Secondly, the study also has implications for both teachers and me as it has helped us to improve our gender and cultural responsiveness when mediating our teaching. Thus, this study was of significance to the participants as it generated opportunities for us to enhance our PCK on how to integrate the cultural backgrounds of our learners into science teaching as espoused by Mavuru (2022).

Thirdly, this study sought to close the gap between policy formulation and policy implementation, calling for collaboration between developers and implementers in making sure that the policies are correctly interpreted and implemented. I now look at the recommendations that arose from the study's findings.

8.6 Recommendations

As explained in the previous chapters, the study focused on exploring and expanding teachers' gender and cultural responsiveness when mediating the learning of chemistry topics. The study expressed that being gender and culturally responsive in the science classroom cannot be over-emphasised. Hence, this study serves as a stepping-stone for further research that advocates change and development in terms of gender and cultural responsiveness in science and other subjects. Emerging from this study, I thus offer some recommendations for consideration by curriculum developers, subject advisors within the directorate of Programmes and Quality Assurance (PQA) and teachers.

Curriculum developers need to conduct CPD workshops for teachers on what is expected in interpreting the curriculum. This will allow the teachers to have the same understanding when it comes to curriculum interpretation. Providing the curriculum without further discussion on what it entails might lead to some misconceptions when interpreting it. Also, teacher training institutions should thoroughly prepare the teachers on how to address gender and cultural issues in their specific subjects. They need to provide pedagogies on how to tackle these issues and incorporate these concepts in the teaching and learning process.

Equally, I recommend that subject advisors constantly observe and support the teachers to ensure that they are implementing the curriculum and other educational policies as they ought to be. This will afford them an opportunity to discuss any issues that trouble them in their teaching. That is, teachers' professional development should focus more on the interpretations of the documents. Teachers need to be guided on how to interpret the curriculum and policies for them to have a common understanding of what these documents require.

This study also recommends that all teachers in their cluster centres or circuits should work together to form PLCs (Chauraya & Brodie, 2018; Ngcoza & Southwood, 2019). This might enable them to tackle issues affecting their teaching and learning processes. Engaging with one another allows them to share best practices and address any issues. In the same vein, schools should also sensitise the parents on how gender stereotypes might hinder the teaching and learning process. These teachers come from these communities, so if they come to school with an understanding of how gender and culture operates, they will be in a better position of using this knowledge in their classes.

Lastly, the study recommends that teachers need to encourage their learners to write reflective journals so that their writing and language skills could be improved. This will also give a voice to learners so that their learning needs can be addressed by their teachers.

8.7 Limitations of the Study

It should be acknowledged that every study has strengths and limitations and this study is no exception. For instance, this study was conducted with six Grade 9 Physical Science teachers from six schools in the Oshikoto Region. Since the study involved a small sample and left out other Physical Science teachers in the region, the sample does not represent the whole population of Physical Science teachers. Hence, it would be difficult to generalise these findings. Notwithstanding, the study generated rich data sets that can inform the implementation of gender and culturally responsive pedagogies.

Another limiting factor was finance. It was hard to increase the sample size as it would cost more in the transportation of the participants to the venue for the CLWs. Thus, the study opted for participants from the neighbouring schools that offer Physical Science in Grade 9. There was also a missed opportunity during the classroom observation (phase one). I only had one camera in the classroom which mostly focused on the teacher. The research would have been enriched if I had a second camera that could have captured the whole classroom engagement, particularly during the hands-on practical activities in phase one.

Similarly to Liveve (2022) and Simasiku (2023), I planned to further validate my findings with my participants through sharing circles. However, my participants could not make time since they were busy preparing the learners for final external examinations. Hence, these commitments limited us from validating the findings.

8.8 Areas for Future Research

This research serves as a stepping-stone for further research that advocates gender and cultural responsive in the teaching and learning process. The study provides further suggestions for study focusing on the following.

- A study working with the learners to understand their perspectives when teachers are gender and culturally responsive. This involves how it influences (or not) their learning of science.
- A study focusing on institutions of higher learning and how they engage the teachers in training with the issues concerning gender and cultural aspects in teacher training for specific subjects.
- This study was conducted with members from a similar cultural background. It might be interesting to conduct a study in which members are from different cultural backgrounds.
- A study focusing on officials and how to engage teachers in the interpretation of educational policies, particularly those that deal with gender and cultural responsiveness.

8.9 Reflections

I started my academic journey with Rhodes University in 2015 when I was admitted for a Bachelor of Education Honours. After completing the Honours, I registered for Masters in Science Education in 2018. Even though my previous study focused solely on IK, this study shifted to gender and culture. I developed curiosity to understand how gender and culture impact teaching and learning, particularly in science. Most studies focused on empowering the girls in the learning of science and studying in general. This is evident in the increase in the number of women who are graduating from various institutions. For instance, in 2018, at Rhodes University, 63% of graduates were women, in 2021 it increased to 66%, with a slight

decrease in 2023 to 64%. This is not only happening at Rhodes University but at other universities as well. The danger, though, could be that in the process of empowering the girls, we might be neglecting the boys. Hence, this study embarked on looking at how teachers are paying attention to both boys and girls during the teaching and learning process. It also looked at how they can be supported in carrying out gender and culturally responsive practices.

On a personal level, embarking upon this study has taught me to be resilient and keep on pushing forward. One of the challenges that I experienced was balancing the time between my study, my family and my professional career. During the process of writing up this study, I was promoted as a school principal. It became very difficult as I had to fulfil this new responsibility which also required much of my time. Also, I was heartbroken when my proposal was sent back twice. My world came crumbling down after receiving feedback from the Higher Degree Committee. I was on the verge of giving up on this study. However, I learnt during my study with Rhodes University is that giving up was not an option. With the support that I received from my supervisors, I always found my way back. Their moral support and motivation encouraged me to keep on pushing forward. I am forever grateful for this support.

Concerning the research process, I have also learnt a lot, particularly through working with other colleagues. Some of the participants I came to know for the first time after taking up this study. I have learnt that it indeed requires trust, commitment and dedication when working with other people. One of the challenges I experienced was also time constraints. It was really difficult to work with other people, considering that they also had their own responsibilities to fulfil. It took me a whole month to receive the questionnaires back from all six teachers. As this was the first instrument for data gathering, I found it difficult to wait to get them back after the scheduled time. It was also difficult finding the perfect time for some of the participants in order to conduct the semi-structured interviews, even though I was the one required to travel to the participants' venues. It was indeed a daunting task. Now and then, I had to adjust to fit the situation at hand and divert from the initial plan. However, after persistently negotiating with the participants, it became possible to carry out this study.

I developed a fear that it would not be possible to gather all the participants at one venue. This phase was the heart of this study. However, to my surprise, in all the CLWs that were conducted I recorded a 100% attendance. It could be surmised that participants developed interest in the study. For example, there were questions like *"Is our pastor coming today?"* This was referring to the critical friend who gave the presentation on the power of reflection. It could also be that in this study we all positioned ourselves as co-learners. Hence, the created learning space might have been conducive for all participants. It also gave me confidence that during all the interventions there was great engagement among all participants. I was humbled by the rapport built from the inception and continuous support and engagement of these teachers. These teachers demonstrated their commitment towards the successful completion of this study. This was evident in their eagerness to attend these workshops. For instance, we had to reschedule our last workshop because some participants had other commitments on the planned day and they did not want to miss out on this opportunity. The co-development of the tool and the planning of the exemplar lesson proved that these teachers were willing to make changes to their teaching practices. Hence, it could be argued that these CLWs made a positive impact in terms of their professional development.

Overall, this study provided me an opportunity to critically engage with various literature, particularly during this era where gender and culture play major roles in the teaching and learning process. In addition, I experienced a stumbling block on how to use the third generation of CHAT. However, with assistance from the members of our PLC I managed to work with it. With the experience gained, I now see myself as a conscientious and real researcher. I am always encouraged by the Ubuntu quote: "*If you want to go fast, go alone. If you want to go far, go together."* Learning indeed occurs through interactions with others as espoused by Vygotsky.

8.10 Conclusion

Gender and cultural issues play a major role in the teaching and learning processes. While acknowledging this, it is worth noting that teachers who are curriculum implementers play a role in ensuring that learners' gender and cultural backgrounds are not used to discriminate against them during the teaching and learning process. Hence, this calls for teachers to be on the lookout for all gender and cultural stereotypes that could be experienced in the classroom

and to ensure that none of the learners are subjected to such discrimination. Notwithstanding, for the teachers to successfully implement these strategies, they need to be afforded an opportunity for professional development and also reflect on their teaching practices. The NCBE advocates teaching and learning to be gender and culturally responsive. This calls for teachers to be equipped on how to enact such a curriculum.

This study employed a formative intervention to explore and expand gender and culturally responsive practices for Grade 9 Physical Science teachers when mediating the learning of chemistry topics. In order to achieve this, four research questions were posed. Qualitative data were generated from questionnaires, semi-structured interviews, classroom observation, stimulated recall interviews and CLWs.

The study revealed that there are contradictions that constrain teachers in being gender and culturally responsive. These include a lack of professional development regarding the implementation of educational policies, low participation of learners, low self-esteem and a lack of examples that are not gender and culturally biased. The study further revealed that teachers and learners are members of a society where they are exposed to gender and cultural biases and stereotypes. Hence, this affects their teaching and learning processes.

The study recommends that teachers need to be provided with professional development regularly in order to be aware of how to interpret educational policies. Furthermore, it recommends that teachers should be engaged in PLCs so that they can enact being gender and culturally responsive when mediating learning of their lessons. Finally, in this study, the participants developed the mediational tool (see Figure 7.3) as an attempt to address gender and cultural biases in teaching and learning processes. As such, the study contributes to the body of knowledge in terms of gender and culturally responsive teaching practices. Indeed, "*A journey of a thousand miles begins with a single step*" (Chinese Proverb).

REFERENCES

Abah, J., Mashebe, P., & Denuga, D. D. (2015). Prospect of integrating African indigenous knowledge systems into the teaching of sciences in Africa. *American Journal of Educational Research*, *3*(6), 668-673.

Abraha, M., Dagnew, A., & Seifu, A. (2019). Gender responsive pedagogy: Practices, challenges & opportunities-A case of secondary schools of North Wollo Zone, Ethiopia. *Journal of Education, Society and Behavioural Science*, 1-17.

Abraha, M., Seifu, A., & Dagnew, A. (2020). General secondary school science teachers' gender responsive pedagogy practices in North Wollo Zone. *International Journal of Education and Management Studies*, *10*(2), 120-127.

Abraha, M., Seifu, A., & Dagnew, A. (2021). Manifestation of the FAWE's gender responsive pedagogy in the Ethiopian general secondary school science teaching. *International Journal of Management (IJM)*, *12*(1), 1560-1571.

Adkins, T. A. (2012). 'Can't nobody sleep' and other characteristics of culturally responsive English instruction. *Multicultural Perspectives, 14*(2), 73-81.

Admiraal, W., Schenke, W., De Jong, L., Emmelot, Y., & Sligte, H. (2021). Schools as professional learning communities: what can schools do to support professional development of their teachers? *Professional development in education*, *47*(4), 684-698.

Agunbiade, E., Ngcoza, K., Jawahar, K., & Sewry, J. (2017). An exploratory study of the relationship between learners' attitudes towards learning science and characteristics of an afterschool science club. *African Journal of Research in Mathematics, Science and Technology Education*, *21*(3), 271-281.

Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. Teachers College Press.

Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching, 36*(3), 269-287.

Ajayi, V. O., & Ogbeba, J. (2017). Effect of gender on senior secondary chemistry students' achievement in stoichiometry using hands-on activities. *American Journal of Educational Research*, *5*(8), 839-842.

Alharahsheh, H. H., & Pius, A. (2020). A review of key paradigms: Positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences*, *2*(3), 39-43.

Aliyu, A. A., Singhry, I. M., Adamu, H. A. R. U. N. A., & AbuBakar, M. A. M. (2015, December). Ontology, epistemology and axiology in quantitative and qualitative research: Elucidation of the research philosophical misconception. In *Proceedings of the Academic Conference: Mediterranean Publications & Research International on New Direction and Uncommon*, *2*(1), 1054-1068.

Altan, S., & Lane, J. F. (2018). Teachers' narratives: A source for exploring the influences of teachers' significant life experiences on their dispositions and teaching practices. *Teaching and Teacher Education*, *74*(1), 238-248.

Altan, S., Lane, J. F., & Dottin, E. (2019). Using habits of mind, intelligent behaviors, and educational theories to create a conceptual framework for developing effective teaching dispositions. *Journal of Teacher Education*, *70*(2), 169-183.

Ambusaidi, A., & Al-Farei, K. (2017). Investigating Omani science teachers' attitudes towards teaching science: The role of gender and teaching experiences. *International Journal of Science and Mathematics Education*, *15*(1), 71-88.

Amory, A., & Hardman, J. (2014). Introduction to cultural-historical activity theory and tool mediation. In *Activity theory, authentic learning and emerging technologies: towards a transformative higher education pedagogy*. Routledge.

Ananga, E. D. (2021). Gender responsive pedagogy for teaching and learning: The practice in Ghana's Initial Teacher Education Programme. *Creative Education*, *12*(4), 848-864.

Andersson, K., Hussénius, A., & Gustafsson, C. (2009). Gender theory as a tool for analyzing science teaching. *Teaching and Teacher Education*, *25*(2), 336-343.

Andersson, C., & Palm, T. (2017). Characteristics of improved formative assessment practice. *Education Inquiry*, *8*(2), 104-122.

Angula, N. A. (2019). Education for all: The Namibian experience. In *Democratic teacher education reform in Africa* (pp. 8-28). Routledge.

Antinluoma, M., Ilomäki, L., Lahti-Nuuttila, P., & Toom, A. (2018). Schools as professional learning communities. *Journal of Education and Learning*, *7*(5), 76-91.

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). Balancing acts: Elementary school girls' negotiations of femininity, achievement, and science. *Science Education, 96*(9), 67-89.

Asghar, J. (2013). Critical paradigm: A preamble for novice researchers. *Life Science Journal*, *10*(4), 3121-3127.

Asheela, E., Ngcoza, K. M., & Sewry, J. (2021). The use of easily accessible resources during hands-on practical activities in rural under-resourced Namibian schools. In U. Ramnarain (Ed.), *School science practical work in Africa. Experiences and challenges* (pp. 14-31). Routledge.

Atallah, F., Bryant, S. L., & Dada, R. (2010). Learners' and teachers' conceptions and dispositions of mathematics from a Middle Eastern perspective. *US-China Education Review, 7*(8), 43-49.

Ayele, M. A., Woldeyesus, K. M., Aboretugne, M. A., Gobaw, M. K., Wamisho, A. D., Mamie, A. H.,... & Berhe, G. D. (2019). Teachers' classroom teaching practices in Amhara Region and Addis Ababa City, Ethiopia. *Africa Education Review*, *16*(3), 1-21.

Bairagi, V., & Munot, M. V. (2019). *Research methodology: A practical and scientific approach*. Taylor & Francis Group.

Bakkabulindi, F. (2015). Positivism and interpretivism: Distinguishing characteristics, criteria and methodology. *Educational Research: An African Approach*, 19-38.

Bakshi, R. (2016). Gender responsive pedagogical discourses: A challenge to teacher training. *School of Education and Behavioural Sciences*, *21*(1), 265-272.

Bang, M., Brown, B., Calabrese Barton, A., Rosebery, A. S., & Warren, B. (2017). Toward more equitable learning in science. In *Helping students make sense of the world using next generation science and engineering practices*, 33-58.

Başar, F., & Demirci, N. (2018). Attitudes of nursing students toward gender roles: a cross-sectional study. *Contemporary Nurse*, *54*(3), 333-344.

Batiibwe, M. S. K. (2019). Using Cultural Historical Activity Theory to understand how emerging technologies can mediate teaching and learning in a mathematics classroom: a review of literature. *Research and Practice in Technology Enhanced Learning*, *14*(1), 12.

Bertram, C., & Christiansen, I. (2020). *Understanding research: An introduction to research reading*. Van Schaik Publishers.

Bettez, S. C. (2015) Navigating the complexity of qualitative research in postmodern contexts: assemblage, critical reflexivity, and communion as guides. *International Journal of Qualitative Studies in Education, 28* (8), 932-954.

Bialka, C. S. (2017). Understanding the factors that shape dispositions toward students with disabilities: A case study of three general education pre-service teachers. *International Journal of Inclusive Education*, *21*(6), 616-636.

Biraimah, K. L. (2016). Moving beyond a destructive past to a decolonised and inclusive future: The role of ubuntu-style education in providing culturally relevant pedagogy for Namibia. *International Review of Education*, *62*, 45-62.

Bottiani, J. H., Larson, K. E., Debnam, K. J., Bischoff, C. M., & Bradshaw, C. P. (2018). Promoting educators' use of culturally responsive practices: A systematic review of in-service interventions. *Journal of Teacher Education*, *69*(4), 367-385.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Brodie, K. (2020). Professional learning communities in mathematics education. In S. Lerman (Ed.), *Encyclopedia of mathematics education*. Springer. https://0-doi.org.wam.seals.ac.za/10.1007/978-3-030-15789-0_130

Brooms, D. (2019). "I was just trying to make it": Examining urban Black males' sense of belonging, schooling experiences, and academic success. *Urban Education, 54*(6), 804-830.

Brown, B. A., Boda, P., Lemmi, C., & Monroe, X. (2019). Moving culturally relevant pedagogy from theory to practice: Exploring teachers' application of culturally relevant education in science and mathematics. *Urban Education, 54*(6), 775-803.

Brown, B. D., Horn, R. S., & King, G. (2018). The effective implementation of professional learning communities. *Alabama Journal of Educational Leadership*, *5*, 53-59.

Brown, G. T., & Gao, L. (2015). Chinese teachers' conceptions of assessment for and of learning: Six competing and complementary purposes. *Cogent Education, 2*(1), 1-19.

Brown, J. C. (2017). A metasynthesis of the complementarity of culturally responsive and inquiry-based science education in K-12 settings: Implications for advancing equitable science teaching and learning. *Journal of Research in Science Teaching*, *54*(9), 1143-1173.

Brown, J. C., & Crippen, K. J. (2017). The knowledge and practices of high school science teachers in pursuit of cultural responsiveness. *Science Education*, *101*(1), 99-133.

Brown, M. A., & Di Lallo, S. (2020). Talking circles: A culturally responsive evaluation practice. *American Journal of Evaluation*, *41*(3), 367-383.

Busetto, L., Wick, W., & Gumbinger, C. (2020). How to use and assess qualitative research methods. *Neurological Research and Practice*, *2*, 1-10.

Busyro, B. (2017). Female Imam and Khatib: The progressive tradition of gender- responsive practices in Balingka, West Sumatera. *Journal of Indonesian Islam*, *11*(2), 531-550.

Calvert, L. (2016). The power of teacher agency. *The Learning Professional*, *37*(2), 51-56.

Ceci, S. J., Ginther, D. K., Kahn, S., & Williams, W. M. (2014). Women in academic science: A changing landscape. *Psychological Science in the Public Interest*, *15*(3), 75-141.

Cetin-Dindar, A., & Geban, O. (2017). Conceptual understanding of acids and bases concepts and motivation to learn chemistry. *The Journal of Educational Research*, *110*(1), 85-97.

Chapin, J., Skovgaard, M., & Warne, V. (2020). *Integrating gender responsive pedagogy into higher education: Our approach.* International Network for International Network for Advancing Science and Policy (INASP).

Chapin, J., & Warne, V. (2020). *Gender responsive pedagogy in higher education: A framework.* International Network for International Network for Advancing Science and Policy (INASP).

Chauraya, M., & Brodie, K. (2018). Conversations in a professional learning community: An analysis of teacher learning opportunities in mathematics. *Pythagoras*, *39*(1), 1-9.

Chen, C. H., & Tsai, C. C. (2021). In-service teachers' conceptions of mobile technology-integrated instruction: Tendency towards student-centered learning. *Computers & Education*, *170*, 1-13.

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin*, *143*(1), 1.

Chikaire, J., Osuagwu, C. O., Ihenacho, R. A., Oguegbuchulam, M. N., Ejiogu-Okereke, N., & Obi, K. U. (2012), Indigenous knowledge system: The need for reform and the way forward. *Global Advanced Research Journal of Agricultural Science*, *1*(8), 201-209.

Chikunda, C. (2012). A capability approach its potential for transformative education research focusing on education for sustainable development and gender issues in science teacher education. *Southern African Journal of Environmental Education, 29*, 133-150.

Chikunda, C. (2013). *Exploring and expanding capabilities, sustainability and gender justice in science teacher education: Case studies in Zimbabwe and South Africa* [Unpublished doctoral thesis]. Rhodes University.

Chikunda, C. (2014). Identifying tensions around gender-responsive curriculum practices in science teacher education in Zimbabwe: An activity theory analysis. *African Journal of Research in Mathematics, Science and Technology Education, 18*(3), 264-275. https://doi.org/10.1080/10288457.2014.956409

Chikunda, C., & Chikunda, P. (2015). Capability approach: Potential for transformative education research on gender and culture in Zimbabwe. *Cultural and Pedagogical Inquiry, 7*(2), 10-26.

Chikunda, C., & Chikunda, P. (2016). Patriarchy rules: Transforming resistance to gender inequalities in science teacher education in Zimbabwe. *Cultural and Pedagogical Inquiry*, *8*(2), 11-22.

Chilisa, B. (2012). *Indigenous research methodologies*. Sage Publications.

Cho, S., & Jang, S. J. (2021). Do gender role stereotypes and patriarchal culture affect nursing students' major satisfaction? *International Journal of Environmental Research and Public Health*, *18*(5), 2607.

Christidou, V. (2011). Interest, attitudes and images related to science: Combining students' voices with the voices of school science, teachers, and popular

science. *International Journal of Environmental and Science Education*, *6*(2), 141-159.

Ciesielska, M., Boström, K. W., & Öhlander, M. (2018). Observation methods. In *Qualitative methodologies in organization studies: Volume II: Methods and possibilities* (pp. 33-52).

Clark, A., Holland, C., Katz, J., & Peace, S. (2009). Learning to see: Lessons from a participatory observation research project in public spaces. *International Journal of Social Research Methodology, 12*(4), 345-60.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education*. Routledge.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.). Routledge.

Colen, T. (2013). *The relationship between teacher-learner interaction and the laboratory learning environment during Chemistry practicals in Namibia* [Unpublished doctoral thesis]. University of South Africa.

Constitution of the Republic of Namibia. (1990) (Act No. 1 of 1990).

Council for the Accreditation of Educator Preparation. (2013). *CAEP standards for accreditation of educator preparation*. http://caepnet.org/standards/introduction.

Creswell, J. W. (2012). *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (4th ed.). Pearson.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods* (4th ed.). Sage Publications.

Creswell, J. W. & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods* (5th ed.). Sage Publications.

Creswell J. W., Ebersohn L., Eloff I., Ferreira R., Ivankova N. V., Jansen J. D., … Plano Clark, V. L. (2016). *First step in research*. Van Schaik Publishers.

Cronje, A., De Beer, J., & Ankiewicz, P. (2015). The development and use of an instrument to investigate science teachers' views on indigenous knowledge. *African Journal of Research in Mathematics, Science and Technology Education*, *19*(3), 319-332.

Crossa, V. (2012). Relational positionality: Conceptualizing research, power, and the everyday politics of neoliberalization in Mexico City. *ACME: An International Journal for Critical Geographies*, *11*(1), 110-132.

Crotty, M. (1998). *The foundation of social research: Meaning and perspective in the research process*. Sage Publications.

Daneshfar, S., & Moharami, M. (2018). Dynamic assessment in Vygotsky's sociocultural theory: Origins and main concepts. *Journal of Language Teaching and Research*, *9*(3), 600-607.

Daniels, H. (2008). Reflections on points of departure in the development of sociocultural and activity theory. In B. van Oers (Ed.), *The transformation of learning: Advances in Cultural-Historical Activity Theory* (pp. 58-75). Cambridge University Press.

Di Tullio, I. (2019). Gender Equality in STEM: Exploring Self-Efficacy Through Gender Awareness. *Italian Journal of Sociology of Education, 11*(3), 226-245. https://doi.org/10.14658/pupj-ijse-2019-3-13.

Dorji, T. (2020). Gender responsive pedagogy awareness and practices: A case study of a secondary School under Thimphu Thromde, Bhutan. *International Journal of Linguistics and Translation Studies*, *1*(2), 100-111.

Drechler, M., & Van Driel, J. (2007). Experienced teachers' pedagogical content knowledge of teaching acid-base chemistry. *Research in Science Education, 38*, 611-631.

Durden, T. R., & Truscott, D. M. (2013). Critical reflectivity and the development of new culturally relevant teachers. *Multicultural Perspectives*, *15*(2), 73-80.

Ebadi, S., & Gheisari, N. (2016). The role of consciousness-raising through critical reflection in teachers' professional development: A sociocultural perspective. *Cogent Education, 3*(1). http://dx.doi.org/10.1080/2331186X.2016.1147990

Edwards, A. (2005). Relational agency: Learning to be a resourceful practitioner. International *Journal of Educational Research, 43*(3), 168-182.

Ellemers, N. (2018). Gender stereotypes. *Annual Review of Psychology*, *69*, 275-298.

Engeström, Y. (1987). *Learning by expanding: An activity theoretical approach to developmental research.* Orienta-Konsultit.

Engeström, Y. (1999). Expansive visibilization of work: An activity-theoretical perspective. *Computer Supported Cooperative Work (CSCW)*, *8*(1), 63-93.

Engeström, Y. (2000). Activity theory as a framework for analyzing and redesigning work. *Ergonomics*, *43*(7), 960-974.

Engeström, Y. (2001). Expansive learning at work: Towards an activity theoretical re-conceptualisation. *Journal of Education and Work*, *14*(1), 133-156.

Engeström, Y (2009). The future of activity system: A rough draft. In A. Sannino, H. Daniels & K. D. Gutierrez (Eds.)*, Learning and expanding with activity theory* (pp. 303-330). Cambridge University Press.

Engeström, Y. (2010). Activity theory and learning. In M. Malloch, L. Cairns, B. Evans & N. O' Connor (Eds.), *The Sage handbook of workplace learning* (pp. 86-104). Sage Publications.

Engeström, Y. (2016). *Studies in expansive learning: Learning what is not yet there*. New York Press.

Engeström, Y., & Sannino, A. (2010). Studies of expansive learning: Foundations, findings, and future challenges. *Educational Research Review Journal, 5*, 1-24.

Engeström, Y., & Sannino, A. (2016). Expansive learning on the move: Insights from ongoing research/El aprendizaje expansivo en movimiento: aportaciones de la investigación en curso. *Infancia y aprendizaje*, *39*(3), 401-435.

Engeström, Y., & Sannino, A. (2021). From mediated actions to heterogenous coalitions: four generations of activity-theoretical studies of work and learning. *Mind, Culture, and Activity*, *28*(1), 4-23.

Erinosho, S. Y. (2013). Integrating indigenous science with school science for enhanced learning. *International Journal for Cross Disciplinary Subjects in Education, 4*(2), 1137-1143.

Ertl, B., Luttenberger, S., & Paechter, M. (2017). The impact of gender stereotypes on the self-concept of female students in STEM subjects with an under-representation of females. *Frontiers in Psychology*, *8*(703), 1-11.

Esteve, O. (2020). Teacher agency in plurilingual learning contexts. In S. Laviosa & M. González-Davies (Eds.), *The Routledge handbook of translation and education* (pp. 417-433). Taylor & Francis.

Eun, B. (2008). Making connections: Grounding professional development in the developmental theories of Vygotsky. *The Teacher Educator, 43*(2), 134-155.

Eun, B. (2019). The zone of proximal development as an overarching concept: A framework for synthesizing Vygotsky's theories. *Educational Philosophy and Theory*, *51*(1), 18-30.

European Institute for Gender Equality (2019). *Substantive gender equality*. https://eige.europa.eu/thesaurus/terms/1401.

Feldman, J. (2020). The role of professional learning communities to support teacher development: A social practice theory perspective. *South African Journal of Education*, *40*(1), 1-8.

Fentie, T. (2017). Implementation of gender responsive pedagogy at Debre Markos College of Teacher Education. *Proceedings of the 9th Multi-Disciplinary Seminar, Research and Knowledge Management Office*. St. Mary's University.

Flick, U. (Ed.). (2018). *The SAGE handbook of qualitative data collection*. Sage Publications.

Fomunyam, K. G., & Teferra, D. (2017). Curriculum responsiveness within the context of decolonisation in South African higher education. *Perspectives in Education, 35*(2), 196-207.

Foot, K. A. (2014). Cultural-historical activity theory: Exploring a theory to inform practice and research. *Journal of Human Behavior in the Social Environment, 24*(3), 329-347.

Foxx, S. P., Saunders, R., & Lewis, C. W. (2020). Race, gender, class and achievement: A culturally responsive approach to urban school counseling. *Professional School Counseling*, *23*(1/2), 2156759X19899184.

Ganley, C. M., Vasilyeva, M., & Dulaney, A. (2014). Spatial ability mediates the gender differences in middle school students' science performance. *Child Development, 85*(4), 1419-1432.

Gay, G. (2010). *Culturally responsive teaching: Theory, research, and practice* (2nd ed.). Teachers College Press.

Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice* (3rd ed.). Teachers College Press.

Gay, L. R., Mills, G. E., & Airasian, P. W. (2011). *Educational research: Competencies for analysis and applications* (10th ed.). Pearson Higher Ed.

Gedera, D. S. P., & Williams, P. J. (Eds.) (2016). *Activity theory in education research and practice.* Sense Publisher.

Gess-Newsome, J., Taylor, J. A., Carlson, J., Gardner, A. L., Wilson, C. D., & Stuhlsatz, M. A. (2019). Teacher pedagogical content knowledge, practice, and student achievement. *International Journal of Science Education*, *41*(7), 944-963.

Giuliano, P. (2017). Gender: An historical perspective. *Working Paper 23635*. http://www.nber.org/papers/w23635.

Göker, S. D. (2016.). Use of reflective journals in development of teachers' leadership and teaching skills. *Universal Journal of Educational Research, 4*(12A), 63-70.

Goodhew, S. C., Reynolds, K., Edwards, M., & Kidd, E. (2022). The content of gender stereotypes embedded in language use. *Journal of Language and Social Psychology*, *41*(2), 219-231.

Götzmann, N., & Bainton, N. (2021). Embedding gender-responsive approaches in impact assessment and management. *Impact Assessment and Project Appraisal, 39*(3), 171-182.

Grant, C. (2017b). Excavating the South African teacher leadership archive: Surfacing the absences and re-imagining the future. *Education Management, Administration and Leadership*, 1-19. https://doi.org/10. 1177/1741143217717274

Greene, M. J. (2014). On the inside looking in: Methodological insights and challenges in conducting qualitative insider research. *The Qualitative Report*, *19*(29), 1-13.

Griner, A. C., & Stewart, M. L. (2012). Addressing the achievement gap and disproportionality through the use of culturally responsive pedagogy practices. *Urban Education, 48*(4), 585-621.

Gudyanga, A. (2016). *Participation of Zimbabwean female students in physics: Subject perception and identity formation* [Unpublished doctoral thesis]. Nelson Mandela Metropolitan University.

Gullberg, A., Andersson, K., Danielsson, A., Scantlebury, K., & Hussénius, A. (2018). Pre-service teachers' views of the child—Reproducing or challenging gender stereotypes in science in preschool. *Research in Science Education*, *48*(4), 691-715.

Gupta, A. (2006). *Early childhood education, postcolonial theory, and teaching practices in India: Balancing Vygotsky and the Veda*. Palgrave Macmillan.

Gwekwerere, Y. (2016). Schooling and the African child: Bridging African epistemology and Eurocentric Physical Sciences. In G. Emeagwali & E. Shizha (Eds.), *African indigenous knowledge and the sciences: Journeys into the past and present* (pp. 57-75). Sense Publishers.

Haapasaari, A., Engeström, Y., & Kerosuo, H. (2016). The emergence of learners' transformative agency in a Change Laboratory intervention. *Journal of education and work*, *29*(2), 232-262.

Häkkinen, P., Virtanen, T., Virtanen, A., Näykki, P., Pöysä-Tarhonen, J., Niilo-Rämä, M., & Järvelä, S. (2020). Finnish pre-service teachers' perceptions of their strategic learning skills and collaboration dispositions. *Journal of Education for Teaching*, *46*(1), 71-86.

Haimene, J. S. (2018). *Exploring how the integration of indigenous knowledge in the topic of acids and bases influences Grade 10 Physical Science learners' conceptions, dispositions and sense-making* [Unpublished master's thesis]. Rhodes University.

Hangula, L., Kamwi, M. K., Likando, G., & Shanyanana, R. N. (2018). Higher education systems and institutions, Namibia. *Encyclopedia of International Higher Education Systems and Institutions*, 1-7.

Hanson, S.L., Sykes, M., & Pena, B.L. (2018). Gender equity in science: The global context. *International Journal of Social Science Studies, 6*(1), 33-47.

Harrison, N., & Skrebneva, I. (2020). Country as pedagogical: Enacting an Australian foundation for culturally responsive pedagogy. *Journal of Curriculum Studies*, *52*(1), 15-26.

Hart, C. (2018). Doing a literature review: Releasing the research imagination. *Doing a Literature Review*, 1-352.

Heijnen-Maathuis, E. (2008). *From parity to equality in girls' education: How are we doing in South Asia?* United Nations Children's Fund, Regional Office for South Asia.

Hoaglund, A.E., Birkenfeld, K., & Box, J.A. (2014). Professional learning communities: Creating a foundation for collaboration skills in pre-service teachers. *Education, 134*(4), 521-528.

Holmes, A. G. D. (2020). Researcher positionality: A consideration of its influence and place in qualitative research: A new researcher guide. *Shanlax International Journal of Education, 8*(4), 1-10.

Hopwood, N. (2022). Agency in cultural-historical activity theory: strengthening commitment to social transformation. *Mind, Culture, and Activity*, *29*(2), 108-122.

Horsthemke, K., & Schafer, M. (2007). Does 'African mathematics' facilitate access to mathematics? Towards an ongoing critical analysis of ethnomathematics in a South African context. *Pythagoras, 65*, 2-9.

Howard, T. C. (2010). *Why race and culture matter in schools: Closing the achievement gap in America's classrooms*. Teachers College Press.

Hsieh, W. M., & Tsai, C. C. (2017). Taiwanese high school teachers' conceptions of mobile learning. *Computers & Education*, *115*, 82-95.

Huang, S. L., & Fraser, B. J. (2009). Science teachers' perceptions of the school environment: Gender differences. *Journal of Research in Science Teaching, 46*(4), 404-420.

Hussain, M. A., Elyas, T., & Nasseef, O. A. (2013). Research paradigm: A slippery slope for fresh researchers. *Life Science Journal, 10*, 2374-2381.

Iwu, R. U., & Azoro, A. V. (2017). A study on the barriers to participation of females in science, mathematics and technology education in Imo State: The way forward. *Educational Research and Reviews*, *12*(17), 832-838.

Jensen, B., Whiting, E. F., & Chapman, S. (2018). Measuring the multicultural dispositions of preservice teachers. *Journal of Psychoeducational Assessment*, *36*(2), 120-135.

Jett, C. C., Curry, K. M., & Vernon-Jackson, S. (2016). Let our students be our guides: MacNair scholars "guide" three urban teacher educators on meeting the needs of culturally diverse learners. *Urban Education, 51*(5), 514-533.

John- Steiner, V., & Mahn, H. (1996). Sociocultural approaches to learning and development: A Vygotskian framework. *Educational Psychologist, 31*(3/4), 191-206.

Johnston, P., Wilson, A., & Almerico, G. M. (2018). Meeting psychometric requirements for disposition assessment: Valid and reliable indicators of teacher dispositions. *Journal of Instructional Pedagogies*, *21,* 1-12.

Kahamba, J. S., Massawe, F. A., & Kira, E. S. (2017). Awareness and practice of gender responsive pedagogy in higher learning institutions: The case of Sokoine University of Agriculture, Tanzania. *Journal of Education, Humanities and Sciences, 6*(2), 1-16.

Kaino, L. M. (2013) Traditional knowledge in curricula designs: Embracing indigenous mathematics in classroom instruction. *Stud Tribes Tribals, 11*(1), 83-88.

Kala, N., Yaman, F., & Ayas, A. (2013). The effectiveness of predict–observe–explain technique in probing students' understanding about acid–base chemistry: A case for the concepts of pH, pOH, and strength. *International Journal of Science and Mathematics Education*, *11*(3), 555-574.

Karlson, I., & Simonsson, M., (2011). A question of gender-sensitive pedagogy: Discourses in pedagogical guidelines. *Contemporary Issues in Early Childhood, 12*(3), 274-283.

Kayaalp, D. (2019). Towards culturally responsive education: A qualitative approach. *European Journal of Education*, *2*(2), 77-85.

Khatri, K. K. (2020). Research paradigm: A philosophy of educational research. *International Journal of English Literature and Social Sciences (IJELS)*, *5*(5), 1435- 1440.

Kibirige, I., & Van Rooyen, H. (2006). Enriching science teaching through the inclusion of indigenous knowledge. In J. de Beers & H. Van Rooyen (Eds.), *Teaching science in the OBE classroom* (pp. 1-13). Macmillan.

Kimani, E., & Mwikamba, K. (2017). Gender dynamics in science and technology. *Gender Dynamics, 12*(2), 70-81.

Kind, V., & Chan, K. K. (2019). Resolving the amalgam: Connecting pedagogical content knowledge, content knowledge and pedagogical knowledge. *International Journal of Science Education*, *41*(7), 964-978.

Koç, C. & Köybaşi, F. (2016). Prospective teachers' conceptions of teaching and learning and their attitudes towards multicultural education. *Academic Journals, 11*(22), 2048-2056.

Kuhlane, Z. (2011). *An investigation into the benefits of integrating learners' prior everyday knowledge and experiences during teaching and learning of acids and bases in Grade 7: A case study* [Unpublished masters' thesis]. Rhodes University.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal 32*(3), 465-491.

Lantolf, J. P., Thorne, S. L., & Poehner, M. E. (2015). Sociocultural theory and second language development. In *Theories in second language acquisition: An introduction* (Vol. 1) (pp. 207-226).

Lavallée, L. F. (2009). Practical application of an indigenous research framework and two qualitative indigenous research methods: Sharing circles and Anishnaabe symbol-based reflection. *International Journal of Qualitative Methods*, *8*(1), 21-40.

Leatham, K. R. (2006). Viewing mathematics teachers' beliefs as sensible systems. *Journal of Mathematics Teacher Education*, *9*(1), 91-102.

Leslie, S. J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science*, *347*(6219), 262-265.

Li, H., & Chen, Y. (2018). Conceptions on PBL facilitator's role: a perspective of Chinese teacher. *International Journal of Learning, Teaching, and Educational Research*, *17*(9), 18-33.

Lips, H. M. (2016). *A new psychology of women: Gender, culture, and ethnicity*. Waveland Press.

Liu, X., & Burnett, D. (2022). Insider-outsider: Methodological reflections on collaborative intercultural research. *Humanities and Social Sciences Communications*, *9*(1), 1-8.

Liveve, A. K. (2022). *Revitalisation and indigenisation of the science curriculum through drum making, drumming, music and dance* [Unpublished doctoral thesis]. Rhodes University.

Lotz-Sisitka, H., Mukute, M., Chikunda, C., Baloi, A., & Pesanayi, T. (2017). Transgressing the norm: Transformative agency in community-based learning for sustainability in southern African contexts. *International Review of Education*, *63*(6), 897-914.

Mackenzie, S. H., & Kerr, J. H. (2012). Head-mounted cameras and stimulated recall in qualitative sport research. *Qualitative Research in Sport, Exercise and Health, 4*(1), 51-61.

Mahaffy, P. G., Holme, T. A., Martin-Visscher, L., Martin, B. E., Versprille, A., Kirchhoff, M.,... & Towns, M. (2017). Beyond "inert" ideas to teaching general chemistry from rich contexts: Visualizing the chemistry of climate change (VC3). *Journal of Chemical Education*, *94*(8), 1027-1035.

Makarova, E., Aeschlimann, B., & Herzog, W. (2019). The gender gap in STEM fields: The impact of the gender stereotype of math and science on secondary students' career aspirations. *Frontiers in Education*, *4*, 60. https://doi.org/10.3389/feduc.2019.00060

Maree, K. (2014). *First steps in research* (2nd ed.). Van Schaik Publishers.

Masuku, M. (2019). Indigenous knowledge discourses in Africa. *Indigenous Studies: Breakthroughs in Research and Practice,* 459.

Mavhunga, F., & Kibirige, I. (2018). Tapping the tacit knowledge of playfield swings to learn physics: A case study of childhood reflections by pre-service teachers. *African Journal of Research in Mathematics, Science and Technology Education, 22*(2), 221-230.

Mavhunga, E., & Rollnick, M. (2013). Improving PCK of chemical equilibrium in pre-service teachers. *African Journal of Research in Mathematics, Science and Technology Education, 17*(2), 113-125.

Mavuru, L. (2022). Reimagining indigenous knowledge in a multicultural science classroom. *International Journal of Inclusive Education*, 1-17. https://doi.org/10.1080/13603116.2022.2127498

Mavuru, L., & Ramnarain, U. (2017). Teachers' knowledge and views on the use of learners' socio-cultural background in teaching natural sciences in Grade 9 township classes. *African Journal of Research in Mathematics, Science and Technology Education*, *21*(2), 176-186.

Mavuru, L., & Ramnarain, U. (2020). Learners' socio-cultural backgrounds and science teaching and learning: A case study of township schools in South Africa. *Cultural Studies of Science Education,* 1-29.

Mawaddah, H., Suyitno, S., & Suhita, R. (2021). Javanese women's efforts to face patriarchal culture in the novel Para Priyayi by Umar Kayam. *International Journal of Multicultural and Multireligious Understanding*, *8*(1), 100-110.

Maxwell, J. A. (2008). Designing a qualitative study. *The Sage Handbook of Applied Social Research Methods, 2,* 214-253.

Maxwell, J. A. (2012). *Qualitative research design: An interactive approach* (Vol. 41). Sage Publications.

McElroy, A. B., Hayden, K. R., & Douyon, Y. (2009). *Teacher training: The superhighway to gender equity in Senegal.*

McGuire, L., Mulvey, K. L., Goff, E., Irvin, M. J., Winterbottom, M., Fields, G. E.,... & Rutland, A. (2020). STEM gender stereotypes from early childhood through adolescence at informal science centers. *Journal of Applied Developmental Psychology*, *67*, 101109.

McMillan, J., & Schumacher, S. (2014). *Research in education: Evidence-based inquiry* (7th ed.). Pearson.

McRobbie, C., & Tobin, K. (1997). A social constructivist perspective on learning environments. *International Journal of Science Education, 19*, 193-208.

Mensah, F. M. (2021). Culturally relevant and culturally responsive. *Science and Children*, *58*(4) 10-13.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. Jossey-Bass.

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Mhakure, D., & Otulaja, F. S. (2017). Culturally-responsive pedagogy in science education: Narrowing the divide between indigenous knowledge and scientific knowledge. In F. S. Otulaja & M. B. Ogunniyi (Eds.), *The world of science education: A handbook of research in science education in sub-Saharan Africa* (pp. 81-100). Sense Publishers.

Mhewa, M. M., Bhalalusesa, E. P., & Kafanabo, E. (2021). Secondary school teachers' understanding of gender-responsive pedagogy in bridging inequalities of students' learning in Tanzania. *Papers in Education and Development*, *38*(2).

Mikulecký, P., & Punčochářová, A. (2022). *Use of indigenous knowledge in education.* DIVAI.

Mkosi, N. (2005). Surveying indigenous knowledge, the curriculum, and development in Africa: A critical African viewpoint. *Issues in African Education: Sociological Perspectives*, 85-99.

Miller, L. T. (2020). *Exploring the attitudes and dispositions of pre-service teachers toward culturally responsive practices* [Unpublished doctoral thesis]. The Ohio State University.

Miller, D. I., Eagly, A. H., & Linn, M. C. (2015). Women's representation in science predicts national gender-science stereotypes: Evidence from 66 nations. *Journal of Educational Psychology*, *107*(3), 631-644.

Ministry of Education, Arts and Culture. (2018). *Junior Secondary Semi-External Examination Moderators report*. DNEA.

Ministry of Education Arts and Culture. (2015). *Namibia Junior Secondary Certificate (JSC) Physical Science Syllabus.* NIED.

Ministry of Education, Arts and Culture. (2018). *Namibia National Curriculum for Basic Education*. NIED.

Ministry of Education, Arts and Culture. (2016). *Report on the Examinations JSC.* DNEA.

Ministry of Education, Arts and Culture. (2014 & 2016). *Report on the Examinations NSSCO.* DNEA.

Mlama, P., Dioum, M., Makoye, H., Murage, L., Wagah, M., & Washika, R. (2005). *Gender responsive pedagogy*: *A teacher's handbook.* Forum for African Women Educationalists (FAWE).

Moje, E. B., McIntosh-Ciechanowski, K., Kramer, K., Ellis, L., Carrillo, R., & Collazo, T. (2004).Working toward third space in content area literacy: An examination of everyday funds of knowledge and discourse. *Reading Research Quarterly*, 39(1), 38-71.

Mogari, D. (2017). Using culturally relevant teaching in a co-educational mathematics class of a patriarchal community. *Educational Studies in Mathematics*, *94*, 293-307.

Moon, K., Brewer, T. D., Januchowski-Hartley, S. R., Adams, V. M., & Blackman, D. A. (2016). A guideline to improve qualitative social science publishing in ecology and conservation journals. *Ecology and Society*, *21*(3).

Morales, M. (2021). *Agency and its connection to a socio-cultural perspective on teachers' professional development: The lived experiences of five EFL teachers* (Order No. 28417702). https://www.proquest.com/dissertations-theses/agency-connection-socio-cultural-perspective-on/docview/2555608938/se-2?accountid=13504

Moser, A., & Korstjens, I. (2018). Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis. *European Journal of General Practice*, *24*(1), 9-18.

Mpofu, N., & Nthontho, M. (2017). Connecting the dots: Exploring dispositions in teacher education. *Gender and Behaviour*, *15*(4), 10290-10303.

Mthembu, M., Baiyegunhi, O., Mdleleni, Y., Ndlovu, L., Keal, H., Waddilove, K.,... & Wong, E. B. (2023). A PowerPack of SuperScientists: An innovative concept by African scientists to address gender bias and inequity in science. *Welcome Open Research*, *7*(87), 87-103.

Mukute, M., & Lotz-Sisitka, H. (2012). Working with cultural historical activity theory and critical realism to investigate and expand farmer learning in Southern Africa. *Mind, Culture and Activity, 19*(4), 342-367.

Mukwambo, M. (2012). *Understanding trainee teachers' engagement with prior everyday knowledge and experiences in teaching Physical Science concepts: A case study* [Unpublished master's thesis]. Rhodes University.

Mutanho, C. (2021). *Indigenisation of the science curriculum at a higher education institution: affordances and hindrances* [Unpublished doctoral thesis]. Rhodes University.

Mutekwe, A., & Mutekwe, C. (2012). Manifestations of the gender ideology in the Zimbabwean school curriculum. *Journal of Educational and Instructional Studies in the World, 2*(3), 193-207.

Mwetulundila, P. N. (2000). Why girls aren't fully participating in science and mathematics in Namibia. *Reform Forum, 5*, 14-23.

Ngcoza, K., & Southwood, S. (2019). Webs of development: Professional networks as spaces for learning. *Pythagoras*, *40*(1).

Nguyen, N. T., McFadden, A., Tangen, D., & Beutel, D. (2013). Video-stimulated recall interviews in qualitative research. *Australian Association for Research in Education*. 1-10.

Nhase, Z. (2019). *An exploration of how Grade 3 Foundation Phase teachers develop basic scientific process skills using an inquiry-based approach in their classrooms* [Unpublished doctoral thesis]. Rhodes University.

Nikodemus, K. N. (2017). *Exploring how Grade 11 Physical Science learners make sense of the concept of rates of reactions through the inclusion of the indigenous practice of making oshikundu: A Namibian case study* [Unpublished master's thesis]. Rhodes University.

Ninkova, V. (2020). Perpetuating the myth of the "wild bushman": Inclusive multicultural education for the Omaheke Ju|'hoansi in Namibia. *Comparative Education Review*, *64*(2), 159-178.

Nussbaumer, D. (2012). An overview of cultural historical activity theory (CHAT) use in classroom research 2000 to 2009. *Educational Review*, *64*(1), 37-55.

Nyika, R. (2017). Views and experiences of Gweru Rural Primary Schools teachers on integrating indigenous knowledge systems in the teaching and learning of Environmental Science in Zimbabwe. *Scholars Journal of Arts, Humanities and Social Sciences, 5*(4a), 280-286.

OECD [The Organization for Economic Cooperation and Development]. (2018). *The future of education and skills education 2030.* https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(23.08.2023)

Ogunniyi, M. B. (2007a). Teachers' stances and practical arguments regarding a science indigenous knowledge curriculum: Part 1. *International Journal of Science Education, 29*(8), 963-986.

Ogunniyi, M. B. (2018). Indigenization of the curriculum: The prospects and the challenges. In L. M. Semali & A. Singambi (Eds.), *Proceedings of the 4th Annual Conference of the African Association for the Study of Indigenous Knowledge Systems* (pp. 2-16). AASIKS.

Oloruntegbe, K. O., & Ikpe, A. (2011). Eco-cultural factors in students' ability to relate science concepts learned at school and experiences at home: Implications for chemistry education. *Journal of Chemical Education, 88*(3), 266-271.

Omoyibo, K. U., & Ajayi, B. I., (2011). Understanding gender and global Africa: A critical perspective. *Gender and Behaviour, 9*(1), 3729-3752. https://doi.org.wam.seals.ac.za/10.4314/ gab.v9i1.67470

Onowugbeda, F. U., Agbanimu, D. O., Okebukola, P. A., Ibukunolu, A. A., Odekeye, O. T., & Olori, O. E. (2023). Reducing anxiety and promoting meaningful learning of biology

concepts through a culturally sensitive and context-specific instructional method. *International Journal of Science Education*, 1-18.

Orlove, B., Roncoli, C., Kabugu, M., & Matagu, A. (2010). Indigenous climate knowledge in Southern Uganda: The multiple components of a dynamic regional system. *Climate Change, 100*, 243-265.

Ozano, K. & Khatri, R. (2018) Reflexivity, positionality and power in cross-cultural participatory action research with research assistants in rural Cambodia. *Educational Action Research, 26*(2), 190-204.

Panhwar, A. H., Ansari, S., & Ansari, K. (2016). Sociocultural theory and its role in the development of language pedagogy. *Advances in Language and Literary Studies*, *7*(6), 183-188.

Papageorge, N. W., Gershenson, S., & Kyungmin Kang, K. (2018). *Teacher expectations matter.* NBER Working Paper.

Parker, F., Bartell, T. G., & Novak, J. D. (2017). Developing culturally responsive mathematics teachers: Secondary teachers' evolving conceptions of knowing students. *Journal of Mathematics Teacher Education*, *20*(4), 385-407.

Paudel, A. (n.d). *Gender responsive Pedagogy (GRP), a way of attending the quality of learning.* https://www.academia.edu/28995182/Gender_Responsive_Pedagogy_GRP_a_way_of__attending_the_quality_of_learning

Penuel, W. R. (2014). Emerging forms of formative intervention research in education. *Mind, Culture, and Activity*, *21*(2), 97-117.

Penuel, W. R. (2017). Research–practice partnerships as a strategy for promoting equitable science teaching and learning through leveraging everyday science. *Science Education*, *101*(4), 520-525.

Perso, T. F. (2012). *Cultural responsiveness and school education with particular focus on Australia's first peoples: A review and synthesis of the literature*. Menzies School of Health Research, Centre for Child Development and Education.

Plano-Clark, V. L., & Creswell, J. W. (2015). *Understanding research: A consumer's guide* (2nd ed.). Boston Pearson Higher Ed.

Ploettner, J., & Tresseras, E. (2016). An interview with Yrjo Engeström and Annalisa Sannino on activity theory. *Bellateral Journal of Teaching & Learning Language & Literature, 9*(4), 87-98.

Probyn, M. (2009). 'Smuggling the vernacular into the classroom': Conflicts and tensions in classroom codeswitching in township/rural schools in South Africa. *International Journal of Bilingual Education and Bilingualism*, *12*(2), 123-136.

Ramasike, L. F. (2016). *The use of analogy in conjunction with a conventional practical activity to mediate Grade 11 learners' sense making of Ohm's law* [Unpublished master's thesis]. Rhodes University.

Richards, H. V., Brown, A. F., & Forde, T. B. (2007). Addressing diversity in schools: Culturally responsive pedagogy. *Teaching Exceptional Children*, *39*(3), 64-68.

Risman, B. J. (2018). *Gender as a social structure* (pp. 19-43). Springer International Publishing.

Ross, M. (2017). Conceptions of teaching: An illustrated review. *The Clinical Teacher*, *14*(1), 8-14.

Roth, W. M., & Lee, Y. J. (2007). Vygotsky's neglected legacy: Cultural-Historical Activity Theory. *Review of Educational Research, 77*(2), 186-232.

Rüschenpöhler, L., & Markic, S. (2020). Secondary school students' chemistry self-concepts: Gender and culture, and the impact of chemistry self-concept on learning behaviour. *Chemistry Education Research and Practice*, *21*(1), 209-219.

Rychly, L., & Graves, E. (2012). Teacher characteristics for culturally responsive pedagogy. *Multicultural Perspectives*, *14*(1), 44-49.

Saidin, K. & Yaacob, A. (2016). Insider researchers: Challenges & opportunities. *Proceedings of the ICECRS*, *1*(1), v1i1-563.

Samuels, A. J. (2018). Exploring culturally responsive pedagogy: Teachers' perspectives on fostering equitable and inclusive classrooms. *SRATE Journal*, *27*(1), 22-30.

Sannino, A. (2015). Activity theory as an activist and interventionist theory. *Theory and Psychology, 21*(5), 571-597.

Sannino, A., & Engeström, Y. (2018). Cultural-historical activity theory: Founding insights and new challenges. *Cultural-historical Psychology*, *14*(3), 43-56.

Sannino, A., Daniels, H., & Gutierrez, K. D. (Eds.). (2009). *Learning and expanding with activity theory.* Cambridge University Press.

Sannino, A., Engeström, Y., & Lemos, M. (2016). Formative interventions for expansive learning and transformative agency. *Journal of the Learning Sciences*, *25*(4), 599-633.

Satiya, Q. (2021). Gender Responsive Pedagogy (GRP) for technical and vocational education of secondary school student teachers: A case of a polytechnic in the Midlands Province of Zimbabwe. *Zimbabwe Journal of Educational Research*, *33*(1&2), 112-127.

Savasci, F., & Berlin, D. F. (2012). Science teacher beliefs and classroom practice related to constructivism in different school settings. *Journal of Science Teacher Education*, *23*(1), 65-86.

Schultze, U., & Avital, M. (2011). Designing interviews to generate rich data for information systems research. *Information and Organization*, *21*(1), 1-16.

Scott, S., & Palincsar, A. (2013). *Sociocultural theory*. http://www.education .com/reference/article/sociocultural-theory/

Sedlacek, M., & Sedova, K. (2017). How many are talking? The role of collectivity in dialogic teaching. *International Journal of Education Research, 85*, 99-108.

Seehawer, M. (2023). Research agendas in an Ubuntu paradigm. *Scholarship of Teaching and Learning in the South*, *7*(1), 41-61.

Selepe, C., & Moll, I. (2016). Are teachers facilitators or are they mediators? Piaget, Vygotsky and the wisdom of the teacher. *The Independent Journal of Teaching and Learning*, *11*(1), 6-16.

Sewell, W. J. (1992). A theory of structure: Duality, agency, and transformation. *American Journal of Sociology, 98*(1), 1-29.

Shabani, K. (2016). Application of Vygotsky's sociocultural approach for teachers' professional development. *Cogent Education, 3*, 2-10.

Shafuda, C. P., & De, U. K. (2020). Fiscal policy changes in Namibia: Are Namibians better off after independence? *The Strategic Review for Southern Africa*, *42*(1).

Shah, A. (2017). Ethnography? Participant observation, a potentially revolutionary praxis. *HAU: Journal of Ethnographic Theory*, *7*(1), 45-59.

Shanyanana, R. N., & Cross, M., (2014). Active participation in Namibia's democratic education system: Challenges for the girl child. *Southern African Review of Education, 20*(2), 26-40.

Sheehama, F. N. (2017). *An investigation into science teachers' conceptions of and dispositions towards the implementation of 'assessment for learning' (formative assessment) during science practical activities* [Unpublished master's thesis]. Rhodes University.

Shiimi, H. N. (2018). *A case study of inclusive education practices employed by schools in the Engela cluster of the Ohangwena region, Namibia* [Unpublished master's thesis]. University of Namibia.

Shinana, E. N. L. (2019). *Mobilising indigenous practice of making Oshikundu using inquiry based approach to support Grade 8 Life Science teachers in mediating learning of enzymes* [Unpublished master's thesis]. Rhodes University.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4-14.

Shulman, L. S. (1987). Knowledge and teaching foundations of the new reform. *Harvard Educational Review*, 57(1), 1-22.

Shizha, E. (2013). Reclaiming our indigenous voices: The problem with post-colonial sub-Saharan school curriculum. *Journal of Indigenous Social Development, 2*(1), 1-18.

Silalahi, R. M. (2019). Understanding Vygotsky's zone of proximal development for learning. *Polyglot: Jurnal Ilmiah*, *15*(2), 169-186.

Simasiku, F. S. (2022). *Leveraging a peer-learning community and expert community members in the integration of indigenous knowledge into the learning and teaching of Grade 10 Chemistry on the rate of reactions* [Unpublished doctoral thesis]. Rhodes University.

Simasiku, F. S., Ngcoza, K. M., & Mandikonza, C. (2017). Namibian science teachers' perceptions and experiences on the inclusion of indigenous knowledge in their lesson. In K. R. Otulaja, M. Langenhoven, E. A. Keane, O. Nhalevilo, O. Amosun & K. M. Ngcoza (Eds), In *Rediscovering IKs for continental identity and empowerment in a changing world.* Proceedings of the 3rd International conference of the African Association for the Study of Indigenous Knowledge Systems (AASIKS) (pp.122- 134). WITS.

Sinnes, A. T., & Løken, M. (2014). Gendered education in a gendered world: Looking beyond cosmetic solutions to the gender gap in science. *Cultural Studies of Science Education*, *9*(2), 343-364.

Sithole, A., Chiyaka, E. T., McCarthy, P., Mupinga, D. M., Bucklein, B. K., & Kibirige, J. (2017). Student attraction, persistence and retention in STEM programs: Successes and continuing challenges. *Higher Education Studies*, *7*(1), 46-59.

Skaggs, C. C. (2020). *A District's approach to support teacher agency through teacher-led professional development* (Order No. 27832869). https://www.proquest.com/dissertations-theses/district-s-approach-support-teacher-agency/docview/2399776328/se-2?accountid=13504

Stephens, K. R. (2019). Teacher dispositions and their impact on implementation practices for the gifted. *Gifted Child Today*, *42*(4), 187-195.

Stott, D. (2016). Making sense of the ZPD: An organising framework for mathematics education research. *African Journal of Research in Mathematics, Science and Technology Education, 20*(1), 25-34.

Subero, D., Llopart, M., Siqués, C., & Esteban-Guitart, M. (2018). The mediation of teaching and learning processes through identity artefacts: A Vygotskian perspective. *Oxford Review of Education*, *44*(2), 156-170.

Sutrisno, J. (2020). Self-regulated learning: Intelligence quotient and mathematical disposition. *Journal of Physics: Conference Series*, 1-7.

Swarts, P. (2019). Teacher education reform: Toward reflective practice. In *Democratic teacher education reform in Africa* (pp. 29-46). Routledge.

Tavakoli, M., & Baniasad-Azad, S. (2017). Teachers' conceptions of effective teaching and their teaching practices: A mixed-method approach. *Teachers and Teaching*, *23*(6), 674-688.

Thanh, N. C., & Thanh, T. T., (2015). The interconnection between interpretivist paradigm and qualitative methods in education. *American Journal of Education Services, 1*(2), 24-27.

The Forum for African Women Educationalists. (2006). *Association for the Development of Education in Africa (ADEA): Gender responsive pedagogy*. International Institute for Educational Planning

The Global Partnership for Education. (2017). *Guidance for developing gender responsive education sector plans.* https://www.globalpartnership.org/content/guidance-developing-gender-responsive- education-sector-plans

Thornton, H. (2006). Dispositions in action: Do dispositions make a difference in practice? *Teacher Education Quarterly*, 33(2), 53-68.

Toma, R. B., Greca, I. M., & Orozco Gómez, M. L. (2019). Attitudes towards science and views of nature of science among elementary school students in terms of gender, cultural background and grade level variables. *Research in Science & Technological Education*, *37*(4), 492-515.

United Nations Educational, Scientific and Cultural Organization. (2005). *Exploring and understanding gender in education: A qualitative research manual for education practitioners and gender focal points.* UNRSCO.

UN Women Gender mainstreaming: concepts and definitions http://www.un.org/womenwatch/osagi/conceptsandefinitions.htm

Ural, E., & Gençoğlan, D. M. (2019). The effect of argumentation-based science teaching approach on 8th graders' learning in the subject of acids-bases, their attitudes towards science class and scientific process skills. *Interdisciplinary Journal of Environmental and Science Education*, *16*(1), e02207.

Usak, M., Ozden, M., & Eilks, I., (2011). A case study of beginning science teachers' subject matter (SMK) and pedagogical content knowledge (PCK) of teaching chemical reaction in Turkey. *European Journal of Teacher Education, 34*(4), 407-429.

Vanner, C. (2019). Examining gender safety in schools: Teacher agency and resistance in two primary schools in Kirinyaga, Kenya. *Education Sciences*, *9*(1), 63.

Vass, G. (2017). Preparing for culturally responsive schooling: Initial teacher educators into the fray. *Journal of Teacher Education*, *68*(5), 451-462.

Villegas, A. M., & Lucas, T. (2002). Preparing culturally responsive teachers: Rethinking the curriculum. *Journal of Teacher Education, 53*(1), 20-32.

Virkkunen, J. (2012, September*). The change laboratory as a tool for collaborative transforming work activities.* (Interview with Rodolfo Andrade de Gouveia Vilela, Marco Antonio Pereira Lopes and Manoela Gomes Reis Lopes).

Virkkunen, J., & Newnham, D. S. (2013). *The change laboratory: A tool for collective development of work and education*. Sense Publishers.

Vygotsky, L. S. (1986). *Thought and language* - revised edition. MIT Press.

Vygotsky, L. S. (1978). *Mind in society: Interaction between learning and development.* Harvard University Press.

Wanjama, L.N., & Njuguna, F.W. (2015). *Documented Gender Responsive Pedagogy (GRP) good practices - Case study.* Nairobi: Kenya.

Warren, C. A. (2018). Empathy, teacher dispositions, and preparation for culturally responsive pedagogy. *Journal of Teacher Education*, *69*(2), 169-183.

Wayan, K. Y. I., & Nyoman, S. (2020). Women and Cultural Patriarchy in Politics. *Budapest International Research and Critics Institute-Journal (BIRCI-Journal)*, *3*(3), 2158-2164.

Wellington, J. (2015). *Educational research* (2nd ed.). Bloomsbury Academic.

Williams, L. (2018). Ti wa7 szwatenem. What we know: Indigenous knowledge and learning. *BC Studies: The British Columbian Quarterly*, *200,* 31-44.

Wilsey, M., Kloser, M., Borko, H., & Rafanelli, S. (2020). Middle school science teachers' conceptions of assessment practice throughout a year-long professional development experience. *Educational Assessment*, *25*(2), 136-158.

Wood, H. J. (2019). Gender inequality: The problem of harmful, patriarchal, traditional and cultural gender practices in the church. *HTS Teologiese Studies/Theological Studies 75*(1), a5177. https://doi.org/ 10.4102/hts.v75i1.5177

Xu, X. (2016). Researchers' positioning: insider or outsider? *The Morning Watch: Educational and Social Analysis*, *44*(1-2 Fall).

Yamagata-Lynch, L. C. (2010). *Activity systems analysis methods: Understanding complex learning environments*. Springer Science & Business Media.

Yılmaz, K. (2008). Social studies teachers' conceptions of history: Calling on historiography. *The Journal of Educational Research, 101*(3), 158-176.

Yin, R.K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publishers.

Zahro, A., Witjoro, A., & Sidyawati, L. (2020). Edu gender unity: Development of gender responsive learning model for junior high schools in Indonesia. *KnE Social Sciences*, 170-177.

Zidny, R., Sjöström, J., & Eilks, I. (2020). A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability. *Science & Education*, *29*(1), 145-185.

APPENDICES

APPENDIX A: Ethical Clearance Certificate

Rhodes University, Education Faculty
Research Ethics Committee
PO Box 94, Makhanda, 6140, South Africa
Tel: +27 (0) 46 603 8393
Fax: +27 (0) 46 603 8028
email: e.rosenberg@ru.ac.za

https://www.ru.ac.za/researchgateway/ethics/

2 April 2022

Prof Kenneth Ngcoza

Education Department

K.Ngcoza@ru.ac.za

Dear Prof Kenneth Ngcoza and Ms Johanna Haimeno

Re: Exploring and expanding gender responsive practices for grade 9 Physical Science teachers when mediating learning of acids and bases in rural schools in the Oshikoto region in Namibia

APPLICATION NUMBER: 2022-5238-6604

This letter confirms that your research ethics application has been reviewed and **APPROVED** by the Education Faculty Research Ethics Committee (EF-REC). Your permission letter(s) where applicable have been received and you are free to proceed with your study.

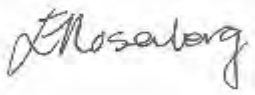
Approval is granted for 1 year. An annual progress report is required in order to renew approval for an additional period. You will receive an email notifying you when the progress report is due.

Should any substantive change(s) be made during the research process, that may have ethical implications, you should notify the Education Faculty REC Chair via email. This includes changes in investigators. The REC Chair will advise as to whether a new application is necessary.

Do keep this clearance letter secure and accessible throughout your study and after its completion. It will be needed when a thesis is examined and when publications are submitted to journals.

Please also submit a brief report to the REC Chair on the completion of the research. This can be done via email. The purpose of this report is to indicate whether the research was conducted successfully and whether any ethics-related matters arose that the committee should be aware of, in order to guide future studies.

Sincerely,



Prof Eurets Rosenberg

Chair: Education Faculty Research Ethics Committee

Page 1 of 1

APPENDIX B: Participants' Letter of Consent

RESEARCH PARTICIPANT INFORMED CONSENT LETTER

(PARTICIPANT)

PROJECT TITLE: Exploring and expanding gender responsive practices for Grade 9 Physical Science teachers when mediating learning of acids and bases in rural schools in the Oshikoto Region in Namibia

Haimene Johanna S. (15As8714), currently a PhD student at Rhodes University, has requested my permission to participate in the above mentioned research project.

The nature and purpose of the research project and of this informed consent declaration have been clearly explained to me in a language that I understand.

I am therefore aware that:

1. The purpose of this formative interventionist study is to explore and expand gender responsive practices when mediating the learning of chemistry.

2. I am made aware that this study will made up two phase

   Phase one: During this phase data will gathered by completing questionnaire, interviews and classroom observation. Interviews and classroom observation will be audio recorded and videotaped respectively.

   Phase two: The intervention for this study will consist of **three** 1h30 - 2 hours long workshops. During the workshops, data will be gathered through; videotaping of participant discussions and reflective journaling. The workshops will be conducted at a place and time that is convenient to me and the other participants.

3. I will be interviewed individually and all the COVID-19 protocols will be observed. Should the COVID-19 restrictions be in force, Google Meeting or Zoom or WhatsApp will be used with my permission. The interview will take approximately 30-45 minutes and will be audio recorded with my permission.

4. By participating in this research project, I will contribute to knowledge on how to be gender responsive when mediating science specifically chemistry by developing a mediational tool, that is gender culturally responsive.

5. My participation is entirely voluntary and should I at any stage wish to withdraw from further participation, I may do so without any prejudice.

6. I understand that participating in this study is voluntary and that I will not be compensated for participating.

7. They may be risks associated with my participation in the project. I am therefore aware that of the following steps:
   a) All information shared in the group is strictly confidential and will not be used for purpose other than of the above mentioned research project.
   b) All the data collected will be kept in a locked cupboard and electronic data will be kept in a computer only accessible through a secure password.
   c) The researcher intends to publish the research findings in the form of a thesis towards a PhD degree in Science Education, and later present it in papers conferences or journal articles; still, confidentiality will be maintained.

8. Any further questions that I might have concerning the research or my participation will be answered by the Rhodes PhD student (johannaamutenya85@gmail.com) or the supervisor Professor Kenneth Mlungisi Ngcoza (K.Ngcoza@ru.ac.za).

9. By signing this informed consent declaration, there are no legal implications.

10. A copy of this informed consent declaration will be kept in a safe place by the researcher.

I, ……have read the above information or confirm that the above information has been explained to me in a language that I understand. I am therefore aware of this document's contents. I have asked all questions that I wished to ask, and these have been answered to my satisfaction. I fully understand what is expected of me during the research.

I have not been coerced or pressurised in any way. I therefore voluntarily agree to participate in the above mentioned research project.

…….. …….
Participant's signature Witness

Date …….. Date ……..

Rhodes University, Research Office, Ethics

Ethics Coordinator: ethics-committee@ru.ac.za

T: +27 (0) 46 603 7335 F: +27 (0) 82 739 4378

Room 220, Main Admin Building, Drostdy Road, Makhanda, 6139

APPENDIX C: Assent Letter

Haimene Johanna S.

P.O.Box 16242

Onayena

+264 81 229 2980

Dear Parent(s) or Guardian

My name is Johanna S. Haimene, currently registered as a part-time PhD student (full thesis) Science Education at Rhodes University (student number 15A8714). I will carry my research with one of the teachers of your child, were classroom observation will be carried out. These observations will be video-recorded. I am seeking consent for your child to take part in this research. The purpose of the research is to explore and expand gender culturally responsive practices for science teachers when teaching science.

Should I be granted the permission, I will conduct this research by applying all the ethics' principles such as treating your child's identity, views and contributions with confidentiality and anonymity. May you please fill the consent form attached if permission is granted?

If you require further information, don't hesitate to contact me at +264 81 229 92980

I am looking forward to hearing from you.

Yours sincerely

Johanna S. Haimene

PhD Student, Rhodes University

Translated letter

KOmuvali omusimanekwa

Edhina lyandje oJohanna Haimene, ndili omulongwa koshiputudhilo sho Rhodes sha South Africa. Otandi ka ninga omapekapeko nayamwe yomaalongi yokanona koye. Omapekapeko ngaka ota gaka ningwa pethimbo lyootundi, nootundi dhika otadhi ka thanekwa. Elalakano lyomapekapeko ngaka oku tala nkene aalongi ta ya longo uunona wetu oshilongwa shuunongononi nonkene ta ya vulu oku kwathelwa opo ya longwe nawa.

Ngele owa pendje eethelo ndi ninge omapekapeko ngaka, uukwatya, omadhiladhilo niiyetwapo yokanona koye otai ka pungulwa nawa na ita i ka gandjwa kwaamboka inaya uthwa okui mona. Kwathandje wu udhithe okambapila ka kopekwa kombapila ndjika ngele owa gandja eziminino okanona koye ka kuthe ombinga momapekapeko ngaka.

Kuuyelele wagwedhwapo omapulapulo naga ukithwe kungame kongodhi ndji 0812292980.

Otandi kanyanyukwa kelongelokumwe lyoye

Gwoye

Johanna Haimene

Omunasikola

Consent form

I_____ (full name of parent/guardian), the father/mother/guardian of _____ (full name of child) hereby confirm that I understand the content of this document and the nature of the research, and I consent to my child participating in the research study. I also understand that my child is at liberty to withdraw from participating at any time without any disadvantage.

I agree and authorise my child to participate in the research and I understand that my child can withdraw from participation without any effect.

Parent's/Guardian's Name_____

Parent's/Guardian's signature_____

Date_____

Contact numbers_____

Translated consent form

Ngame _____ (edhina lyuudha) omuvali gwa _____ onda uvako oshikalimo shoshinyolwa shika, opo omunona gwandje akuthe ombinga momapekapeko. Onduuviteko kutya okanona kandje okena uuthemba okukala inaaka kutha ombinga.

Onda zimina opo okanona kandje ka kuthe ombinga.

Edhina lyomuvali _____

Eshainokaha lyomuvali _____

Esiku _____

Onomola yongodhi _____

APPENDIX D1: Permission Letters to Director of Education and Principals (Oshikoto Region)

Haimene Johanna S.

P.O.Box 16242

Onayena

+264 81 229 2980

The Director of Education, Arts and Culture

Oshikoto Regional Council

P.O.Box 2028

Ondangwa

Dear Ms Eises

Subject: Request for permission to conduct educational research at six (3 combined and 3 secondary) schools in Oshikoto Region.

My name is Johanna S. Haimene, currently registered as a part-time PhD student (full thesis) Science Education at Rhodes University (student number 15A8714). I am the Head of Department at Oniihwa CS, Oshikoto Region. I hereby request a permission to conduct educational research with Grade 9 Physical Science teachers at the following schools; [redacted], during the period of April 2022 – November 2022.

The Namibian curriculum for basic education (NCBE) (2016) advocates for the application of gender *equity* at all levels and on every aspect of the curriculum and teachers are central to the implementation of this curriculum. Thus, this study might provide a platform for Grade 9 Physical Science teachers in promoting gender friendly classrooms and teaching instructions when mediating chemistry topics. It might also help the teachers in selecting pedagogies that would accommodate all learners, regardless of their gender differences and understand the

significance of being gender responsive as an all-inclusive development of both genders in science classrooms. The study also hopes to develop the mediational tools that might expand the gender culturally responsive practices of the Physical Science teachers as this seems to resonate with the principles of inclusivity as advocated by Namibian Physical Science syllabus (2015).

My topic of interest is exploring and expanding gender and culturally responsive practices for Grade 9 Physical Science teachers when mediating learning of acids and bases in rural schools in the Oshikoto Region in Namibia

This study will be guided by the following objectives:

- ➢ To determine Grade 9 Physical Science teachers' perspectives and pedagogical insights on gender culturally responsive practices when mediating learning of acids and bases;
- ➢ To surface the underlying contradictions (if any) that enable and/or constrain gender culturally responsive practices in Grade 9 Physical Science classrooms;
- ➢ To support expansive learning and develop mediational cultural tool for gender culturally responsive practices in science teaching using acids and bases as an example, and
- ➢ To determine how the group discussions and reflections influence (not) the implementation of the mediational cultural tool when mediating the learning of acids and bases.

Should I be granted the permission, I will conduct this research by applying all the ethics' principles such as treating participants' views and contributions with confidentiality. However, since this is the intervention study and hoping to develop a mediational tool that might be used by Physical Science teachers, the issue of anonymity might be a challenge. Consequently, the findings of the study will be presented and shared as a collective contribution. Participants will be provided access to findings of the study. Kindly see attached temporary ethics approval letter from Rhodes University. I therefore need your permission letter, which I have to submit to Rhodes University in order to be granted an ethics clearance certificate.

If you require further information regarding this study, don't hesitate to contact me at +264 81 229 92980 or johannaamutenya85@gmail.com or my supervisor Prof. Kenneth Ngcoza at +27 78 885 2143 or K.Ngcoza@ru.ac.za.

If you require any questions or raise any concerns regarding the way this research is conducted, you can conduct directly the Rhodes University Education Faculty Ethics Committee chairperson, Prof Eureta Rosenberg at Tel: +27 (0) 46 603 8393 or Fax: +27 (0) 46 603 8093 or e.rosenberg@ru.ac.za. Alternatively, you can conduct Rhodes University, Research Office, Ethics Coordinator: ethics-committee@ru.ac.za, Tel: +27 (0) 46 603 7335 or Fax: +27 (0) 82 739 4378.

I am looking forward to hearing from you.

Yours sincerely

Johanna S. Haimene

PhD Student, Rhodes University

Haimene Johanna S.

P.O.Box 16242

Onayena

+264 81 229 2980

The School Principal

[redacted]

P.O.Box 2035

Ondangwa

Dear [redacted]

Subject: Request for permission to conduct educational research at your school

My name is Johanna S. Haimene, currently registered as a part-time PhD student (full thesis) Science Education at Rhodes University (student number 15A8714). I am the Head of Department at Oniihwa CS, Oshikoto Region. I hereby request a permission to conduct educational research with Grade 9 Physical Science teacher(s) at your school during the period of April 2022 – November 2022.

The Namibian curriculum for basic education (NCBE) (2016) advocates for the application of gender *equity* at all levels and on every aspect of the curriculum and teachers are central to the implementation of this curriculum. Thus, this study might provide a platform for Grade 9 Physical Science teachers in promoting gender friendly classrooms and teaching instructions when mediating chemistry topics. It might also help the teachers in selecting pedagogies that would accommodate all learners, regardless of their gender differences and understand the significance of being gender responsive as an all-inclusive development of both genders in science classrooms. The study also hopes to develop the mediational tools that might expand the gender culturally responsive practices of the Physical Science teachers as this seems to resonate with the principles of inclusivity as advocated by Namibian Physical Science syllabus (2015).

My topic of interest is exploring and expanding gender and culturally responsive practices for Grade 9 Physical Science teachers when mediating learning of acids and bases in rural schools in the Oshikoto Region in Namibia.

This study will be guided by the following objectives:

- ➢ To determine Grade 9 Physical Science teachers' perspectives and pedagogical insights on gender culturally responsive practices when mediating learning of acids and bases;
- ➢ To surface the underlying contradictions (if any) that enable and/or constrain gender culturally responsive practices in Grade 9 Physical Science classrooms;
- ➢ To support expansive learning and develop mediational cultural tool for gender culturally responsive practices in science teaching using acids and bases as an example, and
- ➢ To determine how the group discussions and reflections influence (not) the implementation of the mediational cultural tool when mediating the learning of acids and bases

Should I be granted the permission, I will conduct this research by applying all the ethics' principles such as treating participants' views and contributions with confidentiality. However, since this is the intervention study and hoping to develop a mediational tool that might be used by Physical Science teachers, the issue of anonymity might be a challenge. Consequently, the findings of the study will be presented and shared as a collective contribution. Participants will be provided access to the findings of the study. Kindly see attached temporary ethics approval letter from Rhodes University. I therefore need your permission letter, which I have to submit to Rhodes University in order to be granted an ethics clearance certificate.

If you require further information regarding this study, don't hesitate to contact me at +264 81 229 92980 or johannaamutenya85@gmail.com or my supervisor Prof. Kenneth Ngcoza at +27 78 885 2143 or K.Ngcoza@ru.ac.za.

If you require any questions or raise any concerns regarding the way this research is conducted, you can conduct directly the Rhodes University Education Faculty Ethics Committee chairperson, Prof Eureta Rosenberg at Tel: +27 (0) 46 603 8393 or Fax: +27 (0) 46 603 8093 or e.rosenberg@ru.ac.za. Alternatively, you can conduct Rhodes University, Research Office, Ethics Coordinator: ethics-committee@ru.ac.za Tel: +27 (0) 46 603 7335 or Fax: +27 (0) 82 739 4378.

I am looking forward to hearing from you.

Yours sincerely

Johanna S. Haimene

PhD Student, Rhodes University

APPENDIX D2: Permission letter from Director of Education and Principals (Oshikoto Region)

REPUBLIC OF NAMIBIA

OSHIKOTO REGIONAL COUNCIL

Tel: (065) 242500 **DIRECTORATE: EDUCATION, ARTS & CULTURE** Private Bag 2028
Fax: (065) 241660 ONDANGWA
Enquiries: Ms Tende 16 March 2022

Ref: 13/2/9/1

Johanna S. Haimene
P.O.Box 16242
Onaycna

Dear Ms Haimene

RE: PERMISSION TO CARRY OUT A RESEARCH IN SCHOOLS

The Office of the Director acknowledges receipt of your letter seeking for permission to conduct research studies focusing on "*Exploring and expanding gender culturally responsive practices for grade 9 Physical Science teachers when mediating learning of acids and bases in rural schools in the Oshikoto region in Namibia*" a case study of [redacted]

Kindly be informed that permission has been granted to carry out the research in Oshikoto Region, please be guided by the following:

- You have to consult the school principals well in advance to ensure a proper co-ordination of other school activities
- The research should not interfere with the normal teaching and learning process at the schools.
- Participation in the research should be on a voluntary basis.
- The information to be collected should be treated as confidential and only for research purposes.
- And, be advised to adhere to the Covid-19 protocols and measures.

Thank you for showing interest to do the research in the Oshikoto Region. It is our sincere hope that the information you would gather will be useful towards the completion of your qualification.

Sincerely yours

2022 -03- 22

MS ALETTA A. EISES
DIRECTOR OF EDUCATION, ARTS AND CULTURE
OSHIKOTO REGION

Republic of Namibia

MINISTRY OF EDUCATION, ARTS AND CULTURE

OSHIKOTO EDUCATION REGION

[redacted]

P.O. Box 108, Ondangwa, Tel.: 065-240821, Fax: 065-240810, Onathinge-South Cluster, Onathinge Circuit

Principal: Mrs. Helena T. Mwinkeni

Wednesday, March 30, 2022

RE: Permission to conduct educational research

This letter serves to inform Mrs. Johanna S. Haimene (Amutenya) Student Number 15A8714, PHD student at Rhodes University that [redacted] CS has been granted you permission to conduct educational research with grade 9 Physical Science teacher (s) during the period of from April 2022-November 2022.

For any further information do not hesitate to contact the school.

Thank you

[redacted]

School Principal

REPUBLIC OF NAMIBIA
MINISTRY OF EDUCATION
[redacted]
30 MAR 2022
P.O. Box 108, Ondangwa
Tel: 065 - 240 821
Oshikoto Education Region
Onathinge Circuit

APPENDIX E: Dispositions and Conceptions Indicators

Indicators for teachers' conceptions and dispositions (adapted from Atallah, Bryant & Dada, 2010)

Conceptions	
C1	Describing their ideas or thoughts about gender and culturally responsive practices
C2	Describing what they believe is required in gender and culturally responsive classroom.
C3	Describing what they believe is required to do in gender and culturally responsive classroom
C5	Describing what they think is the purpose of purpose of gender and culturally responsive when mediating chemistry topics
C6	Describing what they believe indicates that they have learnt about gender and culturally responsive (how do they know that they have learnt)

Dispositions	
D1	Describing their ability in gender and culturally responsive
D2	Describing their attitudes towards gender and culturally responsive when mediating chemistry topics.
D3	Describing the expectations about being gender and culturally responsive in their teaching.
D4	Describing the perceived value of gender and culturally responsive when mediating chemistry topics.
D5	Describing the evidence that they would provide to others as a 'proof' that they have learnt how to conduct science lessons that are gender and culturally responsive.

APPENDIX F1: Questionnaire Schedule

Adapted from Nhase (2019)

I am really pleased to work with you in this research. In order for me to have a better understanding for your teaching context better, I would like you to assist me with the following information. Please take note, your name will not be disclosed in the study.

Questionnaire for Grade 9 Physical Science teachers

Please use the spaces provided to answer the questions below. Tick [√] where appropriate.

1. Name and Surname	
2. Gender	Male ☐ Female ☐
3. Age	20-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐
4. Experience in teaching Physical Science (in years)	1-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐ 21 and above ☐
5. Which grade(s) do you currently teach?	

Teaching ideas and methods

6. With regards to your teaching beliefs what informs your ideas when teaching Physical Science?

7. Please list the teaching methods/ strategies that you use in your class.

8. Gender and culturally responsive practices is all about providing equal and equitable teaching to both boys and girls and taking into consideration learners' cultural background

With regards to this, how do address gender and culturally responsive practices in your teaching of Physical Science.

9. Are your teachings of Physical Science gender and culturally responsive? Yes ☐ No ☐
   Explain your answer

10. Do you promote gender and culturally responsive in your class? Explain your answer.

Curriculum / content knowledge

Physical Science is made up chemistry and physics disciplines

11. How often do you plan and teach chemistry topics in gender and culturally responsive ways (if you do)?

    If not, why?

12. Do you assess chemistry topics in a gender and culturally responsive way? Explain your answer.

13. What kind of teaching materials /resources do you use in your class that are gender and culturally responsive?

14. In a scale of 1-5 with 1 being very poor, 2 poor, 3 average, 4 good and 5 excellent, how do you rate yourself being gender and culturally responsive when teaching Physical Science particularly acids and bases.

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

15. General comments

Anything you would like to share with me?

Thank you for your time, it is much appreciated

APPENDIX F2: Semi-structured Interview Schedule

These were guiding questions I used as I probed for more information.

Good day colleague, thank you so much for giving up some of your valuable time to speak to me today. As explained in the letter that I sent to you detailing this study, I would like to understand your gender culturally responsive practices when mediating the learning of chemistry topics in Physical Science. I am going to engage you in a series of questions. Some of the questions are contributed from the questionnaire that you have answered thus I just want to get some clarity. You are free to use Oshiwambo if you want to express yourself well.

Interview Schedule (adapted from Cetin-Dindar and Geban, 2017)

How do you understand the concept "gender and culturally responsive practices?"	To establish teachers understanding of the concept.
What are your views, experiences on being gender and culturally responsive when mediating chemistry topics?	To find out about their pedagogical insight regarding gender responsive practices.
Could you please share with me some possible examples (if any) of gender and culturally responsive practices that a science teacher must practice?	To identify if there are gender responsive practices.

` What do you think could be the **benefits** for practising gender and culturally responsive practices when teaching science?	To find out if there are benefits for gender responsive practices.
What do you think could be the **challenges** for practising gender and culturally responsive practices when teaching science?	To identify possible challenges faced by science teachers in practising gender responsiveness.
Do you recommend or not teachers to be gender and culturally responsive when teaching science? Why?	To find out how the teachers view the practice of gender responsiveness in the science classroom.
What else would you like to share with me regarding gender and culturally responsive practices?	To explore and consider any other contributions based on gender responsive practices.

1. Could you please tell me what are your experiences of teaching boys and girls in your science classroom?
   How do you treat learners in your science lessons?
2. What do you understand about the concept of being gender and culturally responsive?
3. What are your views and experiences regarding being gender culturally responsive when facilitating learning of chemistry topics?
4. Could you please share with me any examples of gender and culturally responsive practices that a science teacher must practice?
5. Could you please share with me any **benefits that you know** of about being gender and culturally responsive?
6. What do you think could be the **challenges** for practising gender and culturally responsiveness when teaching science?

7. Do you recommend or not teachers to be gender and culturally responsive when teaching science? Why?
8. What else would you like to share with me regarding gender culturally responsive practices?

APPENDIX F3: Classroom Observation Schedule

Adapted from Nikodemus (2017)

	Notes
Organisation	
Teachers and learners are well prepared for the lesson	
Teacher have all necessary materials and they are readily available.	
Instructional	
Instructions used by the teacher	
Learning materials used by the teacher	

Time allocated to different learners in answering the questions	
Teachers responses to learners (gender perspective)	
A teacher draws on non-participant learners in the lesson.	
Teacher responses to questions asked	
Social interactions	
Learners' participation in the class	
Teachers' interaction with different learners	

Language usage	
Teacher uses appropriate and clear language	
Assessment	
Assessment used by teacher (questioning)	

APPENDIX G: Constructs from the Curriculum and Previous Examination Question Papers

Discussion 1 (CLW 2)

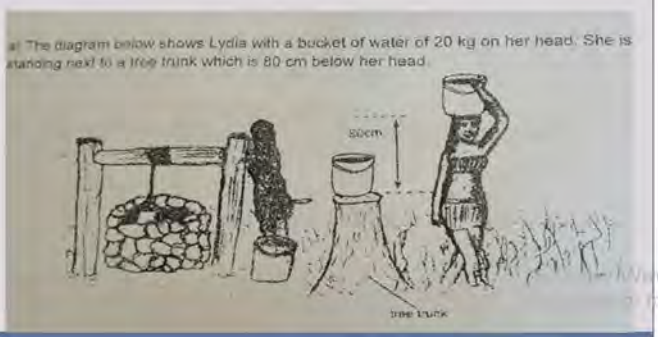
Look at the following extracts from the NCBE and P/SC syllabus respectively

The aims of the curriculum with regard to developing a caring society are to foster moral and ethical values such as reliability, cooperation, democracy, tolerance, mutual understanding and service to others; to develop learners' social responsibility towards other individuals, their family, their community and the nation as a whole; to develop and enhance respect for, and understanding and tolerance of other peoples, religions, beliefs, cultures and ways of life; and to promote equal opportunities for males and females, enabling both genders to participate equally and fully in all spheres of society and all fields of employment.

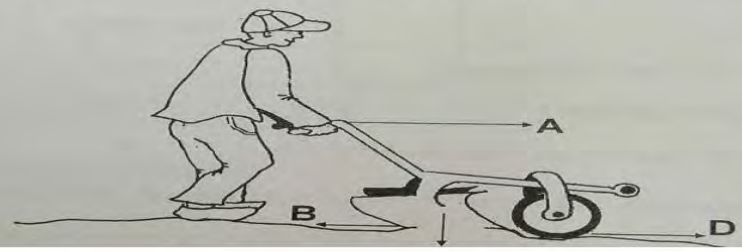
The subjects in the natural sciences and Mathematics area are basic to foster logical thinking skills and form part of the foundation needed for pursuing most careers. Therefore including gender perspectives is important for the science curriculum in order to raise awareness of gender stereotyping (e.g. gender roles we previously associated with doctors, nurses, farmers, artisans, mechanics, lawyers etc.). Teachers are obliged to promote gender equity in all spheres of life. In all activities carried out within the scientific area of study, female learners should experience the confidence, which will motivate them to continue in the natural science stream throughout their school career and beyond.

Discussion 2 (CLW 2)

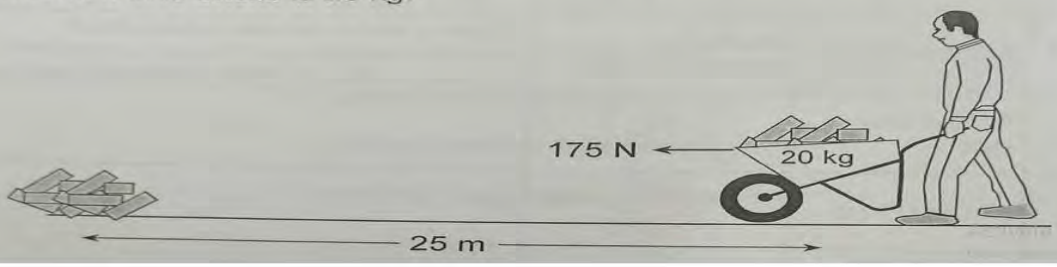
- The following photos are extracted from the Physical Science examination question papers. From a gender and culturally perspective , how will you address these in your science classroom in ensuring gender and culturally responsiveness?



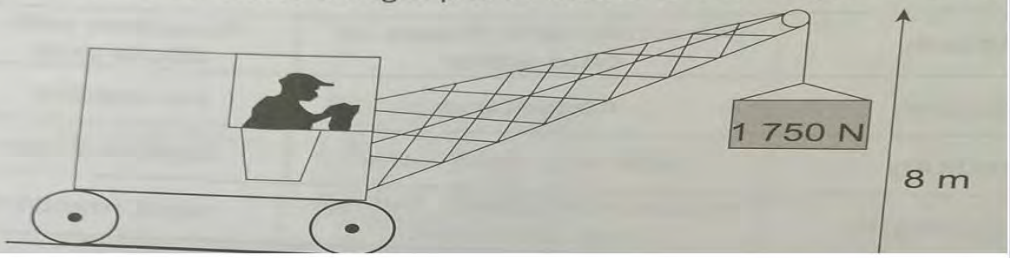
The diagram shows how a plough moves through the soil.



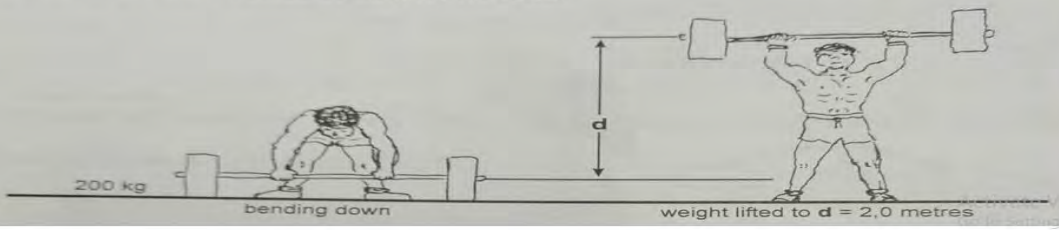
Joseph pushes a wheelbarrow full of bricks. The total mass of the wheelbarrow and bricks is 20 kg.



The diagram shows a crane lifting a pile of bricks to the height of 8 m.



The diagram shows Thomas training his muscles.



APPENDIX H: Exemplar Lesson Plan

LESSON PREPARATION FORM

[redacted]

Date: .... Subject: Physical science Grade: 9 Duration: 40 min

Teacher's name: .... Theme: Matter

Lesson topic: Combustion Reactions

1. Learning objective(s): *Learners will:*
What happens to substance that have undergone Combustion.

2. Basic competency (ies): *By the end of the grade learners should be able to:*
- Describe combustion and recognise that combustion, corrosion of metals and respiration are all examples of the same type of reaction which involves the reaction of substance with oxygen.
- Suggest examples of combustion from everyday life.

3. Teaching and learning media: Methylated spirit, match, candle

Presentation phase

Lesson content and vocabulary	Teacher's activities	Learners' activities
Introduction	Ask learners to recall from grade 8 the gas that support combustion	State oxygen as the gas that support combustion
Development	- Explain the term combustion - Explain to learners the similarities between combustion, corrosion and respiration, word equation can be used to help learners to understand - Demonstrate to learners everyday life examples of combustion	Listen attentively. Observe, ask and answer questions
Reinforcement (assessment & H/W)	~~Note~~ homework or A class work will be given	Do class work/home work.
Conclusion	Main points will be highlighted and emphasised	Take note of main point

Compensatory Teaching: Learning support will be given to learners identified to be struggling.

Reflection: ....

....

Teacher's signature: .... Date: ....

Supervisor's signature: .... Date: ....

CamScanner

APPENDIX I: Colour Coded Transcripts (Questionnaire and Semi-Structured Interview)

COLLATED QUESTIONNAIRE SCHEDULE

RQ: 1. What are Grade 9 Physical Science teachers' perspectives and pedagogical insights into gender culturally responsive practices when mediating learning of acids and bases?

2. Gender

T1: Male

T2: Female

T3: Male

T4: Male

T5: Male

T6: Male

3. Age

T1: 40-49

T2: 40-49

T3: 20-29

T4: 20-29

T5: 20-29

T6: 30-39

4. Experience

T1: 11-15 yrs

T2: 11-15 yrs

T3: 1-5 yrs

T4: 1-5 yrs

T5:1-5 yrs

T6: 11-15 yrs

5. Grades taught

T1: 8-9

T2: 8-9

T3: 9 & 11

T4: 9- 11

T5: 9

T6: 9-11

6. With regards to your teaching beliefs what informs your ideas when teaching Physical Science?

T1: I teach all topics to all learners because boys and girls need to must competencies

T2: Facts and principles of Physical Science and its applications. Enable learners to acquire skills and understand the methods of processes

T3: Competencies from the syllabus and lesson objectives

T4: Physical Science is a subject which involves things around us

T5: the knowledge acquired through my varsity years and the experience I have. The learners understanding and intellectual competence

T6: The level of learners learning ability. Learners learning style. The type of teaching and learning resources available.

7. Please list the teaching methods/ strategies that you use in your class.

T1: Learner centred approach, demonstration methods and lecturing method depending to the learners

T2: Teacher and student centred instruction, group instruction, project based learning, technology

T3: Group discussion, lecture method

T4: Teacher centred method, learner centred method, reading and writing

T5: Discussion and lecture

T6: Talk chalk, direct instruction, directed discussion, lecturing

8. Gender responsive practices is all about providing equal and equitable teaching to both boys and girls and taking into consideration learners' cultural backgrounds

With regards to this, how do address gender responsive in your teaching of Physical Science?

T1: I give the learners one (same) activities no matter boys or girls

T2: By using gender neutral language. By avoiding stereotyping learners. Asking learners to participate regardless of gender. Encourage boys and girls to sit together

T3: No

T4: Every learner, regardless of gender has to participate in Physical Science

T5: All learners are treated equally irrespective of their gender. All learners have equal chances of asking and answering questions

T6: By involving girls and boys in participation at equal proportion

9. I your teaching of Physical Science gender responsive?

   T1: yes

   T2: yes

   T3: No

   T4: yes

   T5: yes

   T6: yes

   Explain your answer

T1: Because I try to close gaps and eradicate gender based discrimination during teaching and learning process

T2: Yes by being fair to both boys and girls

T3: Because it encourage inequalities and unfair treatment in the class.

T4: Both genders are involved

T5: Results always show a very good balance of gender distribution.

T6: Yes the use of words such as boys, girls, male, female man or woman is not approved. I rather use names instead. Involving all learners in demonstration and handling of apparatus in science lab.

10. Do you promote gender culturally responsiveness in your class? Explain your answer.

T1: Yes, because all learners needs equal opportunities in life and I am promoting equality

T2: Yes, by creating a gender-inclusive learning environment

T3: No, because learners in my class need to be treated equally and with fairness

T4: Yes, by making sure that all the participants involve both genders

T5: Yes, due to the norm and having an awareness of ones's own cultural identity and views about differences plus the ability to learn. This stands as a reason to promote gender-culturally responsiveness.

T6: by always motivating learners to respect their peers' views without the basis of gender or ethnicity. By being gender/culture sensitive when emphasising on various science concepts.

11. How often do you plan and teach chemistry topics in gender responsive way (if you do)? If not, why not?

T1: During this time, teaching to me it does not tell me as I do teach two group. I am planning as I teach people with all ability.

T2: By selecting curriculum teaching aids that promote gender inclusiveness.

T3: No. because I want to ensure that all my learners, boys and girls have equal opportunities and equal access to teaching and learning materials. Planning and teaching in a gender responsive way makes some learners think other learners are being favoured and is not fair.

T4: Ensure that all have equal access to teaching and learning materials.

T5: This depends on the syllabus and scheme of work plus the order of the topics per semester. It encourage learners' participation. It support the development of learners especially girls perception of women as able and capable, self-directed and strong.

T6: Daily basis

12. Do you assess chemistry topics in a gender responsive way?

Explain your answer

T1: Yes, I assess equally not looking at the gender I regard them as all learners (boys and girls)

T2: Yes, ensure that both learners have equal access to teaching and learning materials.

T3: No

T4: Yes, assessing all learners from free gender bias.

T5: No when it comes to assessment, gender responsive is not that active due to the fact that assessment is an individual piece of work, that require learners to work and present what they have been taught.

T6: Yes, a uniform/same assessment activity is given to all learners in the same room and same time. All learners are marked with the same approach.

13. What kind of teaching materials /resources do you use in your class that are gender responsive?
    T1: Visual teaching aids
    T2: Female and male posters, charts textbooks
    T3: None
    T4: Mixed seating arrangement to enhance the equal participation of boys and girls.
    T5: Textbook and hand-outs
    T6: chalkboard, textbook, laboratory apparatus and chemicals.

14. In a scale of 1-5 with 1 being very poor, 2 poor, 3 average, 4 good and 5 excellent, how do you rate yourself being gender responsive when teaching Physical Science particularly acids and bases?

T1: 5

T2: 4

T3: 2

T4: 3

T5: 3

T6: 5

15. Anything you would like to share with me?

T1: During teaching and learning we need to motivate our learners so that we can eradicate the old era belief which stated that science is not for girls.

T2:----------

T3: I think gender culturally responsive is all about giving more access to teaching and learning materials to one gender and learners will not benefit equally when the teacher is gender responsive.

T4: ----------

T5: Due to the demand of learning, I would like to say it is high time schools introduce or put a programme in place that support gender responsive since some gender especially girls they feel uncapable of doing some work or performing better.

T6:----------

Interview Transcriptions (T1)

Researcher (R): Could you please tell me what are your experiences of teaching boys and girls in your Physical Science classroom?

Teacher 1 (T1): Mm ok what I have observed so teaching science in class so boys and girls I normally use to treat them equally though some of them they feel like the other group maybe can participate more especially when it comes to boys they do participate more than girls when you experience,**(Participation of boys and girls)** I mean when you are observing.

R: Mm

T1: Though you use to encourage the learners especially the girls at least to take part also just to participate also.

R: Mm maybe what makes the girls not to participate?

- T1: Iyaa sometimes, there is those aa myths like saying no girls they are not good in science **(Cultural beliefs about learning of science, historicity, Engeström, 2001 Chikunda 2014.)**

R: Mm

T1: So, I know this one was carried along from previous years, when you only had teachers, male teachers who are teaching science **(gender stereotypes, Abraha et al., 2021)** mmm.

R: And now what do you do to make the girls to participate now in the class?

T1: So in the class I use to motivate them saying they can also learn science, they must also participate as boys do, **(indicators of Gender responsive)** though sometimes you can also give the examples of especially, I am a male teacher who teach science but I also use to give examples of different teachers who are also females but they can teach, I mean they do teach science.

R: Mm

T1: And this one I motivate them like some of them they want to become nurses and doctors, I use to tell them that the moment you are participating or you become so competent in science, there is a chance for you to become a doctor or the nurse.

R: Ok in Physical Science which topics maybe where the boys participate more than girls, like you know that Physical Science is made up of chemistry and physics, now which part is it chemistry part or physics part or just across?

T1: But what I have observed especially the experience which I do have, so boys they normally use to participate when it comes to those chemistry part. Let me say for example when you are testing something, so especially girls sometimes they do afraid of those chemicals and also sometimes they fear testing gases **(participation of girls in science experiments, Iwu & Azoro, 2017)**. You see, so once they hear for example you are testing hydrogen and hydrogen normally use to produce a pop sound, so once the ladies, I mean the girls heard that sound, some of them they just like, they just want to run away, so but the boys they have got that curiosity at least to see what is happening.

R: Mm so now how do you treat your learners in your science lesson?

T1: As I have said earlier, I treat them equally so when it comes to motivation and also when they give their answer where they need assistance **(Kahamba et al., 2017)** I can just help each and every person in my class so I apply equality in my presentation. You know previous years teachers use to pay attention to the boys than the girls. And this one aa makes male teachers to be the teachers of science. (Historicity in learning of science)

R: Ok now how do you understand the concept of being gender and culturally responsive?

T1: For being gender and culturally responsive, I think this one is just to look at ok aa, let me say for example when you are in the classroom so you have to carry the background of the learners so what they believe and what also you believe or you observe. (**Cultural context; Vygotsky, 1978, indicators for cultural responsive, Mensah, 2021, Gay, 2018 Harrison & Skrebneva** (2020**)** So you know this person at least need to be like treating all learners equally and respond to their needs as per their questions. Let me say if they are asking, you can just answer no matter whether is a boy or a girl. So what you have to do is just to provide the

answers to the learners in the polite and motivating way so that the learners they can do ask questions more and again.

R: Now how do you respond to the cultural background of those learners as you have indicated that you have to look at their backgrounds, their beliefs?

T1: Ok now what I normally use to do I use to ask them at least to come up with some of the what they have learnt, so from their community. so let me say give you an example like for when you **(Miller, 2020, Prior knowledge)**are talking in physics when you are talking about lightning and and so on, so these learners they can tell you that so you don't need to put on red shirt or any any to carry anything which is red during the rainy season. So this one it can cause or you might find yourself being stricken by the lightning. So though in reality you know that, that one it cannot happen like that. So these learners you try at least to correct them in a way that you can also do some practical examples. To give them practical examples what causes the charges and so on but not like having a red something is when it is going to be charged something like that. So you need at least to correct them according to the practical examples. **(addressing misconceptions)**

R: Ok. Now what are your views and experiences being gender and culturally responsive when facilitating the learning of chemistry topics in Physical Science?

T1: Aa this one you see aa it is aa so it is like when you are teaching. So as I have said earlier that we normally use to to teach learners so when you are in the classroom we sometimes or let me say we need to forget that there are boys and girls so what we have to just to say we do have learners. We are teaching learners so at least this one can help you to teach only learners in the same way that you don't even say no this one I have to present this one because there is girls or there is boys. So what we have to do you must only teach learners, so you forget about gender because each and everybody wants to be a successful person regardless of her or his gender.

R: Now we have different, we have those learners from different cultural background for example the girls now if you teach them aa as universally but you know that the girls they have

that perception already that this science is not for them is for the boys. Now how do you approach that?

T1: As it is for the boys or girls?

R: For the girls, with that myth that science is not for the girls?

T1: Ok those learners with that myth, so most of the time we use to ok, luck enough we have got our learners being send to career fair. So those learners when they go there they can see different people presenting different field of studies and so on. So whereby there are also women they are also taking part. So thus why normally I use to to just want them at least or I motivate them at least eradicate this myth of saying no girls are not meant for science or whatever. They are there so thus why we can see there are female doctors and there are also nurses. Those people they do they do they they got that opportunity because of the science subject. Anyway so but we normally, I normally use to motivate them just to leave that myth behind that no science is for ladies, I mean for guys or whatever. So each and every person who sit in the classroom can be taught and become a competent person when it comes to tops or tops of science. Iyaa

R: Ok could you please share with me any example of gender and culturally responsive practice that a science teacher must practice?

T1: Aa ok aa now when it comes to the examples aaa examples for gender and culturally responsive so at least now this one aaa it is more or less of what I have stated when it comes to motivation. So these learners at least they need to be like a person, a teacher should listen to all the ideas aa coming from different learners especially boys and girls or from the learners who are from different background when they are sticking more on their myths **(Cultural Responsive P)**. So but a teachers should do only motivate and encourage the learners that they can do something. What boys can do, girls can also do.

R: Mm

T1: Iiyaa ok

R: Ok could you please share with me any benefits that you know of about being gender and culturally responsive. Are there any benefits to the learners or to the teachers?

T1: Iyaa about this one at least the benefits they are there especially when it comes to the teacher. So if you accommodate those learners in your teaching so you might know a lot from the learners. So then from there once you have learnt all those things you can also, it will be easier for you (**Embrace learners PK, NCBE 2016; Khulane, 2011**) to tackle another group next year. For example when they are doing this one at least you know how to approach those learners, so that you can eradicate that myth of being and for the learners also. So those learners you are creating aa you see you are creating confidence in them. Meaning that even whenever they are going so they will feel like no whatever iyaa a boy or whatever a boy or whatever iyaaa whatever the boy is doing in science we can also do it. So when it comes also to activities when you are give, we don't say no this question 1 2 3 oo is for the whole class, this one is only for the boys. No we only give the whole question paper. So no matter if we are a boy or girls you can just answer all the questions and sometimes you can see most of the girls they can also attempt to answer aa questions correctly.

R: Ok mm. what do you think could be the challenge for practising gender cultural responsive when teaching science?

T1: So this one it is sometimes the challenge is only that when it comes to some of the practical see practical activities especially I have stated already that when you are teaching and you are come up with certain practical, learners especially girls they might be afraid of taking part so rather standing a bit far just observing. So this like because some of the things which can happen there mostly they are afraid that no if something happen (low **self-confidence of girls in participating in science experiments; gender socialisation Chikunda & Chikunda, 2016 Iwu & Azoro, 2017)** I might be as I have said already that when you are giving the conditions or the precautions for example you are carrying out the activity whereby you are using chemicals. So you have to give the laboratory rules and so on. So these ladies, I mean the girls they can even just take it like no let me just be isolate myself this one might cause the problem compare to the boys who likes at least come and see and they want also to do it because but the

ladies the feel like no they cannot even if something happen they cannot even defend themselves.

R: Ok on yourself as on a personal, personal capacity as a teacher. Are there any challenges on your side that maybe can prevent you from being gender culturally responsive when you are teaching Physical Science?

T1: Aaa, I don't think if there is because the main reason that you want is just to include boys and girls in your teaching. Once you see that there are some of the challenges and you they might overcome you, you might find yourself teaching one group. So here I think it is not needed or so just you can't observe those challenges anyway you are ready to teach the whole group.

R: And now with the saying of having learners from different cultural background don't you experience any challenge of how you can accommodate all of them? Like that we have learners that say this work is for boys like iiyaa

T1: Iyaa no this one the very you see as a teacher we normally use to see this things sometimes happening. I mean happening sometimes but what we normally do, we try before. Let me say during the introduction of a certain topic, if you observe that one before you need at least to explain to the learners that this topic no this topic is all about abc but what we have to do we all have to take part. We need all of us, all of us we have to participate and you can also create a room for the learners to hear their background on what are they saying about that one. So that you can at least emphasise on their negative aaaa aaa ok let me say ok on the negative thought when it comes to those topics and whatever. so but mostly what teachers we have we need only to motivate learners and also to pave the way on how to become successful individuals in also science and just to take it simple that no learners they are all equal when it comes there. I mean in the classroom so meaning they can also if you say go and test for oxygen a boy or a girl any person can be just a group leader for a certain aa aa activity. So that can give either the instruction or take or giving chances to learners to participate and so on. This one can be caused if you motivate your learners.

R: Mm do you recommend or not the teachers to be gender and culturally responsive when they are teaching science?

T1: Iyaa this one at least you need to iyaa. I can say I can also recommend because this one once you have got their ideas you can you can help your learners in different ways. So let me say for example if you are not even aware of that you might find yourself giving a test and those learners what they are going to give they are giving answers but they are reflecting on their aa background what they know which is not even stipulated in the basic competencies. So if you are ready to I mean if you know this one you can help your learners **(processes compatible with the socio-cultural context; Harrison & Skrebneva (2020)** at least to guide them so to answer the questions and you have also to focus on basic competencies. Let me say for example aaa when it comes to electricity aa lightning so this one if you are aware, so when you are going to present your lesson you have to tackle those things which are I mean those competencies so you don't need to put in this background things what what and saying no red what what they can cause you to be struck by the lightning. So I think it is needed to listen to what they are telling you so that you can correct them.

R: Mmm did you receive any professional development regarding being gender and culturally responsive?

T1: Iyaa because you know how to approach different people when it comes to approach and sometimes you need also to to teach to guide learners especially those who are saying no we can't do abc so you can be busy motivating them and paving them at least to understand that no they can but you see the way sometimes let me say you can aa by saying that I can say those learners I can say you I have got any experience because I know that sometimes you can deep, you can deeply ask learners questions and how do they feel when it comes to that one when you are presenting this and what they have learnt. So you can also know that you can easily aa take out their thoughts of negative whatever. So this one it helps us you to to became iyaa at least just to understand the even the environment itself. Wherever you are there you can see these people they are thinking about this one even if you are presenting this one in the community you must first you have to tell them that no, it was not like this and this as we have been told iyaa, yes.

R: Mmm ok what else would you like to share with me regarding gender and culturally responsive?

T1: I don't have much to share but at least just to say this one at least it helps a person to understand a group of people and can also merge their behaviour so that they can behave in the same way. (**different cultural background)**With the main reason that they need to achieve something at the end of the day.

R: Mmm ok thank you very much. That was the end.

APPENDIX J: Hands-on practical activity for exemplar lesson

Physical Science Practical Investigation

Topic: Combustion reactions

Group members (max. 4 members)

……
……
……
……

Materials

- 3 Candles
- Beakers of different sizes
- Matches

Instructions

- Label candle A, B and C
- Light the candles (Same sizes)
- Cover two candles as follows: Candle A with small beaker and Candle B with a big beaker
- Leave candle C uncovered
- Observe for 2 minutes

Answer the following questions

1. What happen to candle A, B and C after 2 minutes?
   (a) Candle:A
   ……

(b) Candle:B

……..

(c) Candle:C

……..

2. Give a reason for your answers in 1 (a), (b) and (c).

……
……
……
……
……..

3. What type of reaction takes place when these candles are burning?

……..

4. Write down the general word equation for the reaction mentioned in Q.3.

……

5. Give another example of the reaction mentioned in Q.3 that took place in everyday life.

……

6. In terms of energy change, identity the type of reaction that takes place when candles are burning. Give a reason for your answer.

……
……

APPENDIX K: Mediational tool guide for gender and culturally responsive

Components of lessons	Guidelines
Planning	➢ analysis of the teaching and learning materials ➢ Identification of any gender and cultural stereotypes ➢ Alternative teaching and learning materials and methods that are gender responsive ➢ Identification of local material for mediating the teaching and learning
Presentation	➢ Provide equal opportunity to both boys and girls ➢ Use examples from local environment as much as possible to contextualise science ➢ Involvement of all learners in the experiments (if any) ➢ Assign roles to all learners(both boys and girls) equally ➢ Inviting non-participant learners.
Assessment	➢ Use different examples of roles regarded as for a specific gender in the questioning (question papers). ➢ Avoid using gender stereotyped statements.
Conclusion	➢ Emphasis on gender and culturally responsive methods. ➢ Exposure to different careers available. ➢ Motivation of learners on different career paths.