Exploring Science Educators' Reproduction and Subversion of Gender Stereotyping in a College of Education in Nigeria

by

Daniel Asilika Allu

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DECLARATION

This thesis was written in the School of Education, Science and Technology Education Cluster, at the University of KwaZulu-Natal, with Professor Nadaraj Govender and Dr Angela James as supervisors.

Ethical clearance was granted for the conduct of this study by University of KwaZulu-Natal Research Office. The ethics clearance approval is given as: HSS/1028/018D.

This study duly represents the author's original work except where otherwise indicated and has not been submitted in any form for any other qualifications to any tertiary institution.

Where others' work is referenced herein, it has been acknowledged in the thesis.

Signed

Daniel Asilika Allu

215082629

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"Greetings to all Gender Friends"

ABSTRACT

The cultural production and reproduction of discriminatory gender practices in education and in society has been a global and local concern, thus attracting attention in current debates. Therefore, knowledge theorization aims at questioning and interrogating the socio-historical and patriarchal gender practices in the 21st century. A global transformation of gender may be one of the vital paths to empowering woman and the marginalized in education.

In this study, gender equity, which is a process of attaining equality, is obstructed by socio-cultural relations of power, linked to discrimination, domination and entrenched stereotyping in society and is particularly now a focus too in science and science education. Science has been considered a male domain; a liberal feminist analysis views the space of women in science and science education as emanating from a long history of oppression of females in a patriarchal society. Therefore, orientations related to patriarchy, sexuality and culture currently dictate classroom engagements in science education, which impacts on student's intellectual and career progress. However, an exposure to the impact of gender stereotype and inequality in science education is a possibility towards the intellectual, political, and economic transformation of females.

This study explores six Nigerian science educators' reproduction and subversion of gender stereotyping in physical and life sciences classes and is located within the critical interpretive paradigm. The research methodology comprised qualitative methods using questionnaire, interviews, classroom observations, reflective journals, and collective reflections. A qualitative case study research design was used for the study. Then, I used purposive and convenience sampling techniques to select six experienced science educators with heightened gender awareness in a college situated in North Central Nigeria where the study was conducted. The narrative method employed captures the selection and experiences of science educators and allowed for a nuanced understanding of educators' views about gender stereotype reproduction and subversion. The data were analyzed for themes using gender lens of Critical Theory (CT), Critical Feminist Reproduction Theory (CFRT) and Critical Consciousness Theory (CCT) regarding cultural production and reproduction and gender transformation.

The findings reveal that the construct 'gender' is indeed social construction, repeated acts linked to identity construction of male and female science educators. In this study, educators in physical and life sciences classes are shown to implicitly and/or explicitly reproduce gender stereotypes, but sometimes to subvert discrimination, consciously and unconsciously. Furthermore, educators,

especially the male pre-service teachers, collude to stereotype female pre-service teachers. Also, female pre-service teachers are equally complicit in their own oppression. It appears the science educators, male and female pre-service teachers are not explicitly aware of their complicit gender stereotyping roles in science education during teaching and learning engagements. It was observed that female pre-service teachers are often overtly deterred from participating in the science education space. The unconscious and conscious actions of stereotyping by educators towards their female pre-service teachers are likely to reinforce multiple oppressions in their charges that will impact their future teaching and gendered roles in class. A *pedagogic transformative gender model* of enabling a contradictory, transformative and political college space for science educators and pre-service teachers to negotiate power differentials for a new social gender order is then proposed for collective action.

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LIST OF ACRONYMS

CT	Critical Theory
CCT	Critical Consciousness Theory
CCP	Critical Consciousness Pedagogy
CEDAW	Convention on the Elimination of all Forms of Discrimination against Women
CFRT	Critical Feminist Reproduction theory
FSED	Female Science Educator
MSED	Male Science Educator
PCK	Pedagogical Content Knowledge
FGN	Federal Government of Nigeria
NPE	National Policy on Education
SDG	Sustainable Development Goal
STAN	Science Teachers Association of Nigeria
STEM	Science, Technology, Engineering and Mathematics
STT	Stereotype Threat Theory
PST	Pre-Service Teachers
UPE	Universal Primary Education

CHAPTER 1
INTRODUCTION TO THE STUDY

INTRODUCTION

This study aimed to interrogate the ways in which explicit and implicit stereotypic gender, socio-cultural practices and beliefs are produced, reproduced, reinforced, and challenged or disrupted to allow for spaces for transformative agents in science education environment such as colleges of education in Nigeria. In this chapter, I present the focus and purpose of the study, then a description of background and the context for the study. The rationale and problem statement of the study and the research questions are then provided. The methodological approach is also highlighted. The chapter ends with a summary of structure of the thesis and content of each of the chapters.

In this study, gender stereotype reproduction connotes how stereotypic gender practices, views and beliefs are produced, reproduced, and reinforced by science educators in science education environment. These stereotypical practices, views and beliefs emanating from Nigerian's patriarchal society have filtered into physical and life sciences education in Nigeria, influencing and affecting teaching and learning. In this sense, gender oppressive features, such as oppressive actions and demeaning words by science educators, together with the imagery in text materials in science classes, may continue to lower motivation, decrease participation, and reduce women's confidence to study science in Nigeria colleges of education. These features are also likely to occur in other geographical social environments (De Silva, Khatibi, & Azam, 2018).

The concept *stereotype* here signifies the ascribed role differences given to men and women, boys and girls in science education, while *reproduction* is the conscious or unconscious replication of these cultural roles and practices in the society, particularly in education (Bourdieu & Passeron, 1990; Butler, 2011; Diamond, 2020). *Subversion*, though, involves goal-oriented actions emerging from the need to survive and prevent and resist harm to self, group, and community. It is subtle, that is, non-violent, but a clever way of addressing issues without drawing attention to itself. Subversion is a necessary tool for survival and a way of resisting abusive forms of power that create and/or maintain oppression, inequity, and inequality. Some researchers argue that, while subversion is a democratic or political form of

resistance, not all acts of resistance, such as reluctance to learning and deviant behaviours in the school space, are similar to acts of subversion (Butler, 2011; Portelli & Eizadirad, 2018). The gender notion of *subversion* refers to the ways that the gendered features of the science education curriculum are likely to be challenged and opposed by science educators and pre-service teachers (PST). When these stereotypical practices are challenged through notions of *reproduction and subversion* that create awareness and advocacy, it can enable educators and PST to reclaim their humanity and collective existence, thus applying the gender notion of *transformative resistance*. Transformative resistance could invoke political, economic, moral, and intellectual transformation in science education and peaceful co-existence in the society. However, there is minimal gender research on reproduction and subversion of gender stereotype beliefs and views in colleges of education linked to entrenched historical, economic, patriarchal ideology and sociocultural power relations. This is the type of research which could invoke and promote women's consciousness for freedom and intellectual transformation. Therefore, researching and understanding deep rooted historical, sociocultural gender dynamics, power and patriarchy in science education environment becomes vital. This is because, there is little awareness and understanding of how these constructs are related to the reproduction and subversion of gender stereotypes beliefs that impact negatively on science education. It is evident that PST' interest, self-efficacy, self-concept, performance, and academic progress are severely impacted.

It is likely that gender stereotyping due to politics, sociocultural orientations, socialization process and power differential, has led to entrenched gender inequity and inequality in science education, which need to be challenged through advocacy, building coalitions and forming women resistance movement at local and global ecospheres (Braun & Dreiling, 2019; Ombati & Ombati, 2017). *Inequity* here is the process of unfair treatment, such as role differentials in terms of positions and institutional systemic preferences given to men over women/girls in science education (Sinnes & Loken, 2014). These differentials may be due to perceived specific but different gender roles and biological differences accorded to males and females. Similarly, *gender inequality* is the unequal treatment of females and males in terms of basic resources, economic, political and educational participation due to ingrained consciousness of gender stereotyping (Ombati & Ombati, 2017). Gender stereotyping is defined as the discriminatory perceptions, beliefs and practices related to capability and ability that the society, institutions, and individuals ascribe to men and women-for example, that males are more intelligent than

females and should always be leaders and head of families, while women are considered subordinate and should be subjugated and dominated (Sultana, 2010). Consequently, females are under-represented and discriminated against in the society, education and specifically science education courses and career fields (Eddy & Brownell, 2016; Federer, Nehm, & Pearl, 2016). Therefore, it is likely that the continuous discriminatory practices in the society have attracted comments by researchers, who draw inspiration from the United Nations Assembly position on gender discrimination described as follows:

> In recent times the United Nations (UN) has decried over the widening gap on gender equality in member states. This was evident during the 2019 UN Women's Day speech given by the President, Ms. María Fernanda Espinosa who lamented bitterly that the organisation is losing the struggle for gender equality. Other members of the assembly stressed the need for inclusiveness of women in all sectors in order to intensify development (Obah-Akpowoghaha & Ojakorotu, 2019, p. 1).

Researchers therefore argue that, despite long-standing initiatives to create awareness and improve gender equity and equality across the Science, Technology, Engineering and Mathematics (STEM) fields, women's representation in undergraduate engineering programmes remains low. However, STEM faculties in education, which are supposed to be influential gatekeepers, give little attention to gender inclusive teaching and learning in these fields (Blair, Miller, Ong, & Zastavker, 2017). Yet, little is known about how STEM faculty members construct their responsibilities to advance gender science identity and equality (McNaughton & Billot, 2016). Scholars utilizing a range of approaches to studying identity have contended that, in STEM departmental cultures, faculty members' professional identities often centred on their role as researchers and managers, while teacher education, professional identities are underdeveloped, undervalued, and delegitimized. Hence, there is a dire need to reconstruct professional development and gender identities in education, particularly in science education.

It is significant to note that gender dynamics in the society and particularly in education are not properly interrogated. This is because practitioners in the society and in particular science education sectors are unaware of the visible danger of gender stereotypes and inequalities they pose, as these affect, in the long term, the socio-economic development of any nation

(Kollmayer, Schober, & Spiel, 2018; Ogwuche, Adikwu, & Ossai, 2020). The Global Gender Gap Index score for Nigeria for economic participation and opportunity related to gender rose from 0.612 in 2006 to 0.687 in 2021, but that for educational attainment related to gender fell from 0.816 in 2006 to 0.806 in 2021. In contrast, in India the figure for educational attainment were 0.819 and 0.962 respectively (World Economic Forum, 2021). The McKinsey Global Institute 2018 report (McKinsey, 2018) on gender parity shows that India stands to gain economically, politically and in education from increased gender equality. Also, of significance, a substantial increase of female labour in education and the economy could add $770 billion to the national economy and by 2025 the gross domestic product might have been increased by 1.3 percent (McKinsey, 2018; Roxburgh, Lund, & Piotrowski, 2011; Woetzel, Garemo, Mischke, Kamra, & Palter, 2017).

Alarmingly, the gender gap and inequality are widening and, according to World Economic Forum (WEF) and Gender Inequality Index (GII) projections, these problems may not be fully addressed until the year 2186, about 170 years from now (United Nations, 2014; Mastracci, 2017; Permanyer, 2013). In recognition of these projections related to gender inequality, the Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW), an international treaty, was adopted in 1979 by the United Nations General Assembly, to redress the inequality and discrimination against women. As Cole comments:

> Convention on Elimination of all Forms of Discrimination Against Women recognizes that discrimination against women violates the principles of equality of rights and respect for human dignity, and hinders women's participation in economic, social, cultural, and political life of their countries, thereby obstructing the development of their countries (Cole, 2016, p. 33).

To eliminate discrimination, the CEDAW obliges countries to incorporate the principles of equality and non-discrimination in their countries' constitutions and other relevant legislation. It further demands that all legal instruments that perpetuate discrimination be abolished (Cole, 2016; Mark, Kittilson, & Sandholtz, 2006).

Discriminatory practices such as inequality and reproduction of gender stereotyping may have caused a decline for women in the areas of access, enrolment, engagements, and appointments. These stereotypical and subordinating practices, which trigger low motivation, low confidence, and interest by females, have extensively permeated the education sector. This is evident in

physical and life sciences teaching and learning globally. It may be that curriculum planners, science educators and governments do not have enough knowledge and awareness of gender issues, neoliberal tendencies of capitalism, correspondence theory link to oppressive economic consciousness connected to inequality in science education. Science educators and pre-service teachers generally, despite their potential for agency, seem not to be conscious of and understand the consequences of gender stereotypes (Chikunda, 2010; Tekerek & Karakaya, 2018). Therefore, they do not have enough awareness of subverting or challenging stereotypical practices in the science classrooms, whether in colleges of education in Nigeria or in other countries. Though schools' spaces are influenced by gender, sexuality such as sexual emotions and patriarchal elements contradict the teaching and learning of science. Therefore, working with fresh insights on gender, as well as political struggles, are necessary to achieve science educators and students' understanding of gender equity in an ambiguous social ecosphere. This will further position educators and students as political, ethical, and democratic intellectuals with critical consciousness for change and transformation (Giroux, Freire, & McLaren, 1988; Shor, 2014; Weiler, 2017).

1.1 FOCUS OF THE STUDY

This study focuses on science educators' reproduction and subversion of gender stereotyping in science classes in a federal college of education in Nigeria. To have a nuanced understanding of the phenomenon under investigation, it is crucial to engage experienced science educators teaching in the fields of physical and life sciences who have also had some gender and gender stereotypes exposure from workshops and conferences. These science educators have had long years of teaching experiences as they interact with their PSTs and with colleagues. The assumption is that colleges of education are typical educational spaces where gender stereotypes and inequality are reproduced and reinforced due to socialization processes, but where they can also be challenged (Obiama, Hentschel & Hernandez Bark, 2021). Science educators' views and perceptions will help in understanding the deep-seated reasons and nuances for the reproduction of gender stereotypes and inequality and how these could be resisted or rejected for intellectual growth and provide spaces for educators as transformative agents for change.

The objectives for this study are:

1. To explore the explicit and implicit nature of science educators' reproduction and subversion of gender stereotype beliefs and views.

2. To explore how science educators reproduce and subvert explicit and implicit gender stereotype beliefs and views.

3. To account for why science educators reproduce and subvert explicit and implicit gender stereotype beliefs and views in the way they do.

1.2 BACKGROUND AND CONTEXT OF THE STUDY

Here I draw on existing studies on how gender stereotypes, reproduction and subversion beliefs and practices have been examined in physical and life sciences nationally and internationally. The literature on these issues has been developing both globally and in Nigeria. For example, gender stereotypes are seen as roles that are positively or negatively ascribed to individuals; men and women are judged based on the performance of these roles (Kerkhoven, Russo, Land-Zandstra, Saxena, & Rodenburg, 2016; Sadiq, Abdullah, & Buriro, 2018).

In Nigeria, research on gender and specifically on gender stereotypes, reproduction and subversion beliefs and practices have been given less attention (Obioma, Hentschel, & Hernandez Bark, 2021). The few attempts that have been mobilised have focused only on gender participation, interest, enrolment, and academic performance using quantitative methodologies that minimally highlight gender power relations, agentic possibilities and the transformative potential of educators and students (Akinsowon & Osisanwo, 2014; Kola & Taiwo, 2014; Oyedokun, 2001). However, the mostly quantitative gender analyses in Nigeria and some other countries have been criticised for lack of in-depth analysis and knowledge production of participants' lived experiences. This is because the use of numerical data has reduced complex and interwoven social phenomena to isolated variables. Consequently, both the researcher and the researched rely overly on questionnaires with large data and are not deeply involved during in-depth data production. Thus, there is a dependence on objective knowledge, perceived by positivists as a single reality, instead of recognising the contradictory and complex social world with multiple realities (Creswell & Poth, 2017, p. 26).

Such studies sometimes ignore the significance of the social context within which the 'objective' knowledge is produced (Au, 2020; Jayaratne & Stewart, 1991; Yilmaz, 2008).

Objectivity is what positivists have clung to in their attempt to produce knowledge as truth. Yet, these theorists' positioning has been criticized for ignoring the social environment in which knowledge theorisation occurs, because it presents only one way of viewing reality in a complex social world undergirded with epistemic freedom (Cheng, 2017; Fuchs & Sandoval, 2008).

In this study, the researcher used a descriptive questionnaire, a narrative insight, lesson observations, interviews and journal reflections that informed the qualitative study. This is an attempt to understand and provide the nuances and thick descriptions of the phenomenon of interest – *dynamics that underlie gender inequality in science education*. These dynamics can be traced to gender stereotypes and reproduction in the society that have become then linked to the teaching and learning of physical and life sciences. Gender stereotyping reinforces gender inequality and perpetuates historical, socio-cultural and political role differentials that might be the result of differences in economic development and subsequent discrimination. This account agrees with the argument of some researchers that 16% of the long-term labour income difference and inequality experienced by women in some countries (specifically, in South Asia, East Asia and the Pacific), could be attributed for by gender inequality that subordinates women (Ferrant, Fuiret, & Zambrano, 2020).

Globally, women continue to be marginalized, stereotyped, devalued, and suffer greatly from being treated unequally to men with regard to economy, political and educational opportunities, resulting in unequal access and participation by women. In recognition of this problem, among others, the United Nation's Educational Scientific and Cultural Organisation (UNESCO) avers that, "two-thirds of the world's 792 million illiterate adults are women" (Sharp, 2016 p. 5)**.** Assuredly, these illiterate adult women extend across geographic borders and socio-economic divides, due to the entrenched gender inequality that is rooted in all strata of the communities. It is necessary to create awareness to address this entrenched widespread discrimination and injustice at all levels in the society.

Also, there is a perception globally, in Africa and specifically in Nigeria, that gender stereotypes and inequality are still persistent in secondary schools, colleges of education, universities and in workplaces (Bako & Syed, 2018; Sharp, 2016). In Nigeria, for instance, despite the enactment in the 1999 constitution of Federal Republic of Nigeria part 2, section (18) subsection (1) for adequate and equality of educational opportunities at all levels, gender

inequity and *inequality* in secondary schools, colleges of education and universities persist and are entrenched in education spaces, though challenged via statutes and law such as the constitution of the Federal Republic of Nigeria (Federal Government of Nigeria, 1999), and the National Policy on Education (Federal Government of Nigeria, 2014). The current government policy documents and legislature in Nigeria still translate into little awareness on the need to address gender inequality among regions and tribes as a specific goal for emancipation and transformation. For instance, in Nigeria, where this study is situated, amongst other oppressive and discriminatory practices, the gender equality bill was sent to the national assembly refer to as the senate in 2017. This bill was rejected outright, and no cogent reasons were given for the refusal, largely due to lawmakers' superficial consciousness regarding the transformation, political, economic and moral potential of women. The conditions explored in the study are likely to provide evidence of persistent infractions of the fundamental human right of equality and emancipatory opportunity of women, as promulgated by Nigerian Constitution of 1999 by the National Assembly parliamentarians of 2017. Of course, this is likely why some countries such as Nigeria and South Africa are perceived as patriarchal nations with domestic violence and assault on females. This is likely due to gender stereotypes and the devaluing of females at home and public spaces who are scantily protected by the laws of these countries (Caritus & Umejesi, 2019; Mazibuko & Umejesi, 2015).

The existence, persistence and worsening of the inequalities experienced by women are also visible in research and evidence-based scholarships. However, there is minimal awareness and improvement of these profound inequalities (Bako & Syed, 2018). This is because evidence-based gender research has not been seriously taken into consideration by administrators, policy makers, researchers and curriculum planners when formulating and implementing policies to curb the inequalities, as advocated by the United Nations Education Scientific and Cultural Organisations (UNESCO). Also, for UNESCO, gender equality signifies that both men and women's priorities such as interests, resources and needs are not forgotten but taken into consideration, bearing in mind the diversity of individuals and groups. This might explain why the United Nation's Sustainable Development Goals (SDGs) referred to as the Global Goals (especially number five), encourage all nations of the world to embrace gender equality as a key to national development (Sharp, 2016; Weisenborn, 2018). The universal focus of the SDGs is to increase food security and to end poverty and injustices such as gender inequality, protect the planet and ensure that all people enjoy peace and prosperity.

Further, the United Nation's (UN) Economic and Social Council sector (ECOSOC) observed that gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous, and sustainable world (Sarwar & Nicolai, 2018). Thus, the achievement of equal access by women and girls to education, health care, decent work devoid of violence, and representation in political and economic decision-making, will promote sustainable economic development for the benefit of all societies. The United Nations (UN), comprising 143 countries, promises the hope of equality between men and women in its constitution. For instance, nations such as India, Kenya, Indonesia, Jordan, Portugal, Thailand and Tajikistan, Sweden, Netherlands, South Africa, Zimbabwe have prioritised action plans for gender equality in 2030, but other countries locally and globally are perceived as the worst in term of gender equality and are still reluctant to address gender issues. These countries are Egypt, Ethiopia, Iraq, Indonesia, India, Malaysia, Qatar, Saudi Arabia, United Arab Emirates and Nigeria and are tagged worst countries for gender equality (Sarwar & Nicolai, 2018).

In many nations of the world, gender discrimination is still prevalent in legal systems, politics, and social norms and in education too. Even though SDG5 is specific to gender equality, other SDGs can only be achieved if the socio-political, democratic, and educational needs of women receive the same attention as the needs of men in both public and private sectors, so as to achieve gender equality. Therefore, I concur with scholars who argue that it is difficult to conceptualize about the welfare of the world unless the condition of women is improved for empowerment and economic transformation (Kaur & Sharma, 2019; Mehta & Sharma, 2019).

Achieving gender equality in education and in particular science education will require legislation that promotes the empowerment of all women including boys and girls. It is my opinion that listening to and involving women and girls in the transformative change agenda of the SDGs is vital, if it is to be based on their lived experiences of oppression and domination, as a possibility for critical thinking, change and emancipation. The question then is how girls and boys, men and women and science educators can be consulted and conscientized, then influenced about transformation and ethical positioning, if they are not educated to be aware that they have autonomous power and political agency. This gender consciousness is necessary to disrupt the prevailing gender inequalities that threaten their existence in the social world. Thus, science educators and PST should be viewed not as beneficiaries of change, but as agents of change, to resist taking for granted the oppressive social reality that over the years relegated them to the dark (Goodman, 1988; Parsons & Priola, 2013). More so, engaging women and

girls in the implementation of the SDGs' gender policy is vital. This is because critical thinking, change and transformation for peace, food security, sustainable living and protection of the planet can only take place if women and girls are given the opportunity to interact and narrate their lived experiences. In this way, they can make their contribution to the socio-economic development of the nation through rethinking the gender dynamics embedded in the contradictory and complex education sphere (Arnfred, 2011; Sharp, 2016; Weiler, 2017).

Undoubtedly, society and education are historically and currently gender skewed around the world. For instance, in education, girls and women are under-represented in science courses and career jobs; as a consequence, they represent less than 30% of the world's researchers (Blickenstaff, 2005; Sharp, 2016). This has resultant effects on the identity formation of science education researchers. Teacher identity, research capacity and beliefs about effective teaching depend on pedagogical perceptions, choices that are shaped and transformed through professional work (Blair et al., 2017; Siuty & Education, 2019; Yuan, 2017). In these conditions and contexts, faculty members often stick to tradition-bound teaching identities such as chalk board and teacher centred approaches, which Freire (1973) calls banking concepts of education. This banking idea position teachers with more power, as owners and givers of knowledge, while students are domesticated as recipients and empty vessels who lack access to critical, and constructivist teaching dispositions that could position them as critical thinkers. Therefore, these staff members are unaware of the motivation, interest, democratic ideals and of the capacities of these critical pedagogies that can assist educators during science engagements for promoting learning among diverse and underrepresented students. When departmental discourse and scholarship do not focus on promoting morality, gender equality and good-quality critical teaching approaches, STEM faculties may be ill-equipped to build teaching identities that focus on meeting the needs of all science students. Consequently, STEM faculties might unwarily contribute to the reproduction of gendered patterns such as stereotypes, inequity and discrimination that might affect physical and life science PSTs and, likely, other students' success and survival in the social world. This could inevitably lead to increased oppression and gender divisions, marginalization and gender hierarchy which dichotomises males and females into superior and inferior roles (Kangiwa, 2015; Kreber, 2010).

Gender hierarchy is the expression of a male desire to dominate women, influenced by self-ego and an ideological construct that allows a man to see himself as a stronger sex or personality (Carli & Eagly, 2001; Fox, 2006; N'guessan, 2011). In order to understand how gender

hierarchies are enacted and reproduced in STEM educational settings, researchers argue that, "we have to adopt a form of reflection toward the gender binary, treating it as a useful analytic tool" (Blackmore & Sawers, 2015, p. 25), while also looking at the possibilities to deconstruct and negotiate critically the gendered processes and practices that render gender, power, class and race relations invisible in the society and in education.

Likewise, due to this unawareness to deconstruct and critically examine gender inequality processes and practices, most policies and practices seem designed to put women at a disadvantage in terms of gender equality (Black, 2016). Still are the persistent, national, African, and international concerns about a decline in the number and interest of young students, particularly females, choosing to study science at post–compulsory level and in pursuit of careers in STEM. Some reasons for this decline are the perceptions of scientists held by young students, specifically young women, and science educators' masculine and traditional ideology that influences reproduction and reinforcement of gender stereotypes and inequality in teaching that decrease motivation, self- efficacy and interest (Akinsowon & Osisanwo, 2014; DeWitt et al., 2011). Reproduction of gender stereotypes in this sense means that science educators might bring cultural, political, and religious norms about male and female pre-service teachers to bear in the science classes and text materials, which impact engagement with teaching and learning. At the same time, they try to reinforce and defend their stereotypical actions in the classrooms.

More so, a feminist scholar (Weiler, 2017) reminds us that most feminist research work has been very important but has narrow focus in documenting the biases and distortions of texts and the sexism that underlie such teaching and research practices – for example, in career counselling for boys and girls**.** Such research has tended to ignore the depth of sexism in power relationship and the relationships between gender ideology, class, and patriarchy. Weiler (2017) argues that liberal feminism in highlighting power differentials with regard class males and females, fails to account properly for class analysis in two perspectives: first, it ignores the differences and contradictions that exist between middle-class and working-class women and girls. Second, it does not account for the oppression and exploitation of working-class boys termed "equal oppression" (Weiler, 2017, p. 273). Equal oppression in this context means that both female pre-service teachers and male pre-service teachers are marginalized and subjugated in the school environments. In this sense, they work towards achieving low paid or unpaid jobs which could further oppress and dominate them. Thus, challenging and appropriating critical

feminist approach linked to counter-hegemony that could liberate them then, opens the opportunity for shifts in everyday speech and practice.

These paradigm stances, when applied in education and the social world, likely could subvert or challenge the taken-for-granted knowledge and structures that legitimate social inequity. Scholars suggest that interrogating the dynamics of gender inequality is to engage teachers in critical reflection through developing a transformative praxis about their identities and through constructing activist teaching identities. This, along with enhancing pedagogical skills and strategies to meet the needs of diverse students, is central to promoting inclusive teaching and learning. Thus, challenging systemic gender stereotypes and inequality in education and since gender ideology influences what goes on in the schooling process, politics and the social culture (Moletsane & Reddy, 2011).

Due to lack of consensus on the conceptualisation of the construct *gender*, there exist conflicting voices on how this term is constructed socially. In diverse contexts it is often interchangeably used in physical and life sciences classes and in text materials with the term 'sex'. It seems that these concepts are not properly understood by policy makers, curriculum planners, researchers, and science educators. The categorisation of constructs such as gender, class, race, nationality, knowledge, are perceived as truth but are socially constructed and may be reproduced in any social environment. Hence, as gender is a socially positioned construct, it may be reproduced and subverted or challenged (Haslanger, 2017; Morrell, Epstein, Unterhalter, Bhana, & Moletsane, 2009). Furthermore, due to the misconceptions of gender ideology, the society we live in is culturally, religiously, politically, and socio-economically skewed against women and the disadvantaged. Hence, females are perceived as subordinate and inferior beings and are relegated to the background. Thus, women are marginalized and under-represented in science courses and careers due to the 'leaky pipeline' phenomenon that prevents or limits female secondary school students from accessing university. This leaky pipeline could be gender stereotypes that can perpetuate inequality in physical and life sciences across the years in colleges of education and universities, resulting in high drop-out rates (Blickenstaff, 2005; Repetti & Hoffman, 2018). A study conducted across 66 nations strongly associated science with men more than with women. These gender-science stereotypes and inequality present concerns for science educators and students, to the extent that these associations affect the experiences of women and men, boys and girls studying science courses and even in their career jobs. This leaky pipeline causes a negative attitude of female students

towards science because of the cultural reproduction of gender discrimination (Blickenstaff, 2005; Good, Rattan, & Dweck, 2012; Miller, Eagly, & Linn, 2015). The resulting demotivating attitude of students towards science could be researched through narrative insights embedded within quantitative and qualitative research.

Narrative data captures powerful messages and can account for the lived experiences of the marginalized. It can provide a nuanced understanding of the reproduction and subversion of gender stereotyping and on the impact on female PSTs' oppression and subordination, as discussed earlier. Thus, the research on narrative data that focuses on science educators' lived experiences or realities from their own perspectives could re-awaken science educators' consciousness of gender dynamics that highlight experiences of oppression and subordination (Connelly & Clandinin, 1990; Essien-Wood, 2010; Harfitt, 2017). In support, Clandinin, Caine, and Lessard (2018) argue that narrative inquiry foregrounds the telling of stories as a way of giving and exploring meanings of an individual's experiences. Therefore, the narration method was used in this study. The selected six participants, through questionnaires, interviews, classroom observations, reflective journals, and collective journals narrated their experiences in the physical and life science classes as they engaged with PST in a college of education in Nigeria.

The narrative experiences of science educators were necessary because they allow for a nuanced understanding of educators' beliefs and views about gender stereotype reproduction and subversion. Most of the previous gender research conducted in Nigeria utilised quantitative methods that focused on underachievement, enrolment, participation, and performance of average scores of male and female students, particularly pre-service teachers in physical and life sciences (Akinsowon & Osisanwo, 2014; Jacob, Ighodalo, Justine, & Oteh, 2012). For example, Josiah (2013), using a questionnaire, argues that there is persistent underachievement and representation of females in physics in a Nigerian college of education, while other researchers argue for the lack of participation and performance of females in science subjects in universities and colleges of education in Nigeria by relying on quantitative knowledge generation. These data do not provide rich descriptions of the interwoven gender ideology, sexuality, and power relations to highlight the gender challenges experienced by student and educators. This is because there is no transfer of scientific theory and practical knowledge from academic communities, specifically colleges of education and universities, to society (Apple, 1995; Ekine, 2013; Kola & Taiwo, 2014). Schober, Brandt, Kollmayer, and Spiel (2016, p. 3)

express the chasm thus, “educational research is still trapped in the so-called *ivory tower*, which symbolizes the perceived detachment of universities from the real needs of real people in a real world.” From my literature study, none of the feminist scholars in Nigeria had researched the reproduction and subversion of gender stereotyping in physical and life sciences with regard to qualitative study and the lived experiences of science educators.

Therefore, I explored the reproduction and subversion of gender stereotyping by engaging science educators with the dynamics of historical, cultural, and power relations that underlie gender oppression and subordination. The limited knowledge from research of reproduction of gender stereotypes influenced by market driven capitalist economic orientations exclude teachers and students from understanding the oppressive practices of marginalization. Gender inequality has further devalued females’ traditional traits such as weak, submissive, and passive due to entrenched ignorance and silences that perpetuate and re-enforce gender inequality in science education. In this sense, in the North Korean government critique a non-democratic institution and lack of human rights is possibly convinced on the impacts of capitalist moral and dominant oppressive ideology. This public awareness on discriminatory practices and ethics happened when it places ban on copying capitalist lifestyle of hair dressing, nose piercing and wearing skinny jeans in the country that likely impact on the country’s moral ideals. As Kim Jong President’s comment was reported by Bamidele:

> “We must be wary of even the capitalist lifestyle and fight to get rid of the practices ” (Bamidele, 2021, p. 2).

Probably the North Korean government with ethical orientations is subverting stereotypic gender practices that could likely oppress and subordinate females in the country which may be infiltrated into education sphere if not challenged.

The context for this study is North-Central Nigeria and is the geographical area identified for this study. This study was confined to a specific college of education. It is anticipated that the findings of this study will be relevant to education and science education in highlighting issues emerging on gender discrimination.

1.3 PROBLEM STATEMENT

Due to socialization and stereotyping, women are marginalized and underrepresented in higher physical and life sciences classes and in careers. Thus, the number of female students in science,

particularly pre-service teachers in colleges of education and universities, in Nigeria and other parts of the world, is substantially less than the number of male students (Olasehinde & Olatoye, 2014). While females contribute up to 46% of the work force in education, only 22% of the work force in science fields are females. This may be partly due to physical and life sciences educators entrenched culturally stereotyped teaching practices. Such practices probably demotivate girls from studying science and from achieving in the economy. Thus, this study aims to explore science educators' experiences of how and why they consciously and unconsciously engage in reproduction and subversion of gender stereotyping in science education classrooms. It links to why female students 'leak' away from the science endeavour and lag behind in education, the economic sector, and in politics. Therefore, utilising questionnaires, classroom observations, interviews, reflective journals and collective journals, the study needs to provide a nuanced account of the gendered experience of science educators.

1.4 RATIONALE FOR THE STUDY

This study is relevant to the researcher personally and to science education practitioners generally. This is because as a male science educator I perceived over the years from my own schooling and education that in Nigeria, as elsewhere, gender stereotypes and inequality are still persistent in secondary schools, colleges of education, universities and in workplaces. Consequently, females are still quite under-represented, subjugated, discriminated against in science and other career fields (Odejide, 2003). With my own ingrained and skewed lens of gender experiences in science classrooms, I discovered quite late that stereotyped thinking and behaviour impact the learning and performance of female students. This is because some science educators tend to favour male over female students consciously or unconsciously during classroom interactions. This attitude may have lowered women's performance, decrease their interest, disrupt their critical thinking and impair their self-concept and motivation in physical and life sciences.

From my personal experiences of 21 years as a science educator, after some reflection I realised that I sometimes consciously and unconsciously assigned male students with difficult tasks such as carrying heavy laboratory equipment and chemicals to storerooms, dictating lectures notes, intellectual and leadership tasks, etc., while I assigned female students simple and labour-intensive tasks to do, for example, washing of laboratory curtains and test tubes. The reason was that I perceived male PST to be physically stronger and more intelligent than female pre-

service teachers. Even during group activities, I often assigned boys to head group activities such as problem solving, to head leadership responsibilities during group work, to be class monitors or prefects, and to join science clubs while females took on more mundane tasks, mostly as subordinates. In addition, females were never supported to become presidents of departmental and school associations and in leading as president of the students' union government (SUG), a larger student body. My socio-culturally gendered beliefs, emanating largely from my religious, home and community environments, stuck with me right throughout my career. Only when I began my PhD studies and reflected on gender inequality in my college, did I begin to transform my skewed perceptions of gender. These reflections encouraged me to find out why gender discrimination is so pervasive in colleges of education in Nigeria as well. My perception is that conducting this research will assist me to listen, understand and learn how and why science educators make sense of their lived experiences from childhood education to tertiary education. More specifically, it will explore how physical and life science educators make sense of the nature or forms of gender stereotypes and how and why gender stereotypes might be reproduced and subverted or resisted in colleges of education in Nigeria. In doing so, my study will perhaps create deeper awareness and evoke a transformed level of consciousness of training on teacher education about gender issues and how to deliver a curriculum challenging sexist and gender notions.

Colleges, science educators and their students are seen as agents that can resist, change, and transform societal practices and beliefs that still reinforce gender stereotypes and inequalities in schools and communities. However, these same colleges of education, schools and science teachers continue to create and perpetuate discrimination and inequalities. Science educators are also implicated because they also reproduce discriminatory practices in the form of gender stereotypes and inequalities during classroom engagement, consciously and unconsciously. Students also bring their diverse social and religious beliefs about gender stereotypes into classrooms and college of education that educators may not take into awareness (Mdlolo, 2017; Wood, 2019; Zuze & Beku, 2019). Students display typical patterns of behaviour that their parents treat one another at home and in the society. For example, the father is generally considered the head and the only voice to be heard in the family when it comes to decision making, so the parents and educators with patriarchal consciousness believe that a boy ought to be treated the same way in the classroom. Therefore, consciously or unconsciously sometime, male pre-service teachers and science educators reinforce and perpetuate gender

stereotypes and inequality against female pre- service teachers in the college of education through acts of collusion. This is because educators allow male pre-service teachers the opportunity to lead and control group activities in classrooms, even if female students are more capable and hardworking. These boys grow up in an environment that favours male dominance and as a result, they tend to dominate in the science classrooms (Mdlolo, 2017; Motsa & Morojele, 2017).

The education system has an important role to play in addressing gender stereotypes, inequality, and dominance in relation to science educators. Science educators are key stakeholders in the teaching and learning of science, and as such, their positive perceptions, views and understandings of gender awareness and equality in science education can provide the first step in addressing gender stereotypes in science education. Science educators' negative perceptions, views, and lack of understandings of gender stereotyping in science classes and in text materials will continue to pose serious challenges for the representation and career choice of females in science and science education. This is because written, media texts and audio-visual messages reinforce masculine and dominant ideologies that may be unconscious to science educators and students. Often, curricula contents, written and oral, and stories about men and women have profound impact on educators and students' memories and awareness that might be difficult to unlearn. Thus, educators with a lack of a nuanced understanding of gender stereotypes and the potentially oppressive mechanisms of learning materials and classroom practices socialize students into different roles in classrooms. Quite blatantly, African men and women are often negatively illustrated in science teaching materials and are stratified into roles differentials, reinforcing gender stereotypes in education and in the social spaces (Chikunda, 2010; Mahlomaholo, 2011; Mustapha, 2012).

The evidence from the few available studies reveals that science educators have little awareness of gender issues and do not have a significant understanding of reproduction and subversion of gender stereotyping in science classes to support due to complexity of gender relations (Chikunda, 2010; Omirin and Adewumi, 2022). Therefore, more critical awareness and exposure to effect change and transformation, and theorising of gender discrimination practices must be created to support them in addressing the issue of gender stereotypes and the power dynamics that maintain gender practices in classrooms. In this regard, science educators could be capacitated to improve and transform their beliefs systems and the way they interact with pre-service teachers in classrooms, with the aim of reducing or eliminating tendencies of

reinforcing and reproducing gender stereotypes, and inequalities. This study will thus contribute to creating critical awareness on reproduction and subversion of gender stereotype in education that could allow for equity, political and transformative agents in science education in Nigeria. In addition, relevant stakeholders could use the knowledge generated to develop strategies, teacher professional development initiatives and intervention programmes that can effectively address the gender issues in science education.

Mdlolo (2017) claims that there is little research conducted on teachers and students' perspectives on gender stereotype, reproduction and power relations embedded inside science classrooms practices and in the school environment. More so**,** limited research is available on pre-service teachers and science educators with regard to the reproduction of gender stereotypes and the resistance linked to power relations, as these issues impact on performance, motivation, and enrolment of students (Gul, Khan, Mughal, Rehman, & Saif, 2012; Kambouri-Danos & Evans, 2019). There is limited current research on how science educators' professional and personal identities intersect and impact on teaching and learning linked to gender stereotypes and the cultural reproduction of power (Blair et al., 2017). There are though several studies that have been conducted to explore the beliefs and understanding of science educators about gender stereotypes, and inequality in science education (Taiwo, 2017; Chikunda, 2010; Molestane & Reddy, 2011). These have mostly been conducted with primary school teachers and pre-service teachers in colleges of education; the prevailing focus though is on students' performances rather than on the power relations, patriarchy and heterosexism that influence colleges of education settings (Josiah, 2013; Kola & Taiwo, 2014).

Thus, the rationale for the study is the scarcity of research on gender stereotypes and socio-cultural reproductions with regards to Nigerian educational contexts for science educators and pre-service teachers. A gender conscious teaching practice, linked to political and democratic tenets in social environments, will encourage a gender inclusive learning atmosphere that will promote equal participation between male and female educators and students (Specht et al., 2016). This study thus addresses science educators and PST to interrogate the dynamics of gender stereotypes and reproduction and the effects on teaching and learning of physical science and life science at college of education and university education. Therefore, the focus of this study is on science educators who engage pre-service teachers (PST) with science pedagogical content knowledge (PCK) to be future science teachers at secondary schools. In

time, some of these PSTs will develop to become critical science educators at tertiary institutions of learning in Nigeria and globally.

1.5 RESEARCH QUESTIONS

The study sought to address the key issues emerging from the following:

1. What is the nature of Nigerian science educators' reproduction and subversion of gender stereotype beliefs and views?

2. How do Nigerian science educators reproduce and subvert gender stereotype beliefs and views?

3. Why do Nigerian science educators reproduce and subvert gender stereotype beliefs and views in the way they do?

1.6 METHODOLOGICAL APPROACH

This study is located within the critical interpretive paradigm and uses a descriptive questionnaire with narrative insights and qualitative approach. Data were collected using questionnaire, classroom observations interviews, reflective journals and collective journals. This study applied the purposive sampling and convenience sampling techniques. The study focused on six science educators, using questionnaire, interviews classroom observations, reflective journals and collective journals to explore their beliefs, views and understandings about reproduction and subversion of gender stereotyping in teaching biology, chemistry and physics in a college of education in Nigeria.

The approach to the methodology and research processes are discussed in detail and in-depth in the methodological chapter. Ethical issues are addressed fully as well. The section concludes with the data analysis through descriptive analysis, thematic analysis of coding and categorisation. This process enabled the findings of the research to be linked to research theory, questions, and related literature.

1.7 THE STRUCTURE OF THE THESIS

This section briefly highlights each chapter of the thesis:

Chapter 1: Introduction to the Study. The aim of this chapter is to describe the focus and the purpose of the study. Firstly, an introduction is presented, then the description of background,

context, focus, rationale, and problem statement to the study are presented. Research questions and objectives are stated. The chapter ends with a summary of the structure of the thesis and the contents of each of the chapters.

Chapter 2: Literature Review. In this chapter, both theoretical and empirical studies relevant to the study are reviewed. The literature review is done in the following sequence: theorising the concepts, such feminism, gender stereotypes, reproduction, and subversion, understanding gender stereotypes, reproduction, and subversion in science classes, science educators' reproduction and subversion of gender stereotypes in science classes. This was followed by an exploration of gender, science and society, correspondence theory and neoliberalism. Then accounts of teacher education, professionalism and identity are discussed critically.

Chapter 3: Theoretical Framework. This chapter focuses on the theoretical framing undergirding this study, which are critical theory and critical feminist theory, while critical consciousness theory provides an additional lens for the study. Herein, the relevance of each perspective to the study is discussed.

Chapter 4: Research Design and Methodology. The aim of this chapter is to present a description of the methodology employed in the study. The study employed the critical interpretive paradigm, descriptive questionnaire, a qualitative approach and a purposive sampling technique as well. Questionnaires, classroom observations and semi-structured interviews were used for data production. The study sample participants comprised six science educators, two females and four males. The rationale behind participants' selection is described. This is followed by a description of ethical procedures used in the study. Measures used to prevent or reduce bias, and to increase data trustworthiness, validity and credibility are explained. The strengths and limitations of the study are also stated.

Chapter 5: Qualitative Data Analysis. The research data and findings are presented. The research findings are based on analysis of data from the questionnaires, lesson observation and qualitative data. The findings from the questionnaires are presented through descriptive analysis. A Likert scale was used for tables followed by inferences, deduction, summary, and findings. Qualitative data was analyzed systematically using thematic content/data analysis to establish patterns, codes, and categories, from which themes were then be identified. The findings of the study were interpreted, discussed, and compared in the light of the findings of previous studies, which are reviewed theoretically and empirically related to the current study.

Chapter 6: Discussion on Theoretical Perspectives, and on Assertions Regarding Production and Reproduction. Discussion takes place on the theoretical perspectives, production and reproduction assertions generated. In this chapter, the underpinning theories and perspective are discussed to illuminate further critical feminist reproduction theory and the study.

Chapter 7: Implications emerging from findings, assertions and discussions are presented and accounted for. The findings generated from the data production are presented linked to the three research questions. That is, the nature of gender stereotyping, how science educators reproduced gender stereotypes and why they do what they do in physical and life sciences classrooms in the college of education in Nigeria.

Chapter 8: Summary of findings, conclusions, recommendations, contributions to knowledge, limitations, and personal journey are provided herein.

CHAPTER 2
REVIEW OF RELATED LITERATURE

INTRODUCTION

In chapter one, I introduced the study topic and discussed the background, context, and problem statement. The rationale for the study and the focus of the study were provided. The research questions and an account of methodological approach were also given. I then included the structure of the thesis to guide readers.

In this chapter, I review literature on the concepts of feminism, gender stereotypes reproduction and subversion. I also discuss the reproduction of gender stereotypes and subversion in science classes including the concepts hegemony and masculinity, then corresponding theory linked to power and oppression in education. Next, I discuss socialization process and neoliberalism in education, to illuminate economic and educational oppressive practices against women. I discuss gender power and schooling linked to inequality of females in education and specifically science education. Furthermore, I focus on feminist resistance as cultural reproduction, feminist teaching as counter-hegemony and effects of gender stereotypes, then discourse on teacher education and professional development. The chapter concludes with a section on teachers as transforming agents in schools and colleges.

2.1 UNDERSTANDING FEMINISM CONCEPTS

2.1.1 Feminism

The term ‘feminism’ is conceptualised by feminists to drive home their goals of primary importance as entailing basic human rights, the achievement by women of equal access to resources, individual autonomy, economic and political power in society, as well as making these goals feasible and achievable (Agassi, 1989; Butler, 2011; Lachover, 2020). The disregard for women, underrepresentation, and falsification of women through stereotypes that portray them as inferior, subordinate, second class citizens and voiceless objects, triggered women around the late nineteenth century to stand up against injustices and enacted political and democratic struggle in the social space, to gain control of their lives for liberation (Cameron, 2017; Öztop Haner, 2017).

I concur with Freire, who comments that:

> While no woman will liberate herself by own efforts, neither is she liberated by others alone (Freire, 1970, p. 66).

Drawing from the above, I believe change, liberation and transformation are likely possible through collaborative, subversive, political and democratic conscious movements. The aim of feminism is to disrupt the inequity and inequality enacted as false consciousness in the social world which serves to dehumanize and undermine women (Giroux, 1983b; Sargis, 2008). Thus, likely due to stereotypic practices and realisation of dehumanization of women in education and the social world led to the conscious pursuance of equal access to resources, economic and political power for change, emancipation and transformation underpin western feminism, global feminism and African feminism, concepts that I elaborate in the next section (Freire, 1973; hooks, 2010; Lachover, 2020).

2.1.2 Global Feminism

Global feminism is a feminist theory closely aligned with the post-colonial theory of liberation and postcolonial feminism. It concerns primarily the forward movement of women's rights on a global scale/arena. Thus, perceive all women as females experiencing similar challenges and more or less underscore colonial tendences (Barley, 2008; Moghadam, 2018). Using historical lenses different to those from the legacy of colonialism, global feminists adopt international causes and political movements that seek to dismantle what they argue are the predominant structures of global patriarchy, marginalization, and inequalities. For instance, challenging slavery of Mudejar women in Spain around 1986 to the present. Global feminism is also known as world feminism or international feminism which birthed western feminism (Çağatay, Grown, & Santiago, 1986; Ferree & Tripp, 2006; Moghadam, 2018).

2.1.3 Western Feminism

Western feminism generally refers to white middle-class women who initiated the political struggle for emancipation and were the first to benefit from social change and advanced privilege (Bordo, 2020; Okide, 2021). For example, in UK, Wollstonecraft (1959-1997) advocated for females' education and human rights. This political movement and activism though meant advancement for some women but not for all. It is an exclusive feminist political movement that seems not to accommodate cultural differences of black women who are suppressed, oppressed and marginalized (Barkley, 2008). The increased labour force participation of white middle-class women in the industrial sector has been triggered by the

increased provision outside the home of services formerly provided inside the home such as cleaning, food, health, and personal services. These menial jobs are disproportionately filled by women of colour, that is, African American, Latina, Asian (Barkley, 2009; Okide, 2021). Western feminism may not even include all women who live in the United States. Undoubtedly, has focused on equality of opportunities such as right to work, earn wage and hold equal seats in political, educational and economic leadership as reasons for the struggle and emancipation. Of course, some critics have pointed to this exclusiveness as a way of distancing the relationships between women of different backgrounds even further. This disparity of experiences has led to a flawed discourse in women's studies because there is an inherent racism in the way American culture operates. In this regard, Barkley remarks:

> We are likely to acknowledge that white middle-class women have had a different experience from African American, Latina, Asian American, and Native American women; but the fact that these histories exist simultaneously, in dialogue with each other, is seldom apparent in the studies we do. The overwhelming tendency now is to acknowledge and then ignore differences among women. The effect of this is that acknowledging difference becomes a way of reinforcing the notion that the experiences of white middle-class women are the norms; all others become deviant (Barkley, 2009, p. 33).

Barkley (2009) here emphasises the disparities between women created by advancement for only the elite White women within the United States. According to Bordo (2020), Western feminism is limited in its scope and value because it is based on a notion of equal opportunity that does not adequately take into account the cultural gender diversity of women and its implication for the empowerment of men and women. In addition, it intended to end domination within Western cultures only and seem not to emphasize on complementary feminism.

Western feminism may also be understood in terms of the following three waves of feminist struggle to help highlight the history, crises, and interrogation of feminism internationally and locally. These are discussed as follows.

2.1.4 1st Wave Feminism

First-wave feminism originated in the late nineteenth century, it arose as a movement among white, middle-class women in the global North who were reasonably well-off and had access to resources and education. The middle-class women stereotype women of colour who question

the idea of essentialism promoted by white middle-class females. It was distinguished by women of colour challenging white feminist assumptions on the primacy of sexism. Thus, the first wave of feminism almost exclusively addressed the issues of these women who were of 'high-society'. Of note, the first wave focused on absolute rights such as suffrage and overturning other barriers to legal gender equality, voting and reproductive rights. Scholars argue that it did not include the realities of women of colour, who felt the pressure of racial and class oppression or of being economically disadvantaged and were forced out of the home into domestic jobs catering for white women needs (Dixon, 2011; Gurel, 2009).

2.1.5 2nd Wave Feminism

The second wave of feminism is characterized by the international elements of feminism and culminated with the first UN Decade of Women (1975-1985), which emphasised the divide between western and non-western feminism. Second-wave feminism inspired women to look at the sexist power and political struggles that existed within their personal lives and broadened the conversation to include issues within the workplace, sexuality, gender, family, and reproductive rights. Feminist theory during the first century of feminism had failed to account for differences between women in terms of race, class, and power. It still overly reflected the interests of the white western women who started the movement and within the last twenty years, postcolonial feminism emerged (Baxandall & Gordon, 2002; Gurel, 2009; Molony, 2017).

2.1.6 3rd Wave Feminism

The third wave of feminism is driven by women from third world countries who criticize the largely western assumptions that the essence of being female is enough to unite women globally. Due to the cultural and socio-economic divide between western women and women from developing countries, hence 'Transnational feminism' was developed as a feminism that strives to organize around issues of oppression and dehumanisation (Gurel, 2009 p. 5). This encouraged complex analyses of how gender and sexuality intersect with other sites of power, class, and race, and support local actors of women and students. However, one must not forget that feminism continues to be non-monolithic, contentious and in flux, that is, it is based on small but significant groups with diverse views coming together to be heard and to challenge accepted social norms that marginalize them (Gurel, 2019) .

Third wave feminism, in conjunction with many other feminist movements from Latin America and Asia reflect the diverse nature of woman's lived experience, individuals or in groups. In efforts to move away from 'grand narratives or fixed norms derived from globalisation; postcolonial theory was formed as a scholarly critique of colonial discourse. By acknowledging the differences among diverse groups of women, postcolonial feminism addresses what some call the oversimplification of Western feminism as solely a resistance against sexist oppression. Postcolonial feminism, in contrast, also relates gender issues to other spheres of influence within society (Dixon, 2011; Lather, 1995).

Third world feminism is an intriguing concept that appears to be driving more significant change globally than Western feminism ever could. This is because it addresses the needs of women who are not represented in the global scene. Third world feminists take a radical approach that refutes the idea of a universal experience for all women. Females have lived experiences of oppression differently, hence their understanding of the social world differs. While calling for attention to the hybridity and multiplicity of experiences and identities, third world feminists also embraced the diversity and differences in perspective among women. Acknowledging the necessity to recognise multiple sources of domination in women's lives, they questioned the universalisation of women's experience and recognised instead the differences among women from different social locations. Considering many differences that make up the category 'women' thus allows feminism to focus more adequately with the complex and many issues we face today. This different approach is necessary because Western feminism ignores the realities of women who are being confronted with diversities of values, religion, and cultures. Thus, western approaches have been criticized for overemphasizing western women's essential attributes which could be transformed into single indivisible force for change, despite religious and contextual differences. For many African women, religious and socio-cultural values are just as important as feminist ones, so they must find a balance between the two that works in their own culture to embrace both Western and African feminism for peaceful co-existence, harmony and social justice (Curtis & Cardo, 2018; Yu, 2009).

2.1.7 4th Wave Feminism

The fourth wave of feminism is a new model of feminist consciousness that is birthed or reproduced because of the resurgence and replication of continued oppressive systems and attacks on women's right all over the world, for example, the pervasive messages and images that permeate social media globally. Although there are equity efforts by governments and

institutions globally, research indicates that a lot of people still stereotype feminist movements, negating the potential for powerful and re-energized political struggles that likely could drive emancipation of women in the world (Hazrati, 2020).

However, the arrival of fourth wave feminism was undergirded by a political shift in Britain's political landscape, characterized by economic recession, austerity, riots, and political violence. Both men and women began to heighten political awareness and social movement to free themselves from all forms of oppression. This triggered women consciousness to analyse and interrogate their lived gendered experiences in the form of domestic violence, rise in sexism, mental health challenges amongst women and men, including women's financial insecurity that threaten their existence (Chamberlain, 2017a, 2017b). Thus, this wave of feminism aligns with the technological age in the form of print, news, and social media for activism. Fourth wave feminists embrace socio-political inclusivity, using internet to ask questions about what empowerment, equality and freedom really mean as they relate to women's education and work. This is also a movement that contradict the neoliberalist agenda of individualism and free market consciousness that coerce and oppress women. This the activists do by taking to social media to mention and disgrace persons and institutions that cause harm or dehumanizes women in institution and the social world.

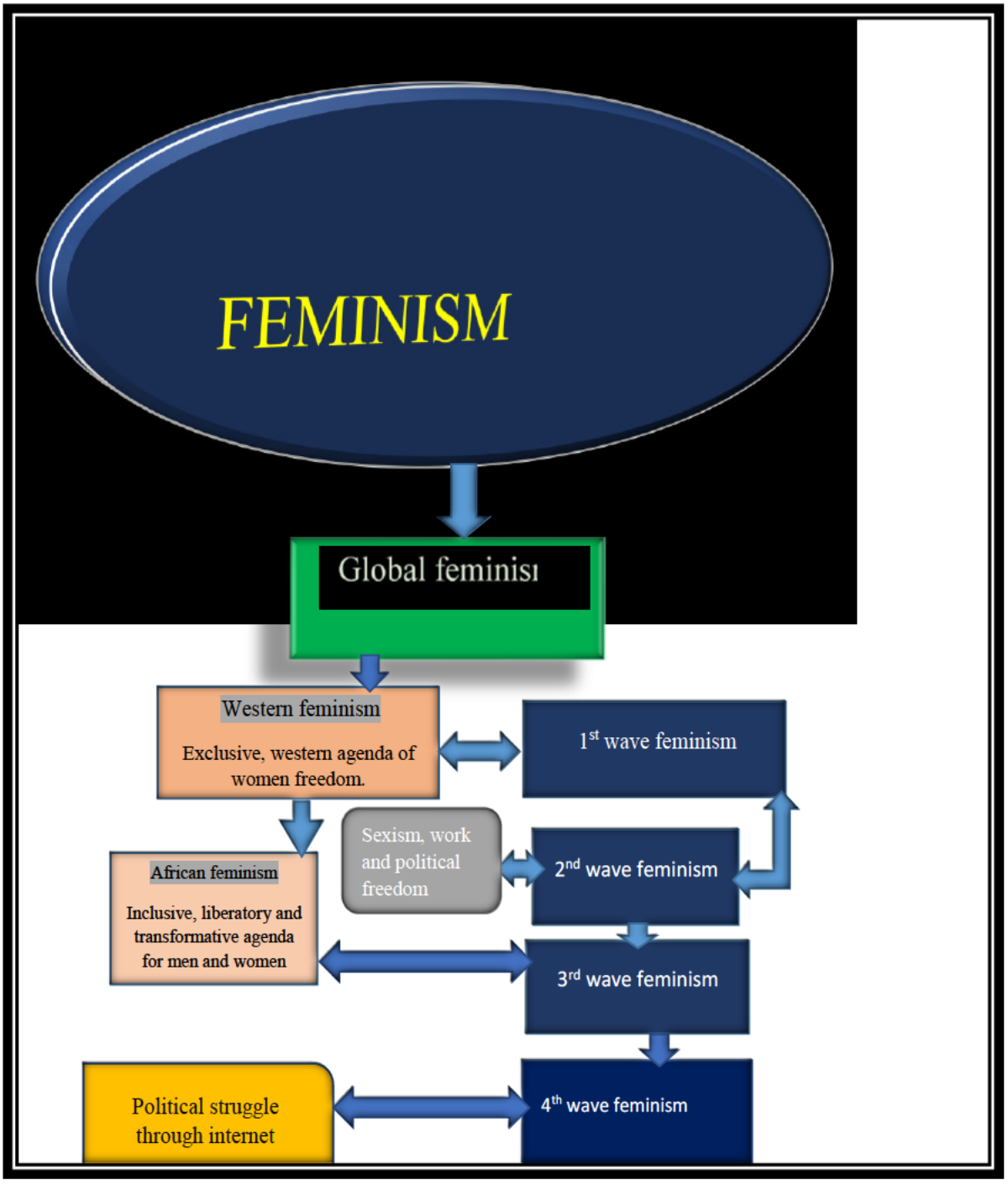
The multiple voices of common goals could present the possibility for an inclusive, successful agenda for equality, peace, and prosperity in a social justice environment. This could empower feminists and women to overturn the conventional capitalist logic that is positioned to disempower women, who for instance, are desperate for paid jobs for survival (Blevins, Sauerwald, Hoobler, & Robertson, 2019; Hazrati, 2020). African feminism which is based on reformation of women gender experiences and rejection of discrimination is explored further as follows.

2.1.8 African Feminism

African feminism emerges due to critical reflection on the ways in which oppressive political philosophies and regime of gender sexuality facilitate the exploitation of African females. Thus, based on humane reformation and rejection of separatism model of discrimination and stereotyping against African women (Byrne, 2020; Mekgwe, 2008; hooks, 2010). African feminism is defined by Mekgwe (2008) as a discourse that takes care to describe those concerns peculiar to the African situation. It is inclusive female struggle that seem to respect cultural

differences, diversity of black African females, and focuses on positive change, love and transformation of oppressed societies. Africa feminism is for everybody, and visionary feminism is politics rooted in the love of male and female being, refusing to privilege one over the other. Love cannot exist in any relationship that is based on domination and coercion. Thus, men and women cannot love themselves in a patriarchal culture if their self-definition and confidence rely on submission to patriarchal rules that pervert their humanity and existence. For instance, African women's writing when it emerged in the 1970s mainly set out to dispel the mal-representations and dehumanisation of African womanhood that typified literature written by westerners at that time. African feminist practitioners, in writing and in activism, sought to disrupt and demonstrate that they were relevant to the African context and that they did not simply seek to emulate their western feminist counterparts (Coetzee, 2017; hooks, 2010; Mekgwe, 2008). Further, African feminism, both as an activist movement and as a body of ideas, underlines the need for an inclusivity, liberation and positive transformation of society, such that women are not oppressed and marginalized but are treated as full citizens with equal rights in all spheres of life. It can then be thought of as a belief system that emerges as a result of racial discrimination against women of colour such as African females. Thus, struggled to end domination in all its guises, and then liberates people so that they can develop their potential and attain best lives. This liberation, in turn, leads to larger change and social transformation. Thus, in African culture, the gender equality struggle emphasizes the necessary complementarity rather than the conflict that exists between African men and women. Furthermore, researchers elaborate that what affects a woman has impact also on a man is the principle embedded in African feminism (hooks, 2010; Schuster, 2017). Interestingly, I perceive that the movement seems to respect and value men in the society and then encourages men to contribute to the gender equality struggle to liberate individuals such as females who are marginalized. Thus, attempts to end forms of domination and discriminations in diverse cultures and context through complementary feminism. In addition, this body encourages technological apparatuses, media, gender discourse, activism, workshops and community engagements to create awareness on domination and inequality. Next is a figure showing patterns and feature of feminism.

Figure 2.1 Model Depicting the Historical Patterns and Features of Feminism



Though feminism a global movement is vital in promoting political awareness for emancipation, transformation of women and discriminated individuals, Western feminism focuses on liberation of women in the global arena neglecting African women who were subordinated and marginalized.

From the foregoing historical pattern, it is evident that feminism is a political and democratic movement aimed at gaining access to different political and economic resources through drastic or subtle power struggle for the benefit of women and men in the society for peace and transformation. However, women do not want to work in a patriarchal society enacted and perpetrated by men. Therefore, there is a still a lot to be done if equality and equity in access, enrolment, participation of females in science and science education need be achieved in Africa and the world over. Men and women, boys and girls would like to work in a non-patriarchal societies, free from domination, marginalization and coercion, hence there should be a push towards the concept of virtual global feminism called inclusive complementary feminism movement (Dore, 2020; Zack, 2005**).** This space is where both men and women, male and female students and teachers, in diverse contexts, could express their opinions and take political action on issues concerning gender inequality, inequity, reproduction, and the subversion of gender stereotyping. This will create broader awareness and address the decline in enrolment, motivation and interest of females in science courses, career jobs and social spaces. Complementary feminism can proffer remedial approaches to enhance gender equity and equality globally and locally in line with United Nations Sustainable Development Goal 5.

The researcher observed that western feminism in its attempt to liberate women generally and particularly the whites, promoted forms of racial, gender, and class stereotypes (Barkley & Major, 2020). This is because the western feminism attempted to favour only white middle-class and working-class western women, neglecting the lived experiences and cultural diversities of African American, Asian and Latina women and those in developing countries. The goal of Western feminism, underpinned by women rights movements due to lack of

awareness about the complexities of discriminations and oppressions women experienced in the social world., is different from African feminism discourses which aim at positive transformation of the society by embracing lived and diverse cultural experiences of African men and women through love and complementary efforts. African feminism will more likely free individuals such as educators and students to develop their full potential in science and science education for the socio-economic development of the society. All these feminist struggles for equality are underpinned by differential socialization of individuals and influence of gender and sex orientations in the gendered social world (Barkley & Major, 2020). Next is the understanding of the concepts gender and sex, gender stereotype reproduction and subversion.

2.2 UNDERSTANDING GENDER AND SEX, GENDER STEREOTYPE, REPRODUCTION AND SUBVERSION CONCEPTS

2.2.1 Gender and Sex

The concept gender is not a fixed idea, because varied conceptual approaches of gender exist, possibly due to its different meanings attached in different societies. That is, there are different meanings for the word given by different media writers and researchers, and it can be 'fluid' (Morrell et al., 2009). Gender as a concept is sometimes hard to understand; what it means, and how it differs from the closely related term sex. To avoid the existing confusion between these two polarized terms, WHO (2016, p. 22) states that sex refers to the biological and physiological characteristics that defines men and women whereas gender is considered as the socially constructed roles, behaviours, activities, and attributes that a given society deems appropriate for men and women. Ryle (2011) asserts that sex is the anatomical and physiological attributes associated with femaleness and maleness. Nobelius (2014) refers to sex as biological differences, chromosomes, hormonal profiles, internal and external sex organs while gender describes the characteristics that society or culture delineates as masculine or feminine. For example, Man = male sex + male social role and Woman = female sex + feminine social role.

Scholars view the idea that gender is always a concern for females because, girls suffer more discrimination and violence than boys (Morrell et al., 2009). They rather perceive it as a relational concept that binds boys and girls, men, and women together in a condition marked by inequalities in power. Gender is thus, a multi-dimensional concept

that intersects with social divisions such as race, class, and ethnicity and that includes agency and identity (Mihalcea & Garimella, 2016; Morrell et al., 2009). Paechter (2003) also sees it as an identity that is constructed through time, rather than a stable identity. Gender is therefore not a fixed biological trait inherent in an individual but a social construct that is learned and that gives men more access to freedom, opportunities, and resources to develop their potential than women. For example, a traditional African society may expect females to put dresses, kneel while serving men with food and do most of the household chores, whereas, men are expected to wear long or short trousers, pay bride wealth (lobola in Southern Africa) for a wife and to perform hard-manual work to get food, shelter, safety, and security for the entire family. Gender is also seen as the practices that constitute masculinity and femininity and the hierarchical division of roles in social institutions and social identity (Butler, 2011; Moradi, 2019; Nicholson, 1994). More recently, gender has been defined as the axis of power, political masculinity and social autonomy underpinned by gender stereotypes reproduction (Mariano & de Souza, 2020; Ozbay & Soybakis, 2020; Sobieraj & Krämer, 2020).

2.2.2 Gender Stereotypes

Gender stereotyping could mean positive and negative discriminations. Positive gender stereotyping connotes positive messages- *favourable beliefs that motivate a group.* For instance, Asians have high intelligent quotients (IQs), all Canadians are exceptionally polite, males likely have "intellectually ability" to do science than females, and Whites are successful (Strand, 2000 p. 5). Negative gender stereotyping denote-*action and beliefs that involves discrimination and bias* in assigning roles to female and males in the society (Ellemers, 2018). For example, all librarians are women who are old, wear glasses, tie a high bun, and have a perpetual frown on their face, all politicians are philandering and think only of personal gains and benefits. Women who smoke and drink do not behave well (Strand, 2000). Gender stereotypes influence society to avoid, restrict or make difficult the development of men's and women's potential. Stereotype Threat Theory (STT) explains achievement differentials in mathematics and science for women, men, and minority students. Stereotype threat theorists posit that the risk of confirming a negative stereotype about an individual or group acts as a psychological burden that negatively impacts on performance (Sunny, Taasoobshirazi, Clark, & Marchand, 2017). Pavlova, Weber, Simoes, and Sokolov (2014) argue that gender stereotype as a construct affects both male and female performance on a variety of cognitive tasks.

Stereotyping affects both females and males, with a more pronounced impact on females, as in the case when given spatial task such as car manoeuvring parking space (Forbes & Schmader, 2010). But it seems strange or odd that an explicit negative message for males elicits a striking deterioration in performance of females. For example, women, on hearing that physics is difficult for men, may likely not chose physics course to study and may perform poorly if chosen (Forbes & Schmader, 2010; Mazerolle, Régner, Rigalleau, & Huguet, 2015). In addition, Mazerolle et al. (2015) posit that a stereotype threat impedes subjective experiences of an individual's memory who are exposed to stereotype context. This is because the strain of being stereotyped affects the cognitive ability of individuals and hence decreases the performance of the group whose gender is being stereotyped (Bordalo, Coffman, Gennaioli, & Shleifer, 2016; Schober et al., 2016).

In providing an explanation, Strand (2000) argues that gender stereotypes serve as shortcuts to processing information. That is, stereotypical information is processed faster (Strand, 2000). Therefore, the information processed could be influenced by gender, class, and racial stereotype threats in the social space and in education. This is likely to have impact on performance and standardized assessment outcomes. It is evident that stereotypes held about people in a particular context may create psychologically threatening situations that could be associated with and trigger fears of confirming judgments about one's group as being either competent or incompetent in each task. This might inhibit participation, learning and performance (Johnson, Barnard-Brak, Saxon, & Johnson, 2012; Steele & Aronson, 1995).

It is vital to add that, due to lack of good understanding of people or countries, we make certain assumptions, sometimes wrong, about individuals, groups, and society. Those coded assumptions are stereotypes that have become common knowledge and are constantly reinforced in multiple but different socio-cultural spaces. Therefore, when we pass judgments on people's identity without knowing their actual situations and challenges, we are stereotyping them. This stereotyping may consist of false assumptions. There are general positive and negative stereotypes that categorise men and women in different communities based on their entrenched practices. People generally stereotype out of bias against a group of people or religion and stereotyping becomes a way of conveying their likes and dislikes. Of course, stereotyping stems from commonly held socio-cultural views about differences of a group of people in the society that were internalised, practised and then translated into a legitimized norm. Norms and views may arise from an incident or false assumption, and then maybe used

to stereotype every member of the community. However, the most common sources are racial stereotypes and gender stereotypes. Race, nationality, gender, and sexual orientation are the powerful elements that influence people to stereotype others. Stereotyping must be avoided in totality as it leads to perceiving and treating groups as a single entity with the same identity, which may be false (Coffman, 2014; Sadiq et al., 2018; Strand, 2000).

Every race, culture, country, religion, and community have some stereotypes. It is a way of oversimplifying groups of people and one of the easiest ways of establishing identity. By conforming to a fixed or conventional image and norm, the identity of people can be recognized and understood easily. It is though hard to be objective if one doesn't reject stereotypical practices. For harmonious living, it is better not to reproduce gender stereotype based on race, class and gender, but it is vital to pass judgments only when you are familiar with others lived experiences, so as reduce reproducing cultural gender stereotypes in the social environment including education (Shih, Pittinsky, & Ho, 2012; Strand, 2000).

2.3 GENDER STEREOTYPES IN EDUCATION

The urgency in promoting gender equality and inclusivity in education as a result of entrenched stereotypes is persistently highlighted in research output, reform documents and policy guidelines. These reform policies and guidelines aimed at disrupting the entrenched gender stereotypes in education and the social world (Koster and Litosseliti, 2021; Mustapha, 2013). Of course, gender stereotype in the social world and education is constructed as the discriminatory practices against males and females. Therefore, in this study gender stereotype pertains to explicit and implicit discriminatory treatment of males and female pre-service teachers in science classes. The discrimination could be subjective, intuition, a prejudice and past negative or positive construction of what an individual has been perceived. Yet, this perception lead people to construct males as being strong, intellectually and emotionally competent and females being warm, recipient, incompetent and passive in the society and in education due to entrenched beliefs and practices (Ifegbesan, 2010). The continuous discrimination and stereotypic practices in the society have reinforced the wide gender gap between males, females and the marginalized (LGBTQIA) in the global environment including Nigeria. However, concerted efforts promised hope for equality and inclusive engagement to reduce all forms of stereotypic practices against females and the marginalized in the social space and education settings. For instance, Convention on the Elimination of all forms of

Discrimination Against Women, 1981; Beijing conference of 1985, Education for All, Millennium Development Goals, MDGs 2000, and Sustainable Development Goals SDG 2016, number five on gender equality could be significant in this context. The disruptive efforts amongst others aim at eliminating gender discrimination were in my opinion vital impetus towards equality, including foregrounded discourse and debates on gender inequality in education. For instance, Koster and Litosseliti (2021), investigated gender and sexuality in Dutch language text books that were published between 1970-2018. The results show that teachers' talk and self-gendered ideologies mostly ignored gender biased representation in texts and practices, thereby limiting their consciousness in subverting gendered texts and beliefs. Also, most teachers in Qatar and Turkey were either unwilling to talk about gender related issues in the classroom or perceived gender stereotypes as irrelevant. In addition, Pawelczyk and Pakula, (2015), conducted a meta-analysis on gender stereotypes and designed activities in text books in Malaysian, Indonesian, Pakistani and Bangladeshi contexts. The comparative study reveal that school textbooks contain discriminatory contents (Islam &Absadulla, 2018; Pawelczyk and Pakula, 2015). In addition, the study reveals elementary classroom teachers in Poland discussing non-gendered texts in a gendered and stereotypic manner (Pawelczyk & Pakula, 2015). Further, Tiano (2012) found that Finnish teachers considered their practices to be gender inclusive and neutral but expressed gender stereotypic views and practices unconsciously. In agreement, Sunderland, et al. (2001) argue that text books do not exist in vacuum, hence investigated gender talk around texts by observing English, German and French language in Greece, Portugal and United Kingdom. Results show that texts and teacher talks were characterized with gendered bias and gender specific beliefs against females. Authors then suggested critical gender response on teacher talk and gender specific texts to avoid reinforcing gender stereotypes which exclude females from educational engagement.

Furthermore, in Africa, Limboro (2014) conducted a study on the influence of teachers' pedagogical gender practices in Nairobi's informal settlement schools. The result show that gender pedagogical practices of teachers marginalize and stereotype female students even further, because the constructed pedagogies were bias in nature including socio-economic and violence space experienced by females. In addition, Muasaya and Kazungu (2018) argue that teachers have limited knowledge on gender responsive pedagogies when teaching males and females thus reproduce and reinforce gender differentials.

In Nigeria, it is quite disturbing that the debates surrounding reproduction of gender stereotype, the subversion of beliefs and practices in science education classes linked to historical, sociocultural, political and economic power are limited. For instance, Ifegbesan studied secondary school teachers' gender stereotypic practices, beliefs perception and student's socialization process in Ogun state Nigeria. The result showed stereotypic beliefs and practices against females in education. Although the study is vital in highlighting gender stereotype beliefs and perception in education, it is limited in focus, by neglecting power relations, sociocultural, patriarchal orientations, curriculum ideology and political stances that reproduce and sustain gender stereotypes beliefs and views for so long. Thereby slowing equity, liberation and transformation consciousness of female students' intellectual progress. Of current, Omirin and Adewumi (2022) also conducted a survey in secondary school in Ekiti-Nigeria on multiple intelligence and performance of female and male students in mathematics. They found that male performed better than females in mathematics test. This, I perceive another binary set or dichotomization of students according to gender achievement. Because, the difference in performance could be historical, socio cultural, economic, political construction and curriculum ideology that over the years denied females achievement due to existential stereotype threat (Bourdieu, 1998; Shor, 2017; Mclaren, 2017; Weller, 2017).

In my view therefore, the global and national researchers who argued for the reformation of gendered texts materials, language, student perception, participation, classroom practices and responsive gender pedagogies though provided significant theorization, had limited focus on power relations, patriarchy, historical, political and economic combine forces that reinforce the stereotypical beliefs and practices in education and the social ecosphere (Weiler, 2017; NGSS, 2013). In addition, these scholars suggested gender sensitive curriculum, workshops, and gender-neutral educational texts in disrupting inequality and stereotypic practices in education. This I perceive as another recycling discourse, debates and curriculum reforms that have over decades yielded minimal efforts on equality in education globally and in Nigeria (Blumberg, 2008; NGSS, 2013; Galda and Boljo, 2022). Thus, revalidating the vicious circle of discriminatory discourse, policies and curricula that in my opinion have yielded little equity mechanisms and impact in disrupting or subverting inequality in education for liberation and transformation. In concert, Galda and Boljo (2022) argue that the vicious circle of stereotypes and teachers' limited awareness of responsive models to combat educators' and students' stereotypical behaviors still exist in education. This is because, little is said about entrenched

power relations and socialization process that could be responsible for producing, reproducing and subverting gender stereotype, due to deep rooted historical, sociocultural, economic and political orientations in sociocultural and science education space. In this sense, this study seeks to interrogate the missing discourse of reproduction and subversion beliefs linked to history, sociocultural, economic, curriculum ideology and political power relations, patriarchy and socialization process that have coded tendencies to reproduce and then perpetrate gender stereotypes in science education, globally and in Nigeria.

2.3.1 Gender Stereotypes in Science Education

Despite some progress in recent years in researching gender and science, and in achieving gender equality in scientific research, gender discrimination remains a challenge for policymakers, and the scientific community space. Concordantly, the promotion of women at all levels of academic research and learning of science has become a priority in the science agendas of many national and international institutions, including in science education. Although the number of female scientists in institutions and workplaces has increased, gender equality has not been achieved due to the ways in which gender has connected with science knowledge and practices (Blumberg, 2008; Elu, 2018). It is discomforting to note that a vast amount of statistical data relating to gender issues in science research shows that women are still suffering from two types of discrimination: horizontal segregation, where women are significantly represented only in certain fields, notably biology and medicine and vertical discrimination, which is commonly described as the ‘glass ceiling’ or ‘leaky pipeline’ impacting on the economy of the community (Rutherford, 2020).

Miller et al. (2015b) provide a glimmer of hope, in that, in the past 40 years, the proportion of women in science courses and careers has dramatically increased in some nations, though not in others. Still yet, pervasive stereotypes associating science with men emerge early in development and still permeate different cultures (Chambers, 1983; Steffens, Jelenec, & Noack, 2010). Chambers, about 40 years ago, asked some Canadian and American children (about 5,000) to draw a picture of a scientist, and to his dismay only 28 children (0.6%) depicted a woman scientist. Although most children still associate science with men, these associations may have weakened over time, at least in the United States, as a large study from 1960 to 2013 shows 38% of America children depicted a woman scientist. These changes in stereotypes mirror women’s increasing participation in science in United States. For instance, women

earned 19% of the US chemistry bachelor's degrees in 1966 but now earn 49% in 2015 of such degrees. Furthermore, the percentage of women among employed U.S. scientist rose 28% to 49% in biological science, 8% to 35% in chemistry, and 3% to 11% in physics and astronomy (Farland-Smith, 2009; Hill, Corbett, & St Rose, 2010; MacIsaac, 2019; Milford & Tippett, 2013). But still researchers point out that men scientists are overly represented in National Science Teachers Association NSTA books recommended for science teaching. For instance, in 2014 men were 64% of those represented, and in 2015/2016 70%. This shows skewed representation against women (Finson, Farland-Smith, & Arquette, 2018). In Nigeria, 20% of females in the north-western and eastern parts have low access to science education. Still, 80% of women are illiterate in the eight northern states surveyed compared to 54% of men in Nigeria (Egbulonu & Eleonu, 2018; Opara, 2015). Musso, et al. (2022) conducted survey in Italy and Nigeria on gender stereotypes experiences of adolescent students' empowerment and engagement linked to context and gender. The study shows that, empowering low performing female students with strategies could help them overcome or counteract gender stereotypes in STEM. Although the study is vital in highlighting gender stereotypes and socioeconomic status, it is limited in ignoring the deep-rooted nature of gender stereotype, how and why gender stereotypes are reproduced and reinforced in the two contexts for some decades.

Another study conducted in Germany and Nigeria by Obioma, Hentschel and Hernandezbark, (2022) on gender stereotypes, communal and agentic characteristics of males and females reveal the presence of gender contradictory communal and agentic characteristics and beliefs amongst men and women, due to cultural gender perception in the two countries. Based on authors' findings that Nigerian women are more agentic and communal than German females, and then German men are more communal than Nigerian men, I argue that, though the findings have theoretical significance, it further stereotyped females and men in the two countries. However, the females in Nigeria could use their agentic potential as change agents to subvert gender stereotypes in social space including science education characterized with discrimination. Still, on discriminatory practices in Nigeria, Abdullahi et al. (2019) studied gender gap in STEM in Nigeria and found that, the male students participated and perform higher than female students due to stereotypic practices. In concert, Aina and Akintunde (2013) conducted a survey on gender performance in physics in a college of education in Nigeria. The male pre-service teachers performed higher than females in the physics course. Also disturbing, Opara, (2015) conducted a study on females' access and engagement in science education.

Findings reveal low access and participation of females due to entrenched illiteracy that is skewed against females. The low access, diminishing engagement, lack of interest by females in science education, I perceive could be historical, political and economically constructed and orchestrated by the dominant class and the females themselves.

Aside Nigeria, some African countries are experiencing stereotypic practices, yet making efforts toward equality. For instance, Ananga (2021) conducted a study in 46 teacher colleges of education in Ghana about reproduction of gender stereotypes and pedagogical response to learning. The results show that educators discriminate and have little awareness of gender responsive pedagogy during mathematics and science engagements. In addition, a study conducted by Spaull and Makaluza (2019) on educational outcomes in South Africa show that girls outperform boys in mathematics and physical science high school matric examination, ignoring the received wisdom of stereotyping, that boys always outperform and participate more than females in education. Also, two studies conducted by (Morojele, 2014) revealed greater similarity between stereotypes about men and stereotypes about scientists than between stereotypes about women and scientists. Men and scientists were seen highly agentic, and women as highly communal. Elaborating, men are seen as leader-like, analytic, competitive, and independent, whereas women are seen as kinder, warmer and more understanding, dependent and helpful. This has granted more power to men than women in the society and scientific fields which has permeated and has deep implications for science education, also being entangled with gender discrimination (Morojele, 2014; Motsa & Morojele, 2017; Williams & Best, 1990).

2.3.2 Entanglement of Science Education with Gender Stereotype

People in science education has over the years treated boys and girls differently, leading to skewed gender discrimination, stereotypes and underrepresentation of girls in science education in favour of boys. For example, the underrepresentation of females due to stereotype threat in physics, is linked to science identity because girls are perceived to have less connection to real world and context. But the same physics identity has no impact on boys representation with the same connection to the social world (Hazari, Sadler, & Sonnert, 2013; Hazari, Sonnert, Sadler, & Shanahan, 2010).

I concur with the ideas given by researchers that the origin, history, and cultural development of science as a discipline is rooted in hegemonic version of masculinity and has an image that

appears difficult to disrupt. Thus, it becomes challenging for women and other marginalized groups to find their space in science education and to be regarded as equals in the science disciplines (Connell, 2012; Mouffe, 2014). Since women and other marginalized or stereotyped group find little space in science and science education, they often lack self-efficacy, self-confidence, self-recognitions and self-motivation, due to the stereotype threat affects that deter them from participating and performing equitably and effectively in science and science education (Beilock, Rydell, & McConnell, 2007; El-Amin et al., 2017; Schober et al., 2016). For example, apart from the subordination of women that could likely trigger fear and lack of confidence, there are likely to be other masculinities in science classes. For example, there are boys who exhibit either dominant masculine hegemony, such as domineering masculinities, or complicit masculine hegemony such as silent participants who enjoy the benefits that accrue from being in the dominant group, or those who play the role of subordinate masculinity such as the gay men (El-Amin et al., 2017; Sharp, 2016). The subordinate's women and complicit hegemonic masculine individuals and the subordinate masculine are likely to be marginalized and stereotyped in the science class due to their lack of confidence and ignorance of the power dynamics. Drawing from Freire, "ignorance is a key tool to oppression" (1972b, p. 55), embracing conscientization and more critical consciousness in schools will raise the awareness of science educators and PST to believe that masculinity, marginalization, and reproduction of gender stereotype is historically, and culturally positioned and can be challenged through knowledge production to regain confidence, self-esteem, and self- efficacy.

Even though there have been robust scholarships on the impact of history and societal gender issues in science, science education has accounted little or superficially for the causes of gender discrimination and stereotypes between boys and girls and still and has failed to research on students of different sexes and gender. The current studies on women engagement in science (Ekine 2016; Kola, 2012) focus mostly on lack of female's participation, enrolment and performance, to the detriment of both girls' and boys' gender enlightenment in science and science education. Scholarship is yet to shed much light on the causes of gender stereotype, reproduction entangle with coded oppressive power and subversion that could lead to empowerment and transformation. This leads to a blurring of ideology and science education curriculum with regard boys and girls being discriminated, oppressed, and stereotyped (Arnot, 1982; Weiler, 2017). The two interwoven constructs such as stereotype and reproduction are seemingly bound and complex in science classes that affect educators and students during

physical and life sciences teaching and learning. Thus, urgent perspectives are needed to redress gender inequity and inequality issues and specifically science educators' reproduction so as to position them for conscious subversion of gender stereotype and discriminatory practices in science classes. In this study, I perceive that urgent framework such as critical feminist reproduction theory and critical consciousness perspective tools, framework and constructs may reawaken, reimagine, and reactivate the cognitive ability of science educators and pre-service teachers in the college of education in Nigeria and globally. These perspectives are discussed in detail in chapter three of this study. However, the broad highlights here in this chapter are meaningful as reference to guide readers. Critical consciousness is relevant as science educators' awareness of themselves as critical thinkers and as how they engage their students in science classroom. By exposing the constructs of reproduction and gender stereotype that impede teaching and learning, students become aware of persistent gender inequities and stereotypes. This approach will also afford the opportunity to be aware of equity interventions perspectives such as girl's friendly science education, sensitive science education and neutral science education that have been put in place over the years but has so far failed to bring sufficient change to science education classrooms (Sinnes, 2012). More so, critical feminist reproduction theory will position science educators and students as actors able to embrace collective political struggle in informing counter-hegemony for change and transformation in science classes. These lenses may likely highlight the neoliberal dominant agenda of oppression and marginalization of men and women in economic terms which disguise under schooling system to reproducing middle-class and working-class females and males into wage labour to further their dominations.

Even though researchers have provided some insights into science education teaching and learning, inequity, discrimination, and gender stereotypes persist among educators, students educational and career pursuits (hooks, 2010; Rapa, Diemer, & Bañales, 2018). Hence, there is a need for educators and researchers to shift grounds and have a rethink and restructuring of science education using different models of critical consciousness and feminist critical teaching and learning methods, that will bring transformation and emancipation perspectives for both the educators, males, and females, including the community in which they live. Thus, my alignment with critical consciousness and critical feminist perspective as lens that will guide this study in creating a critical awareness on the entrenched neoliberal capitalist ideology which aim to reproduce men and women in the economic labour force for economic gains only

2.3.3 Reproduction of Gender Stereotypes in Science Education

Bourdieu (1998) argues that schools play a central role in reproducing social and cultural inequalities. The school system is an institution for the reproduction of culturally legitimated norms through hidden linkages between scholastic aptitude and cultural norms. He believes that, despite ideologies of equal opportunity and meritocracy, educational systems are still not called upon by the dominant classes "to do anything other than reproduce the legitimate culture and produce agents capable of manipulating it legitimately" (Bourdieu & Passeron, 1990, p. 59). On meritocracy, Bourdieu questions the coded meritocratic illusion that has been persistently discussed in scholarship, the fallacy of individuals possessing innate intelligence or 'giftedness'. In his discourse, Bourdieu has argued that it is the culture of the dominant group that controls and influences the economic, social, and political resources embodied in schools. Those educational institutions sometimes reinforce the marketisation and profitability agenda of the cultural capital of the dominant class, attesting to their so-called gifts and merits. This consciousness has "turned colleges and universities into factories, producers of marketable knowledge" (Faviere, 2015, p. 24). These institutions thus encourage a focus on individual business goals rather than critical thinking and citizenship ideals for common good.

Due to the neoliberal dominant hidden ideology, educational differences are sometimes and frequently misrepresented as resulting from individual giftedness rather than from entrenched class-based differences. Bourdieu and Passeron argue that the abilities measured by scholastic criteria most of the time stem not from natural 'gifts' but from the higher or lower accord between class cultural habits and the demands of the educational system linked to the curriculum practices that define success within it (Bourdieu & Passeron, 1990, p. 59). To him the educational differences promote stereotypic effects among male and females.

2.3.3 Effects of Stereotype Threats in Society and Science Education

Internationally and in African society, girls are conditioned to believe that women are inferior to men and their place is in the home. Therefore, they are to be 'seen and not heard.' These rhetorical and stereotypical beliefs against women have become entrenched in the minds of girls and boys as they internalise these faulty messages from home and social spaces. Therefore, the girl-child suffers emotional disorientation, which at times results to feeling of insecurity, poor self-esteem, lack of confidence and low performance when they become adults. For instance, a survey of harmful traditional practices against women and girls in Nigeria shows

that proverbs and local sayings in form of jokes about females' actions and inactions act as psychological barriers against change, transformation of attitudes and behaviour. Such cultural practices sometimes help to dehumanise and undermine girls' self-esteem and self-efficacy on a given task (Ajayi, 2007; Ezeliora & Ezeokana, 2011; Ogwuche, Adikwu, & Ossai, 2020).

Spencer, Steele, and Quinn (1999, p. 5) investigated the impact of stereotyping on female performance in Mathematics, where participants were subjected to three threat conditions, namely, i) explicit threat, where students are told prior to the test that men perform better than women on mathematics, ii) implicit condition, where students were not given any information on gender differences regarding the test but were left to normal mathematics testing situation and iii) nullified conditions, where students were told prior to taking a mathematics test, that there were no gender differences on the test. The results indicated that the men outperformed the women in the implicit stereotype threat (ST) condition. However, gender differences disappeared in the nullified ST condition. This revealed that when no information was provided on gender differences, women still underperformed due to the perceived prevalent implicit stereotype that women have less ability to perform than men in mathematics problems (O'Brien & Crandall, 2003; Quinn & Spencer, 2001; Spencer et al., 1999).

Furthermore, Picho and Schmader (2018) examined ST in chemistry performance, where high school chemistry students were exposed to a chemistry text conveying images of some male scientists, some female scientists, or a mixed group of male and female scientists. Results indicated that the women performed best on the chemistry test, in the female' image condition. The men performed best in the male image condition. The men and women performed similarly in the mixed gender image condition with no effect of test anxiety revealed in all the three conditions (Picho & Schmader, 2018; Schmader & Johns, 2003; Spencer et al., 1999).

Another study was conducted about ST in high school physics, on men and women who were assigned randomly to three ST conditions: i) explicitly – information was given that women perform lower than men in physics, ii) implicitly – no instruction on gender performance differences pronounced on the test and iii) nullified condition – no information on gender at all concerning the test. The results indicated that men outperformed the women on physics problems in the implicit and explicit ST conditions. But men and women performed equally in the nullified condition. From the two conditions above, it shows that being in the physics testing class alone and being informed on gender differences was enough to evoke women's low

performance due to ‘slow working memory’ capacity. Not surprisingly, the nullified condition reminded participating students that men and women can perform equally well in physics, thus eliminating negative stereotype threat effects on women (Bedyńska, Krejtz, & Sedek, 2018; Beilock et al., 2007). Therefore, drawing inspiration from feminist reproduction theory, I argue that women with opposition capacity can change their lives through productive organised resistance. This is possible because they have both intellectual, political and economic potentials to disrupt, emancipate and transform themselves from institutional stereotypic beliefs and practices using feminist productive resistance and counter-hegemony insights as subversive strategies. The feminist critical approach I perceive could enhance intellectual, political and democratic engagement due to internalized consciousness to subvert gender stereotype. In this case subversion is necessary to disrupt the entrenched dominant stereotypical ideology (Bourdieu, Passeron, & Nice, 1977; Diamond, 2020; Mills, 2008). The concept of subversion is elaborated on next.

2.3.4 Subversion of Gender Stereotypes

Portelli and Eizadirad (2018) argue that subversion is a subtle and necessary tool for survival that should be used to liberate individuals who are marginalized, oppressed and disfranchised from immoral forms of power that create, stereotype, maintain, oppress and harm them (Diemer, Rapa, Voight, & McWhirter, 2016; Giroux, 2014). This might give room for social justice and equity. This means that subversion may arise from an intuition as a moral call, an inside voice or sense of consciousness, to pay attention to the needs of the self and others who are stereotyped, marginalized, and oppressed. It is a way to stand up to injustice and inequity, with the goal of challenging abusive forms of power and control over their lives. Researchers submit that, when subverting gender stereotype in education, the focus should be on the construction of genuine knowledge. That is, the aim of combating gender stereotypes should be on the production of critical knowledge that will expose the hidden power relations and inequalities in institutions of learning and social spaces. In the context of this study, that entails narrowing gender inequities in science subjects and the social world. Doing so will emancipate and transform the discriminated, stereotyped and possibly the disenfranchised educators and pre-service teachers and students alike who have been enmeshed in socialization of different gender roles and norms that oppress them in the society (Ikonen, Leinonen, Asikainen, & Hirvonen, 2018; Laing & Maylea, 2018).

Highlighting and challenging gender stereotypes in science education is important because the history of gender stereotyping has led to inequalities and role differentials between men and women. Due to this unequal treatment in practice and sometimes in legislation, positive actions must be re-enacted to foster gender equality. A conscious effort by schools and society to change attitudes and to accommodate cultural differences is a healthy prerequisite for an inclusive and transformative society that is empowering. This is vital because transformation and liberation can be achieved when schools promote democratic, moral, and political consciousness. Though schooling is a complex and contradictory space, schools occupy a unique position in society, and the role of the school is fundamental in promoting gender equality. By re-awakening educators' and students' consciousness in confronting false and coded information, their knowledge base is expanded when embracing the gender discourse prevalent in the scholarship on boys and girl's oppression and marginalization. Gender stereotyping intersects with gender sexuality and class and hence a transfer of vital citizenship skills and knowledge for positive change is required to align with a critical gender order (Deem, 2012; Giroux, 1983a).

In addition, Muasaya and Kazungu (2018) argue that teachers have limited awareness to challenge gender stereotypic behaviours of male and female students. In agreement, Galda and Boljo (2022) argue that educators have minimal knowledge of gender responsive models to disrupt discrimination and stereotypes in the classrooms. The limited knowledge and understanding to combat gender stereotypes, to me could be traced to educators' uncritical knowledge about entrenched historical, sociocultural, economic, and political and socialization process in education and society.

In this regard, the debates on gender and society are elaborated as follows.

2.4 GENDER AND SOCIETY

2.4.1 Society as Agent of Socialization

Gender schema theory states that every society prescribes roles to men and women based on their sex, consciously or unconsciously. A schema can be viewed as a process and perceived product of the interaction between the incoming information and the perceiver's pre-existing cultural beliefs (Almy & Sanatullova-Allison, 2016; Bem, 1981). Bem (1981) believes that children consciously process available information regarding the sex roles they encounter in their socialized environment. Therefore, the "child places the new information into previously

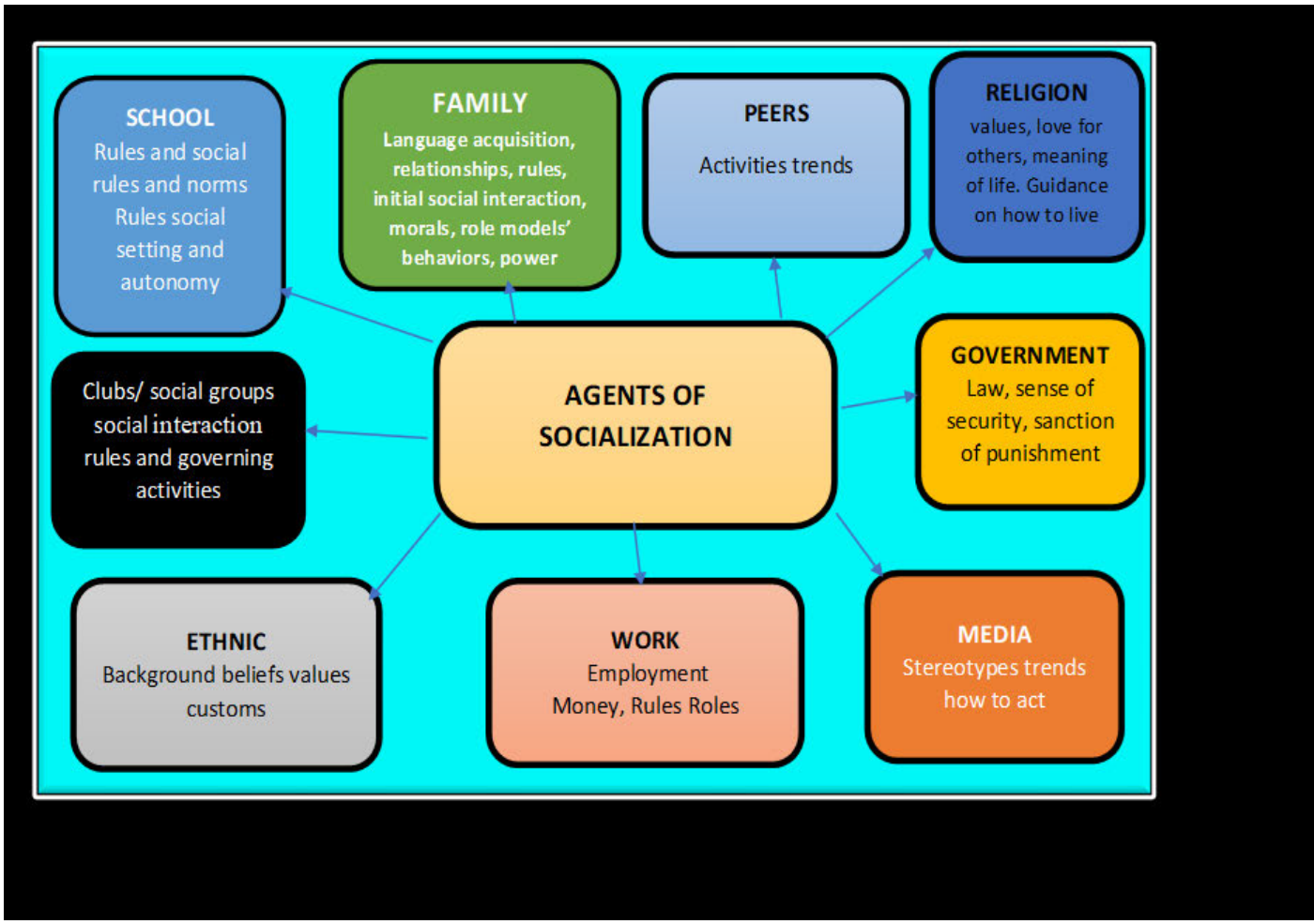
existing schema of how men and women should behave in the social world" (Bem, 1981, pp. 344-345). Consequently, the sex-typed behaviour of individuals in this setting in turn reinforces the gender discrimination concerning the self-concept. As individuals observe and monitor their own behaviour, the gender schema becomes a prescriptive norm that triggers behaviour in that context and social space (Alani, Clark-Taylor, Rogeshefsky, & Cerulli, 2016; Paynter, 2011).

Societal views and beliefs about gender are strongly influenced and mediated by cultural beliefs that are appropriated during social interactions. A study conducted on boys' perceptions of gender in a South African high school found that cultural values and beliefs reflect the earlier socialization of children into different roles (Bojuwoye & Sylvester, 2012; Carter, 2014). Therefore, the cultural values ingrained in children have a great impact on perceptions of gender, gender stereotype and maleness that are then reinforced by hegemonic cultural, historical beliefs and socialization experiences (Montgomery, 2020; Ridgeway, 2019). But most theorists of gender socialization argue that interaction with the society is central with regard to the socialization that takes place. Therefore, human beings "make sense of the world using the realities and meanings that the members of the society imbibe and share" (Dietz, 1998, p. 425). Social groups such as family and peers, and institutions such as religion, government, media, work, and schools are very influential in this regard. Socialization theories such as social learning, cognitive-development, gender schema and psychoanalytic theories are insightful with regards to the ways in which children are rewarded according to sex. Social learning theorists argue that children tend to copy, imitate same sex individuals and their gender roles, thus forming strong bond with the same sex parent (Canevello, 2020; Ryle, 2011). For instance, boys are usually told that they should always be brave, have confidence and should not cry because fathers do not cry anyhow unless on serious issues. But girls are to cry and respect boys. This form of socialization instils fear in boys hence they would be labelled girls if they do not reproduce the ingrained cultural beliefs of being aggressive, strong, domineering and other stereotyping that pervades their society. During this adolescence stage of socialization, boys and girls developed masculine and feminine traits by internalisation into adulthood (Dietz, 1998; John et al., 2017).

Internalization of roles by children in the society is done through imitating the people around one and is often not linked to rewards only, as children appropriate both negative and positive roles in the society, depending on the societal norms at a given time. They also learn their roles through playing at school, imitating actors in social media and friends in the society. Therefore,

the media and childhood school peers have a tremendous impact on children's socialization; for example, the media portrays gender stereotype that influences gender identities. Undoubtedly, more value is given to male than female new-borns in most of the societies around the world. For example, in some African cultures, the male continues with the family's name because females are unlikely to remain in the family house due to marriage. Boys, usually the eldest, are often socialized to take care of their parents when they get older (Cleaver, 2000; John et al., 2017). These boys are sometimes allowed to practise cultural rituals and religious activities of the family, but not girls. For example, in some Nigerian cultures, women are not usually allowed to slaughter a goat, cow or rabbit and burn incense for ancestors, but only males do these sacred practices. Also, men always go to war and are motivated to go to school but not women. Because females are perceived not to be brave enough to defend the environment and are not expected to attend schooling, since they will be married out only to give birth to children, they end up in the kitchen as cooks. These perennial gender preferences impact on the socialization of male and female children gender roles. Therefore, girls experience a high level of discrimination and sexual abuse, stereotypes, domination, and emotional disorientation that are likely due to their awareness of the power transferred to boys in the family, education and social space, as a result of entrenched socialization beliefs and norms (Fulton & Schwarz, 2017; Kuczynski, Parkin, & Pitman, 2014). The agents of socialization are depicted in Figure 2.2.

Figure 2.2 Model of Agents of Socialization (Mdlolo, 2017)



Researchers assert that people, groups, and institutions are the agents of socialization (see Figure 2.2). But the socialization process is often transitional, often moving in one direction. While parents and adults socialize children, teachers socialize learners and students (Fulton & Schwarz, 2017; Ryle, 2011; Witt, 1997). This shows that the powerless are politically socialized but the powerful socialize them using the autonomous political power they have. In this case, power becomes central to the socio-cultural relations that can alter an individual's socialization process. Therefore, the intensity of influence of each of the agents depends on the situation, the individual's experiences, and the individual's stage of life. These 'agents' of socialization with power and autonomy in one way or the other contribute to gender inequalities and to the production and reproduction of stereotypes that underpin oppression and subordination of women culturally and historically as result of gender division (Mariano & de Souza, 2020; Ryle, 2011; Sobieraj & Krämer, 2019).

2.4.2 Gender and the Division of Labour

The division of labour is perceived as the distribution of roles to accomplish tasks in the home or society. But this division of labour is sometimes distributed unequally and differentially between males and females, and women are historically involved more in domestic work than men, which is likely to be the reason why women dominate household chores (Whittle & Hailwood, 2020). For example, in many societies and cultures, males perform duties such as hunting and farming and provide security at home while mostly females fetch wood and water and prepare food. More so, in some African cultures, for instance in the Nigerian culture, men bathe the body of the deceased and dig the grave, while women cook for mourners and sometimes stay for three to seven days with the deceased family. But in the Zulu culture of South Africa, the women sometimes prepare and dress the body of a deceased and provide the mourners with food while men prepare and dig the grave. Also, females take care of children and males are employed in underground mining, for economic purposes. In this sense, I perceive these women's roles stereotypically reinforce the communality, nurturing and submissive characteristics existing in the socio-historical context that have been legitimised as women's responsibilities, to oppress them. Because women's roles require tenderness and care, females are also trained in domestic work that prepares them for marriage. The connection between masculine and feminine gender roles at home and occupational career can be demonstrated in teaching as well. For example, a male is given an office that demands high responsibilities such as the head of accounting department, physical sciences lecturing and head of works departments and field work, but females are assigned or to fewer demanding tasks and rooms linked to food and catering where men are positioned to head. Also, it can be seen in the allocation of workload among teachers, where females are given "domestic science, language, and literature teaching, and men in sciences, Mathematics and industrial arts" (Connell, 1996, p. 213). But this process 1 perceive does link to the specialisation of teachers as well. More so, role differential is visible in education science classrooms when teachers assign tasks to learners by asking strong boys in the science classroom to move a table or carry a large and heavy box and give easy and lighter tasks to females. Gender-skewed tasks distributed by teachers, parents, peers and community members are often sex differentiated roles that are embedded with coded cultural production and reproduction of gender stereotypes in the form of masculine hegemony (Akanle, Adesina, & Ogbimi, 2016; Nwaka, Uma, & Ike, 2020). The concept of masculine hegemony is elaborated as follows.

2.4.3 Hegemony and Masculinity

Weitz (1977) maintains that the outcome of gender socialization is the differentiation of men and women, with men appropriating more power. Although masculinity is perceived as 'the state of being a man', femininity is not defined as the state of being a woman (Connell, 1996, p. 207). Instead, femininity is seen as a stereotype of a woman's role from the past. But existing views of masculinity still conceive of it as associated with power, authority, dominance, bravery, and heroism, while femininity is perceived as objects, others, and deviations for the cultural norms. This set of stereotypes may have informed the persistent inequality in the social space today. Therefore, gender inequality in the home, where men possess more authority in decision-making, may have resulted in the domestic violence experienced by women in the society, due to men's assertion of masculine power (Ozbay & Soybakis, 2020).

Research on masculinity has resulted in various views of masculinity, including those briefly described by Connell (1996, p. 208) below as:

- Multiple masculinities: Different cultures, and different periods of history construct masculinity differently.
- Hierarchy and Hegemony: There are different classes of masculinity; some masculinities are more honoured than others are, and others may be dishonoured. The form of masculinity that is culturally dominant in each setting is called *hegemonic masculinity*. Hegemonic masculinity positions itself in opposition to women and takes its status in relation to other forms of subordinate masculinities.
- Active Construction: Masculinities do not exist prior to social behaviour; rather masculinities come into existence as people act and socialize with each other.
- Masculinities are dynamic: It has been found that masculinities are subject to change due to various environmental and socio-cultural factors and change in the course of time.

As researchers argue, the images of men with masculine characteristics and women with feminine attributes have a powerful normative effect in the society. They establish ways of behaving as feminine or as masculine, so that any individual who attempts to dress, behave, or even think differently faces the social sanction of being, by patriarchal definition, abnormal. As such, they are an important part of understanding both how texts are engendered and how they engender their consumers in the social space and education (Lowe, 2020). Therefore, in

social world and science materials, male characters are represented and internalised and are foregrounded as heroes. This heroic image positions them as being leaders of groups with power to act and enforce decisions and regulations in public spaces. These stereotypical masculine images inform of heroes and the powerful pose threat to females' gender, sexuality, economic orientations and science engagement in configuration of their social gender commitments (Hearn, 2018; Petrova & Simcock, 2021).

This in turn highlights the importance of correspondence theory in shedding light on the underpinnings of cultural reproduction of economic oppression and power relations against females in education and the social world.

2.5 CORRESPONDENCE THEORY, POWER AND OPPRESSION IN SCIENCE EDUCATION

The core of the correspondence theory articulated by Herbert Gintis in 1972 is a model of cultural reproduction, power relations and patterns of economic labour force (Rapa et al., 2018), where capitalism is reinforced and entrenched in the social space and dynamics of daily classroom engagements (Bowles & Gintis, 1981; Cole, 1988). More so, the schooling process with relative autonomy socializes and produce students' differential attitudes and dispositions that position them to be passive recipients of the dominant social and economic capitalist ideology. Thus, schools do not only "produce commodities, but also produce people" (Giroux, 1980, p. 33) as well. Correspondence theorists posit that schools cannot be detached from the socio-economic context in which they are situated, because their primary objective lies within the wider societal economic forces of which it is a part (Apple, 2017; Cole, 1988). Thus, the correspondence perspective uses a class analysis of schooling that shifts the blame for educational failure from teachers and students to the structural dynamics of dominant society. The proponents of correspondence theory assert that working class students, for instance females, are often socialized to low level jobs, while middle- and upper-class students are trained in higher level of cognitive skills and modes of self-protection (Bowles & Gintis, 1981). Consequently, the correspondence between schools and workplace becomes clearer in this type of analysis. However, correspondence theory has been criticised (Giroux, 1980) for failing to account for human beings as agents of change who have the potential to negotiate and re-negotiate contradictory school spaces and workplaces embedded with cultural hegemony that mystifies existing power relations and social divisions. In this sense, the ideologues fail to

account how power is produced, distributed, and sustained during schooling, which Giroux (1980) calls an "intellectual error" because they could run the risk of mystifying rather than demystifying the nature of oppressions and domination of what it attempts to illuminate. As he puts it, any "theoretical stance that does not examine the nature and strength of the ideological and structural constraints that shape the parameters runs the risk of defeating itself" (Giroux, 1980, p. 55).

Drawing on Giroux's inspiration, feminists re-conceptualised the school through critical feminist reproduction theory, aiming to illuminate the contradictory school spaces characterized by tensions of gender ideology, sexual emotions, patriarchy, and economic orientations that spring from the entrenched tensions of neoliberal dominant ideology.

2.5.1 Neoliberalism in Education and Dominant Economic Ideology

Harvey (2005) conceptualises that the neoliberal perspective in education is a political construct based on economic practices that aim at the marginalization of humanity. The neoliberal paradigm stance proposes that human wellbeing can be advanced by "liberating and transforming individual's entrepreneurial freedom and skills within an institutional framework characterized by strong private property rights, free markets and free trade" (Harvey, 2005, p. 22). This show that neoliberalism underscores the value of performance of collection of individuals, particularly females, but retains hegemonic power, which has pervasive impacts on the way we construct, live in, and interpret knowledge in education and the social world. Thus, under neoliberalism, the role of government shifts from regulating markets to enabling them to perform, reinforcing the political economic agenda with coded oppressive tendencies skewed against people (Harvey, 2005; MacDonald-Vemic & Portelli, 2020). As Harvey puts it, if markets do not exist in areas such as education, then they must be created, by state action if necessary (Harvey, 2005, p. 22).

In this sense, neoliberalism press to increase competition for wealth, and to privatize ownership of education that has a track record of penetrating already powerful communities. Further, it commonly shifts the onus of responsibility for social gender inequality, domination and oppression from state to individuals in the society and educational environments. This has implications for social justice and transformation in education and globally. Of course, within the neoliberal model, public schools are charged with providing students with knowledge and skills they will need to pursue personal gains in the workplace. Teachers and educators are

regarded as responsible for academic success and failure, regardless of the systemic factors, contradictions, and constraints they experience. This leads to excessive instrumentalism, corporation, and marketisation of education (Giroux, 2014; MacDonald-Vemic & Portelli, 2020). In this sense teachers, students, parents and school administrators with neoliberal consciousness and power, have been turned into atomized individuals, disguised as neoliberal capitalists striving for personal economic gain rather than changing and transforming the society and education for overall good, with the ingrained personal power they have for democracy and morality (Sant, 2019).

Re-echoing neoliberal economic theory, scholars submit that the increasing economic gender stratification that occurs in the society and education, in the face of neoliberal policies, is the result of economically oppressive choices they enact and continue to promote. This in turn invokes the values of democracy and choice and shows how, in complex and contradictory ways, neoliberalism, democracy and social justice are intertwined and need to be disrupted for women's empowerment. Otherwise, neoliberalism will continue to entrench its singular truth of gender oppression and domination, thereby reinforcing its agenda in schools and social spaces (Larner, 2000; MacDonald-Vemic & Portelli, 2020).

Under the neoliberal model, there is a shifting goal of public education from preparing students to be active and critical citizens to students as consumers with uncritical skills (Apple, 2011; Freire 1972). Thus, the prevailing performance discourse in education claims that school improvements can be achieved through transparent accountability procedures such as standardized test scores, school rankings and merit-based pay for teachers and for best performing educators and students to motivate them (Ball, 2018; Hodge, Holford, Milana, Waller, & Webb, 2018). Further, I perceive, this deflects away from aspects of social and/ or moral consciousness, development and gender transformation that have no immediate measurable performance value. In this sense, both educators' and pre-service teachers' sense of moral positioning, critical thinking, democratic engagement and gender responsibility will be distorted in ways that omit change and transformation consciousness. Undoubtedly teaching and learning in these schools, colleges and universities will be reduced to calculable possibilities in form of scores and certification which produce market information for choosers in the social work force, while the state is left to pick poor performers in education. Therefore, I submit that neoliberalism consciousness though vital in promoting economic consciousness, is driven by dynamics of gender differentials and power for immediate economic benefits,

rather than embracing critical consciousness, intellectual creativity and subversive strategies for equality, transformation, social justice and peaceful coexistence (Ball, 2012a; MacDonald-Vemic & Portelli, 2020).

2.6 GENDER, POWER AND SCHOOLING PROCESS

It is argued that power constitutes truth and is a form of knowledge that impact on behaviour (Apple, 2017; Fulton & Schwarz, 2017). But power is the ability of some actors to influence the behaviour of others, using persuasion, authority, or coercion. Coercive power is the "ability to impose one's will by force, threats or deceits" and authority as "the power that comes from a position in an organisation or institution that is widely regarded as legitimate" (Ryle, 2011, p. 426). Naturally, power can be good and bad, so it depends on whether it can be used positively or negatively. For instance, power and authority could be vital elements for the running of a society and schools by teachers over learners or students. However, men possess more power in education and societies than women. This can be demonstrated in law enforcements, ruling governments, institutions, and in teaching and learning processes. In some parts of the world and societies, women acquire power to practise and negotiate roles, but they do not have as many opportunities as their male counterparts to exercise the power. Power relations involve authority, supervision, domination among teachers, linked to harassment and the controlling of resources among students. Supervision, authority and patterns of dominance are associated with masculinities (Raselekoane, Morwe, & Mulaudzi, 2017; Ryle, 2011). In the society and education system, men often occupy management and supervisory positions. Power relations among children or students are seen as governing resources, intellectual competition, sports facilities, and even science engagements where boys take control over space. For example, boys like to disturb girls during play time in the playground, class and during laboratory engagements. Even in classrooms, boys like to occupy certain of the physical space of the classroom (like the back of classrooms) because they have power over girls. Researchers revealed that while teachers have some perceptions of gender in their lives, they have little understanding of the influence of gender discrimination in the schools in which they teach. More so, only a minority of science teachers have some understanding and awareness of the gender equity and equality issues that emerge during teaching and learning. They do not often, due to ostracism, transfer or reproduce this gender awareness to colleagues and students during school interactions. This is because, some educators and pre-service teachers are unaware that there is a strong relationship between gender, power, achievement and schooling linked to

historical, socio-cultural, economic and political orientations (Bianchini, Cavazos, & Helms, 2000; Lahelma, 2011).

2.6.1 Gender, Achievement and Schooling

Research has shown that science educators attribute girls' achievement in physics due to their hard work and boys as brighter or more intelligent at studying physics courses based on their gender orientation, even when the boys and male students with perceived masculine power perform lower than females. Moreover, women receive less encouragement from teachers, family, and friends to study physics and chemistry modules compared with young male students (Francis et al., 2017). Though biology and chemistry are also associated with males, these fields are perceived to have a significantly lower proportion of men than do computer science, engineering, and physics subjects. Also college women are likely to associate biology, chemistry and physics and mathematics with negative words like 'bad' and 'hard' rather than positive words such as 'good' and 'simple' (Nosek et al., 2009). This is because, females have greater anxiety in mathematics, computer, and physical science than boys and men (Nosek et al., 2009; Udo, Ramsey, Reynolds-Alpert, & Mallow, 2001). Physical sciences are often constructed as masculine and 'hard' domains for women and girls. Therefore, feminist social constructionist researchers argue that science is socially constructed as a high status, masculine domain that is designed mostly for men. Its cultural and institutional environment is populated by middle class men, hence it discourages young men and young women of working class and minority ethnic and cultural backgrounds to study science and to further science careers (Butler, 2011; Chepelinsky, 1989; Mdlolo, 2017). Scholars argue that schools, science teachers and science educators reproduce and reinforce gender roles in science classes and hence affect teaching and learning. Only by disrupting or rather deconstructing this understanding will increased women's participation and performance in the complex science and science education sectors will be achieved (Francis et al., 2017; Weiler, 2017).

Though science education classrooms are found to be contradictory and complex due to the intersection of gender, sexual emotions and patriarchal orientations, science educators and students could negotiate gender dynamics to gain control of their lives. Negotiation happens when science educators and students subvert the production and reproduction of cultural power to gain control of their humanity. But feminist scholars inform us that boys and girl's resistance will be different, depending on what teachers and students perceived as resistance during schooling (Fuller, 1980; Gaskell, 1985; Masta, 2018). Thus, conceptualisations of resistance

will only be understood when teachers and student's sexuality, gender, class, and patriarchal elements are interrogated for better insights. Therefore, using resistance to inform personal, political, and autonomous consciousness, educators and students are most likely to negotiate school dynamics by converting personal power into political power and autonomy. This also requires re-negotiating the existing political, democratic, and moral gender spaces in the school environment to appropriate leaderships positions for themselves (Faas, 2016; Geven, Jonsson, & van Tubergen, 2017).

Most empirical literature to date has only highlighted how gender stereotypes are constructed in cultural environments, economically, politically, and educationally, but has ignored science educators' and students' opposition to curriculum ideology. Therefore, this research work aims at critically examining, and articulating the nuances of gender stereotype, reproduction, and subversion among science educators in physical and life science classes. That is, what is the nature of gender stereotype in science classes? How are the reproduction and subversion of gender stereotypes enacted in science classes? Why do science educators reproduce and subvert gender stereotypes in science classes? These pertinent questions, when critically explored and deeply investigated, will help researchers and educators understand gender dynamics in science classes, hence have the capacity to disrupt inequality to promote gender equality for change, emancipation, growth, and development in the social.

2.7 GENDER INEQUALITY AND EQUALITY IN THE SOCIAL WORLD

The term *gender inequality* means the inability to attain fairness through putting systems in place that are fair and just to everyone in the society, while *gender equality* is the product from sharing socio-political and economic resources equally amongst both men, women, and the minority in a democratic manner for enabling social justice, peace, and harmony. Gender equality means that both men and women benefit from the same results and resources equally. No one is left behind or aside because of his or her gender positioning. It means that men and women enjoy equal human rights and equal social and educational opportunities to utilise their full potential and to contribute effectively to the development of the economy, politics, and the education. It also connotes equal sharing and the embracing of different social roles within the society for democratic governance (Permanyer, 2013).

In a global perspective, the report of Gender Inequality Index [GII] (Sharp, 2016) revealed that there is no country with perfect gender equality. Thus, all countries suffer some loss of human

socio-economic development due to gender inequality and are striving towards equality. Consequently, over the past three decades, research studies have been conducted to address gender equality concerns in several socio-economic spheres, including education (Gilbert, 2001). This has triggered collective struggles by critical feminists who thought that the rights of females should be equal to the rights of their male counterparts, resulting in global political struggles, interventions and the resolve to develop and implement policies and programmes to address gender inequalities in all spheres of life, including education. Such discourses and social movements propelled the eight Millennium Development Goals (MDGs), and currently the Sustainable Development Goals (SDG) by the United Nations to conscientize and to transform the world, particularly education for all citizens. This might have given a boost to all countries affiliated to the UN to prioritise gender equality for both males and females in their respective contexts. However, achieving gender equality has been elusive internationally, especially in developing regions of the world, including the African continent (Brock, 2017; Sharp, 2016).

However, over some decades, both developed and developing countries have shown progress in educating men and women equally. Researchers maintain that, whilst women have made little gains in education in terms of parity at all levels of schooling and work progress in most countries, there are still differences in education, economic and political power between men and women (Atu, Odeh, Odibo, & Agbo, 2019; Stromquist, 1990). Of course, women globally are also behind men in enjoying basic human rights, democratic and political participation. Even though no country has achieved gender equality fully, some countries have done well in closing the gender gap, for example the Nordic countries and Western European countries. On the other hand, females in African countries are still faced with discrimination about participation and access to education compared to males. For example, a study on gender in education in Africa, with special reference to Ghana, Zimbabwe, Nigeria, and Kenya, found that females' illiteracy rates were high as compared to their male counterparts (MacDonald-Vemic & Portelli, 2020; Para-Mallam, 2017; Shabaya & Konadu-Agyemang, 2004). In the same way, scholars affirm that statistics from education indicate that women in sub-Saharan African countries continue to be underrepresented in Science, Mathematics and Technology education. For instance, in South Africa, although the South African government has implemented gender policies, there is a lot more that needs to be done to encourage and motivate girls and women into the science fields because women continue to lag men in science

related fields. Yet, schools continue to be contexts for the gender inequities and inequalities experienced by both male and female educators and learners (Ridgeway, 2019).

The challenges of gender inequity and inequality that affect the whole world, especially the developing regions as described above, are prevalent in most of the socio-economic spheres, including education, which is one of the most critical and essential socio-economic drivers for growth, peace and transformative benefits for women through empowerment. Education contributes to knowledge, increasing women's abilities to face challenges and boosting their confidence to relinquish subordinate positions. Of course, within the education sphere, gender equity and equality levels vary according to disciplines such as the sciences and humanities. For example, the Sciences Technology, Engineering and Mathematics (STEM) subjects are the most affected by gender inequality in the world, including Africa and Nigeria (Para-Mallam, 2017; Rarieya, Sanger, & Moolman, 2014).

2.7.1 Gender Inequalities and Stereotypic Practices in the Nigerian Context

Nigerian society is largely rigged against women, who are treated as second-class citizens and subordinates. Women are mostly considered to be housewives, ornaments, and good mothers (Abegunde, 2014; Eyiuche, 2019; Makama, 2013). Of course, the Nigerian woman, before colonial power influence, played major roles in various societies in the chieftaincy councils and in maintaining the overall harmony, peace, morality, and stability of the community. For instance, Nigeria and other traditional African countries operated on the principles that every individual, male, or female, is an important member of the society who embraced ethical orientations for survival and respect in the society. Thus, they had assigned places and roles in the society that were not inferior, but rather important for the survival of the community. Yet the colonial coercive rule truncated the cultural norms and social cohesion probably for their oppressive and dominating agenda (Abegunde, 2014; Butler, 2010; Omotosho, 2015; Shabaya & Konadu-Agyemang, 2004).

Gender inequality in Nigeria is influenced majorly by dominant colonial ideas, cultures, and beliefs. Undoubtedly, in most parts of Nigeria, women are considered subordinate to their male counterparts. Notably in the Northern part, it is generally believed that women are best suited as home-keepers, while in the Southern, Eastern and Western Nigeria, women are likely not to inherit the properties of the family and do not take part in decision making, hence women feel inferior and dehumanized (Adebayo & Akanle, 2014; Potokri, 2011). Also, some writers in

Nigerian literature as well as educators, political actors, leaders and curriculum planners and teachers assigned superior language in reference to their male counterparts and inferior language to the female citizens, which are always at their mercies. For instance, the former president Olusegun Obasanjo consciously or unconsciously configured the Nigerian woman as "inferior while the man is perceived as superior". This consciousness was likely reinforced by the current Nigerian president Muhammadu Buhari on 4th October 2016, when interviewed on which political party his wife belongs; he commented that the place of his woman is in the kitchen, the living room, and the other rooms. Such statements are not only derogatory but signal inequality and inequity and are demeaning to women (Ogunyemi, 2014, p. 49).

It is likely that the continual production and reproduction of gender inequality and inequity as stereotypes in the science and science education sectors have promoted gender discrimination and unfairness to access, enrolment, curriculum content, teaching and learning etc. Also, the gendered choices of careers, administrative policies and workforce in science and science education classroom in Nigeria could be the consequence of socialization (Eboiyehi, Fayomi, & Eboiyehi, 2016; Josiah, 2013; Makama, 2013). In this sense, I argue that the historical, socio-cultural and institutional socialization process influence educators' and pre-service teachers' gender roles reinforcing stereotypic practices and inequality in science classes.

2.7.2 Influence of Socialization of Educators and Pre-service teachers Linked to Gender Inequality

The socialization of individuals such as science educators and pre-service teachers into varied groups precedes inequality. Researchers enmeshed in the study of gender perceives that our experiences and beliefs about gender are socially constructed. Thus, the process through which individuals such as science educators and pre-service teachers are taught appropriate social roles of how to behave and act in each society is considered 'socialization' (Fulton & Schwarz, 2017; Mustapha, 2012). Cultural and institutional socialization are the main driving forces of gender inequalities and economic differentials in the society and in science education. This is because humans are usually socialized into varied gender roles, class positions and patriarchal orientations in different cultures, institutions, and societies. Hence, males and females, boys and girls undergo categorisation processes differently based on the societal expectations, with roles assigned for their convenience in the social order. Recognition of these gender discrepancies has conscientized several governments over the years to enact, promulgate and reform policies to address prevalent inequalities in education, including science education in

Nigeria (Ekine, 2013; Kuczynski et al., 2014; McLaren, 2017). Policies and legislations link to inequality in Nigeria as presented next.

2.7.3 Policies and Legislations that Seem to Address Gender Inequality in Nigeria

In Nigeria, despite the commitments in policy statements (see Table 2.3) to provide free and equal educational opportunities, among men and women, there is a prevalence of gender stereotypes and entrenched inequality in the Nigerian society.

Table 2.1 Major Policy Guide and Developments Constructs for Nigerian Education Sector

Year	Developmental construct
1976	Free (UPE) Universal Primary Education was free
1977	National Policy on Education: first published in 1977 but revised in 1981, 1995, 1998, 2004, and 2006 to meet challenges of Nigerian state education
2000	(UBE) Universal Basic Education: one major distinguishing elements of the UBE from UPE was the extension of the scheme to free, compulsory, and universal three years post-primary called junior secondary education (undoubtedly, the federal government never implemented compulsory education due to political and likely religious underpinning).
2004	Universal Basic Education Commission Law. This policy statement was enacted as guiding policy that conscientized the Nigerian Government and education sector on its mandate to provide free, compulsory, and universal basic education for all children of different gender from primary and junior secondary level.

The inequality is more in the northern parts than the southern geographical area in Nigeria, the reason being that cultural, ethnic, political, economic, and religious identities and bias led to rejection of western education brought by Christian missionaries that was not accepted by Northern Muslims. Consequently, fundamentalist views on religion reinforced and maintain the entrenched inequalities, poverty, and violence in the north. The northern region is largely Muslim, while the middle belt, which is part of Northern Nigeria is about 40 % Muslim and 60% Christian and has more educational opportunities. The southern region is predominantly Christian with pronounced higher educational literacy rates and outcomes. The southern region

is educationally positioned because of the perceived change and transformation promoted in the formal western education brought about by the Christian missionaries. However, the northern geographical space embraced Arabic education as an ideological apparatus that in some ways may have further oppressed and dominated women and some men from accessing western education and political resources (Anyadike & Nkechi, 2013; Lincove, 2009). The fundamentalist ideology promoted gave rise to likely entrenched violence and gender assault among men and women in the northern region that is visible. For example, from 2013-2021, the security challenges such as Boko Haram, banditry, kidnappers may be partly a product of the absence of educational and political equal opportunities and lack of inclusiveness that has affected student's education throughout Nigeria but with devastating impact in the northern axis.

Female students are worst affected, due to targeted kidnappings of female students in schools. This and financial pressures have led to female dropout rates in the northern region being higher than in the southern parts of the country. The government's developmental response to educational conflict, assault, violence, and redressing underrepresentation of females seems completely overshadowed by the security challenges and response initiatives, which remain elusive, as insurgents in the form of Boko Haram, kidnappers and bandits are increasingly killing and destroying men and women in Nigeria. This has undoubtedly affected the social cohesion and economic growth by impacting on the Gross Domestic Growth (GDP) of the country, as reported by United Nations University (UNU) (Pieri, 2019; Schmidt, 2020).

The current COVID-19 pandemic has disrupted schools and schooling process all over the world, Africa and in Nigeria. As a result, 1.5 billion learners and students were affected in more than 190 countries as surveyed by UNESCO. Due to the Covid-19 pandemic, UNESCO estimated about 11 million more girls between the ages of 12-17 years than boys of the same age may not return to schools. Therefore, failure to prioritise the needs of women and girls in the COVID-19 response by government has further entrenched gender stereotypes and inequalities in education and particularly science education in Nigeria, Africa, and globally (Dillon & Avraamidou, 2020; Eseyin, 2020; Joseph, Alika, Genevieve, & Thobejane, 2021).

Although in Nigeria there were conscious commitments by government to provide equal access to education for both men and females from primary to tertiary education in the country, the Nigerian government has not explicitly addressed the challenge of gender inequalities in

education and science education. This is likely due to the absence of accurate statistical data on education, lack of adequate power supply, lack of technological E-learning and online resources, and reduction of budgetary allocations to education by both democratic and military regimes, which was attributed to the decline in oil revenue. This is also partly due to lack of critical awareness of the dangers of gender stereotypes and inequality. Further, I perceive the sector is also mismanaged by corrupt administrators and science educators and teachers who perceived education as credential mills for profit making; when curriculum reforms are enacted, they are used to privilege a few rather than used to promote critical skills and citizenship education for genuine morality, change and transformation (Ball, 2018; Ewuim, Agbodike, & Igbokwe-Ibeto, 2015).

There is still political, gender activism and intellectual mobilisation needed to re-work the legislative and government focus on gender issues, the reason being that, when a bill was sent to the higher chamber of national assembly called the senate, the bill that could have brought change and transformation for women was outright rejected. Both the legislature and the government need to be more conscious of the need to increase budgetary allocation to education, reduce corruption, enact critical policies and embark on genuine gender education curriculum reforms. In addition, the government could disrupt the existing gender laws to position education, and particularly science education, to catch up with higher education global rankings to attract economic growth and transformation. For example, the government expenditure in education has been dwindling and discouraging due to the infiltration of political and religious elements into education sector. When the Nigerian government launched UPE in 1976, federal and state public expenditure on education was 24.7% compared to 16.4% in 1975. For example, the Federal Ministry of Education's national budget was reduced from 8.6% of the national budget in 2006 to 8.35% in 2008, 7.4% in 2017 and 6.07% in 2020. This is inadequate because, based on UNESCO recommendations, 15% to 20% of the national annual budget should be allocated to education by developing countries such as Nigeria, to reposition education to international levels. An increased budget could attract foreign investors and international students, enable training of staff and students abroad, increase wage pay of staff and fix dilapidated infrastructures, thus stimulating economic growth, peace, and developments (Ezze, Asogwa, Obetta, Ojide, & Okonkwo, 2020; Ogunleye, Owolabi, Sanyaolu, & Lawal, 2017).

Despite several commitments to providing free universal basic education and equal opportunity, government budgetary expenditure on education has been declining over the last two decades due to the government and legislature's lack of awareness that education could bring about change, position the country for economic growth and address social justice issues. Worst still, is the fact that the 4% to 6%% of total GDP recommended by Sustainable Development Goals number five for quality and equitable educational opportunities is given less attention by Nigerian Government. Instead of increasing the budget for quality and transformative education and particularly gender education for sustainable development, the government attention has shifted to the works, housing and security sectors as areas of priorities. The security challenges could be partly due to absence of critical and citizenship education for equality, change and transformation. The absence of quality and moral education could worsen the security challenges in the nation as is visible in colleges of education, polytechnics, and university in Nigeria today. Thus, the Nigerian state may lack critical educators and students with ethical orientations for change and transformation for peace and social justice in the Nigerian state (Eze, 2020; Nteegah, 2020). Therefore, I submit that the lack of critical awareness of destabilising effects of inequality and equality consciousness possibly has led Nigerian government and stake holders in education to subordinate females in appointment thus decreasing their participation, enrolment, critical thinking and creativity for transformation in the democratic nation.

2.7.4 Inequality of Men and Women in Participation and Appointments in Colleges of Education in Nigeria

The National Commission for Colleges of Education (NCCE) is the federal body enacted, protected by law, and dedicated to overseeing non-university teacher education such as federal and state colleges of education and polytechnics. Since the establishment of such colleges Nigeria, there have been widespread discrimination and stereotyping of females in appointment of managerial positions, enrolment, and participation in science education spaces. The discriminatory practices not only exclude women from positions of leaderships but further discriminate against, dehumanize, and render females to second class citizens. Females are generally perceived as individuals who lack the moral and the intellectual ability and political capability to steer the affairs of these institutions for growth and developments. The exclusion strategy is visible in science federal colleges of education, state colleges, polytechnics and universities where women are excluded from such posts as Chancellors, Vice-chancellors,

Provosts and Rectors, but are sometimes given the office of registrar or librarian. More so, it believed that men are more capable and can drive change and development faster due to their intellectual ability, power and perceived agentic behaviours (Abdullahi, Abubakar, Abubakar, & Aliyu, 2019; Adamma, 2017). Yet these institutions of higher learning managed mostly by men could not change and transform the educational institutions fast enough to reckon with the Africa and global higher education ranking. The Times Higher Education (THE) global ranking research output shows that Nigeria is far from occupying any of the 200 positions of top best universities in the world in the global research and scholastic knowledge production. This situation is alarming, and it is likely that most administrators have little passion for intellectuality and research endeavours and thus mismanage resources at their disposals. Instead, they promote ethnic, religious, and socio-political gender discrimination at the expense of critical, citizenship, and transformative skills for emancipation and self-independence of students. Even if women are given a little opportunity, the stereotypical political and religious men will negotiate and re-negotiate to deny or remove them from the office for perceived incompetence. This has grave consequences on the emotional and mental ability of women and in particular female educators and females' students in education. Students who perceive this stereotypical physical assault on women nationally suffer in terms of their emotional state and intellectual confidence, leading to a decrease in female enrolment, access, interest, and performance (Bako, 2018; Paulsen, 2018).

Besides inequality in participation, enrolment, and achievements of females, the textbook materials in science education curricula perpetuate biased language and content and portray science as a male dominant field. Although the current science education textbooks in Nigeria are characterized with fewer sexist materials than those of the past 35 years, there are still few materials that depict female engagement in the pursuit of science, while those that do still maintain cultural gender stereotypes. They continue to reinforce dominant expectations that reflect more men than women, due to lack of awareness and understanding of gender inequality issues that impact on educational opportunities for women (Miller, Eagly, & Linn, 2015a; Paulsen, 2018).

2.8 UNDERSTANDING SCIENCE TEACHER'S CONSCIOUSNESS OF GENDER ISSUES IN SCIENCE EDUCATION

This section describes teacher's realisation and understanding of gender issues, in particular gender stereotype reproduction and subversion in science education space. I present the stereotype threat linked to gender differential roles, then feminist resistance, feminist reproduction theory and counter-hegemony, professional development and teachers as transforming agents.

2.8.1 Teachers' Awareness and Understandings of Gender Issues in Science Education

Researchers note that there are studies conducted in Africa and internationally on gender issues that focus on gender in relation to post-high school and tertiary education. Also, there are few concerns on science teachers and students' engagement with gender, sexual emotions and patriarchy in their schooling. More so, despite the encouraging success of females and research output in STEM, there is little focus on power relations as they affect teaching and learning in science (Essien-Wood, 2010; Lahelma, 2011). For example, in the USA, a study conducted on high school teachers' practical knowledge of gender linked to professionalism, teaching, and learning environment revealed that most of the science teachers perceived that the teaching and learning of science is not influenced by learner's gender. Also, a study conducted by Chikunda (2010) on college science teachers' gender awareness in Zimbabwe found that few of the science teachers had a significant level of gender awareness in their teaching engagements (Chikunda, 2010; Mdlolo, 2017). This investigation revealed that most teachers believed that science was a "factual, or objective discipline that was not affected by people's background, culture, attitudes or gender" (Chikunda, 2010, p. 110). This shows the little effort done by African higher education institutions to conscientize science teachers and educators on gender issues. It was also reported that in Lesotho, the Basotho cultural beliefs and entrenched cultural gender norms which are male dominated, influenced Lesotho science teachers to promote gender inequalities in schools. It was found that teachers sometimes stereotype, hence give more attention and likely favour the male learners more than the females, based on their stereotypical historical, political and socio-cultural backgrounds (Chikunda, 2010; Monyemore, 2000; Morojele, 2014).

The researcher therefore recommends teacher development gender programme for science educators and practicing teachers as well as curriculum reformation for equality in global arena and in Africa, particularly Nigeria.

Although Nigerian research into equality, gender stereotype and reproduction seem limited, this is because most scholarly work centres on the lack of gender engagement enrolment, performance, appointment disparity of male and female in science education and patriarchal orientations. Often it ignores power relations, sexuality and the cultural elements that influence schooling and higher education teaching and learning practice as does the work of policy makers and curriculum reformers. But there is hope for consciousness re-awakening, and this may likely be done through feminist critical reproduction theory and critical consciousness to produce knowledge that could revitalise the inequitable gender science classrooms for change and transformation (Deem, 2012; Ekine, 2013; Giroux, 1983a).

In South Africa, science teachers' views and understandings of gender issues resonate around the different roles given to males and females through cultural and socialization differentials. These gender divisions have culturally underpinned what goes on during teacher-student engagements in school. However, Black African traditions give husbands more authority and power as heads in the homes. This perception is then conveyed to the science classrooms by females who think that males should always dominate and lead in school practices, as if this was a home where fathers have more power and authority in running the home affairs. More so, teachers with male dominance consciousness give more attention and positive reinforcement to boys due to entrenched gender stereotypes (Morojele, 2014). A study conducted by Morojele on gender equity of teachers' understanding in three rural primary schools in KwaZulu-Natal in South Africa found that most teachers believed that learners are socialized into gender roles from homes and are brought up differently in isiZulu customs and traditions, hence are differentiated as boys and girls into division of labour with varied outcomes (Mdlolo, 2017; Morojele, 2014).

Also, in South Africa, Moletsane and Reddy (2011) conducted a survey study on 735 science educators from Mpumalanga, KwaZulu-Natal, Eastern Cape and Gauteng provinces on gender equality in the Mathematics and science school curriculum. These educators were found to have limited knowledge on national or international gender strategies and policies that could encourage girls' participation, enrolment and gender equity and equality in mathematics and

science. The findings also revealed that about 80% of science teachers agreed that there was a need for different gender models for teaching mathematics and science in institutions of education. The teachers indicate that 40% of textbooks are male orientated; 77% of the teachers perceive that there should be activities, strategies, and initiatives to promote girls' interest, participation and performance in mathematics and science (Mdlolo, 2017). Due to the limited teachers' awareness and understandings about gender equality issues in science education there should be emphasis on creating awareness through discourses that centre on gender transformation and change, for example, promoting critical feminist theories and critical gender consciousness models. This is because teachers are agents who have transformative potentials not only to reproduce but have awareness to subvert gender stereotypes to change and emancipate students (Dawson, 2017; Stoet & Geary, 2018). Therefore, I submit that educators and pre-service teachers with adequate gender reproduction and subversion consciousness could challenge normalized oppressive practices that impact on their intellectual, political and economic growth.

2.8.2 Educators' Awareness and Understanding of Gender Stereotyping, Reproduction, and Subversion in Science Classes

Science educators generally have little awareness and understanding of how gender inequalities are reproduced and subverted. Reproduction and subversion could be filtered into the classroom in multiple and interrelated ways consciously and unconsciously by teachers and students. Therefore, both science educators and students usually ignore how cultural reproduction of gender stereotypes seep into the science classes that affect their classroom engagements. More so, science educators have little awareness on student behaviours and sometimes attempt to ignore subversive acts of students (Chikunda, 2010; Lahelma, 2011). They consider student resistant attitudes to teachers and school authority as antisocial behaviours that sometimes attract sanctions. Yet there are minimal theoretical and empirical research studies on how educators can counter hegemonic practices in science classes and there are only a few feminists' critical theorists that highlight counter-hegemony as a political struggle. While gender inequalities are perpetrated and reinforced in schools by teachers and students based on the structure and content of the overt and hidden curricula, they have also been criticized for reproducing and legitimizing inequalities. Therefore, schools are perceived as conduits for the production and reproduction of social oppression and inequalities, impacting on women and

their educational and career pursuits (Chikunda, 2010; McLaren, 2017; Simuforosa & Shamiso, 2016).

For instance, findings of a study by Chikunda on the performance of women in physics and chemistry modules revealed that female students do not identify with the physical sciences (Chikunda, 2010). This is because physical science subjects such as physics and chemistry are viewed as masculine and are perceived as difficult, while life science courses such as biology are considered feminine and easier to study. Gender biases are expressed in these subjects through classroom gender practices, language, images, and text materials that make girls perceive that they cannot perform well as boys. More so, science educators' practices show that science is mainly for boys. Hence, they motivate and give more attention to the male students than the females in the class. Empirical studies show that some science teachers sometime discourage girls from pursuing science subjects, thus encouraging them to concentrate on food and nutrition, fashion and fabrics as their area of study and work (Francis & Paechter, 2015; Simuforosa & Shamiso, 2016). This type of subject categorisation is what is described as gender typing (Ali & Gordon 2018).

Scholars also reveal that science teachers stereotype in the class by assigning tasks to male students and female differently. These teachers sometimes are unaware that they are reinforcing existing gender differential roles linked to the domestic and physical labour of girls and boys (Chabaya & Gudhlanga, 2013). Teachers' stereotypical attitudes are also visible where females are made to sweep the classroom while boys serve as class leaders, handle physical jobs such as arranging the chairs and laboratory equipment, chores that are linked to the reproduction of masculine and feminine attributes. More so, discriminatory behaviours and gender norms regarding such domestic roles as cleaning the classroom could be part of exclusionary measures that cause females' underperformance, lack of participation, emotional disharmony and a high drop rate for girls in education. Also, in sporting activities it is evident that boys are encouraged to handle cricket, rugby and football while girls are stereotyped to enter and participate in netball and hockey spaces (Chabaya & Gudhlanga, 2013; Olive & Thorpe, 2017). This resonates with Apple who claims that:

> We need to change awareness amongst girls and boys about these gender expectations and stereotypes. And we need to also target teachers and the pedagogues that are unaware of the gender-based behaviours that they are

> producing. What we want to do is to give the girls and boys a free choice (Apple, 2017, p. 5).

This show that when we ignore conscientizing educators, pedagogues, and students on the danger of reproduction of gender stereotypes and subversion thereof, students' free choices will be stifled, entrenching gender stereotype effects in education due to gender socialization process and ideology.

Drawing inspiration from critical theory, critical consciousness and critical feminist reproduction theories, I argue that the ingrained gender stereotypic effects could be challenged through appropriating critical awareness about oppression then invoke cultural feminist transformative resistance, organized political activism, and counter-hegemony democratic strategies for change and transformation

2.9 FEMINIST RESISTANCE AND CULTURAL REPRODUCTION THEORY

Feminist reproduction theory is concerned with the ways schools' function to reproduce gender divisions and oppressions. In response to this emphasis on the reproduction of inequality, a growing body of feminist work has emerged that employs the concepts of resistance and cultural production to look at the lived experience and opposition of girls in schools. These theorists emphasise the ways in which schooling reproduces existing gender inequalities, with reference to ideological function of texts and classroom practices thus, reinforcing patriarchal hegemony. More so, much of the feminist work is grounded in Marxist class analysis, therefore, it has focused on the connection between schooling and women's paid work force associated with inequality (Deem, 2012; Kahl Jr, 2015; Kelly & Nihlen, 1982). This feminist approach helped us to unmask the limitations of all-encompassing view of social reality such as Marxist theory that fails to consider human beings as agents who can contest and redefine the ideological messages they receive in schools. In response to these limitations, feminists have begun to examine girls' and women's experiences in schools from perspectives of resistance and cultural production theories. Hence, they caution against the traditional concept of resistance which has been used as counter school or antisocial actions. They aver that this definition is inadequate to explain or understand the lived experiences of girls or women. This is because resistance has different meanings for boys and girls and that girls' resistance can only be understood in relation to both their gender and class position. These theorists insist that women as well as men can resist domination and oppression and they as well as men negotiate

social forces and possibilities to meet their own needs. But because they are oppressed by sexism as well as class, the form of their resistance will be different from that of men. Moreover, schooling may have different meanings for them than it has for boys of their same class or race (Ashenden, Connell, Dowsett, & Kessler, 2020; Davies, 1983; Gaskell & McLaren, 1991). Drawing from the function of schools as linked to inequality, Gaskell comments:

> Schools operating in their traditional function, do not simply reproduce sex-stereotype or confirm girls in subordinate positions. Certainly, they do that much of the time. But they have also long been a vehicle for women who wish to construct their own intellectual lives and careers (Gaskell, 1985, p. 55).

It is observed that girls and women with different race, gender and class subjectivities will have different experiences in schools. Both their resistance and their 'reading' of ideological messages of schools will differ in specific school settings. It is anticipated that girls of different class and race subjectivities will be met with varying expectations on the part of the white and black, male, and female teachers, depending on these teachers' own views of what is gender appropriate. Most recently the concept of counter-hegemony has been introduced as a way of approaching the politically conscious work of teachers with focus on the different experiences of girls and women in schools combating power of hegemony through feminist counter hegemony perspective (Darder, 2017).

2.9.1 Feminist Teaching as Counter-Hegemony

Researchers conceptualize counter-hegemony as not only resistance in the form of various kinds of opposition to oppressive beliefs and practices in schools and the society, but also to include more critical and politicized work in the form of organized and conscious collective oppositional actions. This means the creation of a self-conscious analysis of a situation and the existing order and beginning to build the base to theorise for a new understanding and transformation of the society (Arnot, 1982; Mayo, 2017). Freire's view of critical teaching in a dominant institution leaves teachers in contradiction, but possibilities exist within that very contradiction. Hence it is vital that teachers recognise not only the structural constraints under which they work, but also the potential inherent in teaching for transformative and political work. The concept of resistance highlights the need for classroom teachers to evaluate cultural production of gender stereotypes displayed by dominant and subordinate groups and to reveal both the limits and possibilities for enabling critical thinking and analytic discourse. Thus, the

ability of students to resist and the forms of subcultural resistance become the focus of critical teaching, which is considered as part of counter-hegemony. In this sense the school can provide the site for feminist teachers to raise issues of sexism, race, class, and gender to democratize the school structure for critical citizenship (Butler, 2011; Giroux, 2016; MacDonald-Vemic & Portelli, 2020).

Stemming from the argument of Kessler, Ashenden, Connell, and Dowsett (1985) on the need to democratize the curriculum by reorganizing knowledge to advantage the disadvantaged and mobilise support for democratisation of the schools in relations to gender and structures of power, I perceive resistance of students as an important basis for the building of counter-hegemony, as teachers and students together struggle to understand the gender and institutional forces acting upon their lives by dismantling these forces. Thus, the researcher observed that using the critical feminist approach of counter-hegemony will enable science educators and pre-service teachers to see what is problematic in the science classroom, and appropriate political and democratic possibilities for fundamental social changes that open up for women at the centre of our economic and social transformation. This can only be achieved if there is awareness and professional development on gender issues (Giroux, 2017b; Riddle & Apple, 2019; Weiler, 2017).

2.9.2 Teacher Education and Professional Development

Researchers argue that teacher educators perform a multitude of complex and contradictory roles in schools but have minimal possibilities for professional development to retain these roles. As a result, they need to acquire relevant knowledge and skills as teacher educators. Therefore, it is important that these educators have the skills and knowledge necessary to navigate classroom dynamics throughout their professional career (MacPhail et al., 2019). This is because the quality of teacher education has been conceptualized as a vital element undergirding the quality of teaching and student's achievement and progress. Teacher educators can be perceived as intellectuals who are committed to educating their students and ensuring continued professional development, including that of pre-service and in-service teachers. The quality of any teacher educator depends on their identity, skills, roles and professional development (Loo, 2019; Malm, 2020). Teacher educators in higher institution of learning need to connect research and teaching to critical skills and knowledge on gender issues. Therefore, researching their practices collaboratively raises teacher educator's awareness of contradictions

and complexities between their vision, beliefs and real practice in education, which will enable them to explore new gender possibilities in teaching and learning. This is because critical research will challenge taken for granted assumptions and practices in schools and the social world. This aims to transform teacher education rather than add improvements to the existing system of education (Murray, 2010). Transformation is possible because teacher educators act as mediators between academia, schools, and local communities. This reminds us how teacher educators can be positioned as professional intellectuals or as researchers in universities and colleges of education with critical gender insights. Educators can only be aware and understand gender dynamics and practice effectively in the classrooms if they develop their own professionalism further (Vanassche et al., 2015).

2.9.3 Professional Development

Professional development connotes developing teacher for quality lesson, ethical relationships, and career mobility (Smith, 2017). As he comments:

> The most important lesson I have learned as a teacher, teacher educator, researcher, and leader are the fact that the quality of our work depends on the relationships we establish with people whether these are students, respondents, or colleagues. It is a question of respect and trust, empathy, and ethics that are at the heart of educators. When strong relationships have been created, learning opportunities are endless (Smith, 2017, p. 641).

The current debates on professional development show that educators and teachers can enhance their professional developments by self-initiation and determination to move out of the comfort zone of mediocrity or inferiority to seek new challenges and collaboration with colleagues. In this model, teacher educators can participate in formal and informal consultations with colleagues by promoting and conducting research that develops them and their students professionally. This approach foregrounds investing and skilling educators to appropriate affordances daily to become a teacher or teacher educator undergirded by research and practice-based evidence. A survey study conducted by (Mahlaba, 2020) on academic professionalism shows that professional development preferences are categorised into two: educators with PhDs aligning with skills such as scholarly writing, empirical search for knowledge and presenting articles at conferences; a teacher educator with master's degree, who develop educational capacities like assessments, methods and teaching strategies in teacher education. As

researchers argue, the science education curriculum is embedded with controversies, thus need reformation and professional development of educators to enhance students' skills and achievement. Student achievement, motivation and interest would only be guaranteed if science educators' professional development is given attention for effective classroom delivery. But educators must strive to become self-directed learners to understand the dynamics of gender teaching and learning by reconstructing their science identity (Mahlaba, 2020; Mockler, 2005). This leads us to science educators' developing science identity in the classroom.

2.9.4 Science Identity

Science identity impacts the occupation of science and serves as a mediator for other elements, such as self-esteem, that is, confidence of oneself, and self-efficacy, meaning the ability to complete science tasks and the prominence related to educational success.

> An identity is a set of meanings that define who a person is in terms of role identities, group or category memberships – social identities, or as unique individuals – person identities" (Burke & Stets, 2009, p. 22).

Identity can mediate behaviour and move persons into structural positions within and across institutional contexts. Therefore, an individual who thinks of himself or herself as a science educator or science student will act in ways that convey real meanings to other colleagues and to herself/himself. For instance, both science teachers and students who see themselves as excellent or very good in mastering scientific skills and activities can be perceived as having a higher science identity. Of course, this shows how higher science identity can direct one to negotiate a science career and determine self-efficacy and the self-confidence to perform (Hazari, Brewe, Goertzen, & Hodapp, 2017; Lapsley & Chaloner, 2020; Stets, Brenner, Burke, & Serpe, 2017). Further, gender has been shown to influence science identity connected to self-efficacy. This is because science identity depends on female or male deposition to activities and science achievement. In this sense, educators and students need to continuously develop their science identity to navigate gendered science classrooms for effective transmission of knowledge to students for change and transformation. Change and transformation praxis is linked to identity and autonomy and academic qualifications (Henkel, 2005). For instance, black girls have obtained academic qualifications as an assertion of their own competence and intelligence that was denied them in the black culture as girls. Using identity and autonomy, Black girls from working class families have become conscious of and rejected sexist and

sexually violent attitudes of black boys that were oppressive to them. This has made them to evoke their identity and autonomy by asserting their femaleness to resort to working for wage labour. Further, these girls were also conscious of their family's double standard in which they were expected to do unpaid work while their brothers could be out of the house. In this sense, girl's rejection or opposition is an act of resistance through evoking their identity and collective struggle to negotiate control of their lives for transformation and collective existence (Fuller, 1980; Starr et al., 2020). Therefore, I perceive educators and students as transforming agents with gender awareness could invoke their autonomous potential to subvert oppressive practices in colleges and universities that threaten their humanity and self-determination for intellectual transformation.

2.9.5 Teachers as Transforming Agents in Schools and Colleges

Scholars assert that teachers are failing to position students for moral citizenship. This shows the importance of teachers and educators as transformative agents in schools and the society. This is because they are responsible for organising and defending schools and enacting political and democratic elements to reposition higher education and students for intellectual, moral, and civic responsibilities in the society. Further, they should see themselves as transformative intellectuals who combine scholarly reflection and engagements to educate students in critical skills, morality and social justice (Apple, 2017; Giroux, 2010b; McLaren, 2017). Teaching in public schools, although bounded by institutional contradictions and constraints, holds the possibility of transformative work. This does not mean that there will be no stiff opposition to attempts to disrupt the inherent constraints and complexities to achieve desired goals. Therefore, teachers need to evoke their personal power in form of autonomy to challenge the problems inherent in schools and achieve change and transformation. Inspired by Gramsci's revolutionary theory grounded in the struggle for everyday life, researchers argue that feminist theory and women movement are undoubtedly grounded in the struggle to make the personal subjectivity, a political endeavour (Lather, 1984a; Weiler, 2003). This re-echoed the need to "democratize the curriculum by re-organising knowledge to advantage the disadvantaged; and to mobilize support for democratisation of schools in relation to gender as much as other structure of power" (Kessler et al., 1985, p. 46). In this sense, the Gramscian idea of counter-hegemony can be applied in teaching work as it aims at collective public struggle in schools and society through making the personal political to achieve moral and gender transformation (Deem, 2012; Lather, 1984a; Schuster, 2017). As Lather succinctly elaborates:

> The task of counter-hegemony groups is the development of counter-institutions, ideologies, and cultures that provide an ethical alternative to the dominant hegemony, a lived experience of how the world can be different (Lather, 1984b, p. 55).

Drawing on Lather's conceptualisation of opposition and counter-hegemony, Weiler (2017) highlights the difference between counter-hegemony and resistance thus, emphasizing that "opposition in the form of resistance is usually informal, disorganized, and apolitical", but that counter-hegemony implies a more critical theoretical understanding and is expressed in organised and active political opposition to cultural reproduction of oppression and domination in education that could change and transform the gendered world (Weiler, 2017, p. 273). But I perceive that resistance and/or oppositional consciousness can be reinforced in education because it is likely to be a vital component of ideological and structural transformation.

2.10 CONCLUDING REMARKS

In chapter two, I foregrounded the key concepts as feminism, sex, gender, stereotype, reproduction and subversion in education, science education and the social space. Then, I theorized society and education as agents of socialization, gender and division of labour. I discussed hegemonic masculinity, gender and science, and the entanglement of science education with science and gender. This chapter also provides an account of correspondence theory in education linked to power and oppression, neoliberalism in education and the dominant economic ideology, arguing that the dominant capitalist ideology with its profit consciousness has infiltrated education and particularly science education. Therefore, this dominant paradigm has conditioned both students and science teachers to believe that schools are marketplaces for the sale of commodities rather than spaces for moral positioning, citizenship, and transformation. This marketisation of education has further held both science educators and students back from critical research, critical skills, moral and citizenship learning endeavour that have the potentials to transform the world.

I also focus on gender and power, gender and schooling, gender inequality and equality in society, drawing attention to gender inequality in the Nigerian space, policies and legislations on inequality, comparative engagement and appointment of men and women in the colleges. This section accounts for science teachers' awareness of gender issues, understandings and consciousness of gender stereotypes, reproduction and subversion in science classes, and the

effects of stereotypes threats on female and male in education. The chapter illuminate feminist resistance in the form of opposition to school ideology, then feminist reproduction theory and feminist teaching as counter-hegemony. Furthermore, this section foregrounds teacher education, professional development and a science identity that could prepare science educators and students for a new gender order. The chapter ends with transformative potentials of science educators, students and pre-service teachers as agents of reforms.

A critical review of literature revealed that there is little awareness and scholastic knowledge produced on gender stereotypes and their reproduction in science education in colleges of education and probably university education in Nigeria, because most empirical and theoretical discourse focuses on superficial knowledge generation that highlights female's engagements, enrolment and performance in science education classrooms using quantitative data. More so, some scholars who conducted gender research in education and adopted qualitative methodology approach focused on gender inequity, inequality and stereotype threat effects on performance and career choices, ignoring how cultural gender stereotype could be reproduced replicated, and disrupted in science education. For instance, Mustapha (2010) argued for gender representations in schools and Ayodeji (2010) contented for gender stereotype and practices in learning environments. These contributors though have provided some significant ideas, ignored the dynamics of gender, patriarchal orientations and entrenched power relations that have influence on educators' and students' engagement in science for change, empowerment and transformation. As a result of this, researchers, science educators and students fail to recognise how gender stereotypes are reproduced, and the need for them to be disrupted for the liberation and emancipation of women. This transformative and change possibility in education could provide social justice space for peaceful living and prosperity for all humanity.

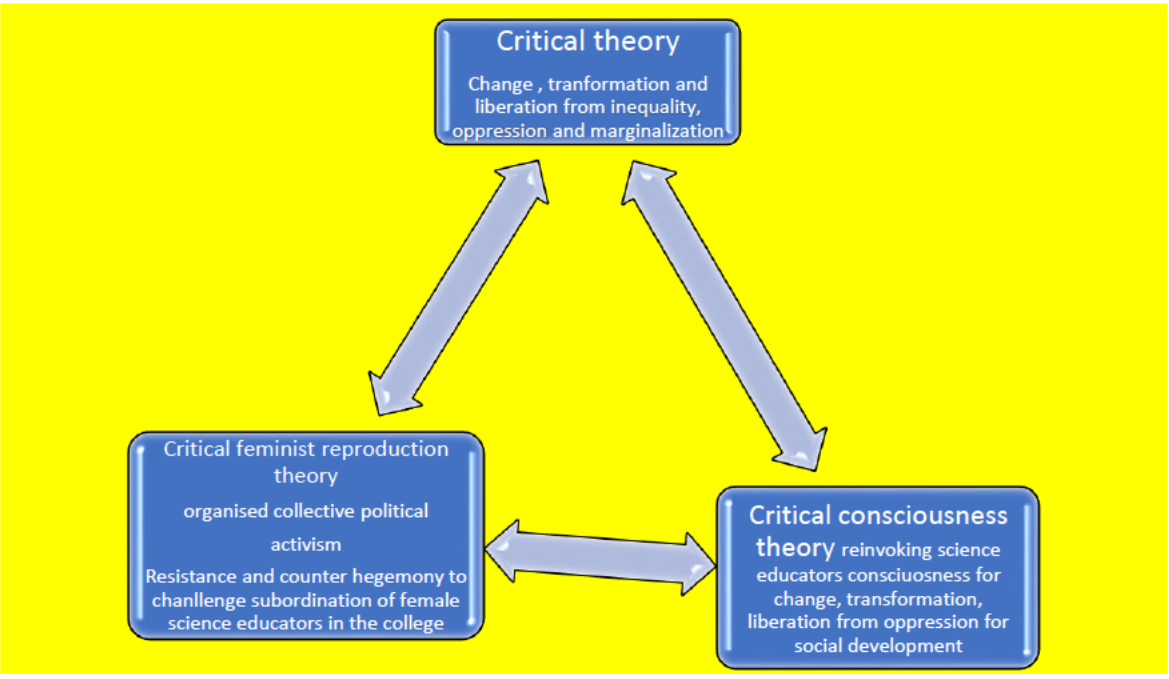
CHAPTER 3
THEORETICAL FRAMING

INTRODUCTION

In chapter 2, I theorized the reproduction of gender stereotypes in science as the main theme. I reviewed literatures in the following subthemes - feminism, gender and sex, gender stereotypes and reproduction, hegemony and science teachers' awareness of gender stereotypes and reproduction. Then I provided an account of neoliberalism, correspondence theory, professional development, science identity and teachers as transformative agents.

In chapter 3, I foreground the model of three theories, namely Critical Theory (CT), Critical Feminist Reproduction Theory (CFRT) and Critical Consciousness Theory (CCT), with major constructs of inequality, marginalization and gender stereotyping, liberation and transformation. The three theoretical framings serve as the pillar to illuminate the study. Herein, I discuss how CT, CFRT and CCT underpin this research by drawing foundations from Paulo Freire's critical theory. Also, I present the relevance of each theory to the research work and conclude the chapter.

Figure 3.1 A Model of Critical Theory, Critical Feminist Reproduction Theory and Critical Consciousness Theory



An account of how each of the theory interconnects is provided the next section

3.1 CRITICAL THEORY

Critical theory in education originated from the criticism that educational research was too technical and concerned with only efficiency and rationality of design, neglecting social inequalities, liberation and issues of power (Gage, 1989; Mack, 2010). To critical theorists, there is the possibility that researchers also focus on the political and economic foundations of how knowledge, curriculum and teaching are constructed. Thus, the dynamics of schools should be interrogated because these play a vital role in the construction of knowledge, based on power in the society. Critical educational theorists perceived school knowledge as historically, economically and socially rooted, and interest bound (Freire, 1972b; Giroux, 1984; Horkheimer, 1982; Sharp, 2017). Thus, "knowledge is a social construction deeply rooted in a nexus of power relations" (McLaren, 2017, p. 58). To them, education usually serves the interest of those who have power in the society. Schools function to reproduce these oppressions and maintain the status quo. I perceive that critical theory perspective has conscientized individuals in education and the social world of the entrenched stereotypic practices against humanity which needs to be challenged for freedom.

Nonetheless, critical theory is criticized for its elitism or exclusivity because it assumes that everyone needs to be emancipated and transformed and that its approach is superior in knowledge production. More so, critical theorists claim that they have been emancipated and transformed and therefore are better equipped to analyse society and transform it than others. Further critique shows that there is a lack of evidence from the critical pedagogues that illustrate what happens when you become emancipated, transformed, and gain a critical consciousness. Is there any evidence that shows that once someone attains a critical consciousness and is transformed, he/she stops reproducing inequalities that subtly oppress people? Thus, further criticism shows that critical research has a deliberate political agenda, not objective and does not remain neutral in research (Mark 1998, p. 6). This re-echoed Lather's concern that: "Critical theory is male centeredness and search for historical actors are possible for fundamental social change that opens when we put women at the center of our transformative aspirations are explored." (Lather, 1984a, p. 11). Critical theory, proposed by Paulo Freire in 1972, is underpinned by transformation praxis, encourages creative teaching and learning, discourages the "banking" concept of education where students are confined to classrooms and are perceived as empty bank accounts without autonomy, to be filled with uncritical information by teachers (Freire, 1972b, p. 77). This impedes critical thinking and creative ability, therefore

making change and transformation of students and teachers difficult. These are people who could be modelled into critical individuals with autonomy and political awareness, who can critique social inequalities for transformation (hooks, 2010; Jefferson & Anderson, 2017; Shor, 2012).

Critical theory enacted by Paulo Freire is a social perspective geared toward critiquing and changing society through critical, democratic, and political means (Horkheimer, 1972; Weiler, 2017). This contrasts with typical constructivist theory orientations that only seek to understand or explain the social space. Therefore, critical theorists aim to dig beneath the surface of social life, to uncover the lingering and embedded oppressive assumptions that blind us from a true understanding of how the world is interconnected and constructed with regard economic capitalist agenda. In this study, critical theory aims at liberating and emancipating marginalized individuals such as female educators and pre-service teachers from economic, political, and intellectual inequalities and oppression in the world, in particular within science education in Nigeria. I perceive that using CT may empower science educators, male and female pre-service teachers to question entrenched gender stereotypes reproduction beliefs and power relations that threaten their progress in the college, science education space and the society. Critical theory may likely empower science educators and pre-service teachers in the college with critical skills to subvert the patriarchal, undemocratic, and apolitical science education environments, in the interests of change, transformation and social justice. Critical theory, if substantially appropriated, has the potential to equip science educators and pre-service teachers to think critically and creatively during class engagements. The liberatory potentials of critical theory can be achieved collectively by the researcher, science educators and pre-service teachers through student association meetings, peaceful group activism, workshops, discussions, and media consciousness to challenge cultural gender discriminations and stereotyping in the college and the society. With critical theory awareness I, educators and pre-service teachers may reach out through the Internet, media and organised collective visits, to government, politicians and parliamentarians to rethink laws and policies that side-line women in education and the society.

Critical theory has served as the foundation for other two theories, CFRT and CCT, the basis being that power relations that inform marginalization and dominations of individuals must be challenged for economic and intellectual freedom and empowerment. Therefore, in this study I perceive that science educators and the pre-service teachers may be ingrained in critical

theory, critical feminist theory and critical consciousness, with the realisation that the capitalist dominant ideology and curriculum structures may be responsible for gender inequality and domination in education and society, which need to be dismantled. Critical theory and other two perspectives aim at change and emancipation of marginalized individuals such as science educators and pre-service teachers, creating the possibility of epistemic freedom and transformation. CT emerged out of the Marxist tradition of cultural replication of oppressive practices against humanity in the social world that were then critiqued by the critical pedagogues. The theory was developed by a group of critical sociologists at the University of Frankfurt in Germany who referred to themselves as The Frankfurt School (Freire, 1972b; hooks, 2010; Horkheimer, 1976; Weiler, 2017).

3.1.1 History and Overview of Critical Theory

Critical theory can also be traced to Marx's critique of cultural production and reproduction of economy and society. This has led to illuminating how the society is embedded with assumptions of power and domination. This perspective draws inspiration greatly from Marx's theoretical basis on the relationship between economic base and ideological structure. It thus tends to focus on how oppression, power and domination operate in the realm of the superstructure. Inspired by Marx' s critical ideas, Hungarian György Lukács and Italian Antonio Gramsci developed theories that explored the cultural and ideological edges of power and domination. Both Lukács and Gramsci pinned their critique on the social forces that hindered people from viewing and understanding the forms of power and domination in the society. That is, the modes of oppression that exist in society that simultaneously control their own lives. Following the period when Lukács and Gramsci developed and published their ideas, the Institute for Social Research was founded at the University of Frankfurt, and the Frankfurt School of critical theorists came to light. The work of Max Horkheimer, Theodor Adorno, Erich Fromm, Walter Benjamin, Jürgen Habermas, and Herbert Marcuse was linked to Frankfurt School that underpinned critical theory. For example, theorists such as Lukács and Gramsci focused on ideology and cultural forces as elements that facilitate domination and present barriers to true freedom. In this sense, cultural gender ideology reinforces domination and oppression of females in science education. Horkheimer asserted that a critical theory must foregrounds two vital things: it must account for the whole of society within a historical and cultural context, and it should seek to offer a robust and holistic critique by drawing insights from all social sciences (Horkheimer, 1982, p. 3). Further, Horkheimer argue that a theory can

only be considered a true critical theory if it has the capacity of being explanatory, practical, and normative. That is, the theory must richly explain the social problems that exist; it must offer practical solutions to the problem and make possible change and genuine transformation. Further, it must clearly abide by the norms of criticism established by the field. Horkheimer condemned traditional theorists for producing works that ignore questions of power, domination, and the status quo. Thus, he built on Gramsci's critique of the role of intellectuals in reinforcing processes of domination and oppression (Breines, 1979; Feenberg, 2014; Giroux, 2010b; Horkheimer, 1982).

In contrast, Giroux commented that theorists associated with the Frankfurt School focused their critique on the centralisation of economic, social, and political control that was entrenched around them. In adopting such an economic and cultural perspective, the Frankfurt School not only "broke with forms of rationality that wedded science and technology into new forms of domination, but it also rejected all forms of rationality that "subordinated human consciousness and actions to the imperatives of the universal laws" (Giroux, 2003, p. 33). This means that the Frankfurt School interrogated perceived power dynamics and domination in science and technology structures, including the role of human consciousness in changing oppression. The concept of critical theory refers to the nature of "self-conscious critique and to the need to develop a discourse of social transformation and emancipation that does not cling dogmatically to its own doctrinal assumptions". It is a school of thought and a process of critiquing the existing inequalities perpetuated in the social world (Giroux, 2017b, p. 31). Thus, the Frankfurt School was committed to penetrate and disrupt the objective appearances of the world connected to money, consumption, distribution, and production, to expose the underlying social relationships of power. This is because none of the economic and educational realities produced represent objective facts. Rather, they are historical contexts underpinned by ideology of domination and subordination. Drawing from a critical lens, feminists appropriated the gendered biased male-centred consciousness of critical theory to enact feminist critical reproduction perspectives (Deem, 2012; hooks, 2010; Lather, 2017). The relevance of critical theory to the study can be highlighted thus.

3.1.2 The Relevance of Critical Theory to the Study

Critical theory is vital in this research due to its centrality on change, transformation, and liberation of all humanity from coded oppressive practices and from the subordination and marginalization of women instituted by capitalist dominant ideology. A critical model is

necessary because the entrenched subjugation and stereotypical mechanisms will continue to impoverish women, female educators and pre-service teachers. This is because some women and men the world over either remain silent, sometimes lack confidence and /or pretend to remain blind to the dynamics of women's subordination. They are afraid or do not risk entering the gender danger zones to challenge inequality in education and society broadly, the processes that dehumanise women and the marginalized. In this light, critical theory if appropriated, will not only inform the emancipation and moral transformation of science educators and pre-service teachers entangled in a stereotypical gendered environment such as physical science and life science classrooms, but likely will promote a socially just society for peace, growth, development and increased economic output.

Therefore, I argue that critical theory could provide possibilities for the emancipation of women and marginalized educators and pre-service teachers in science education and the social sphere. The reason being that this perspective illuminates critical thinking, change and the moral transformation of individuals in an environment characterized with the reproduction of stereotypical practices and beliefs. The choice of CT provides science educators and pre-service teachers with knowledge to interrogate entrenched gender oppression and marginalization in society, particularly science education. This perspective could inform disruption of the science education curriculum that hinders educators and pre-service teachers' social economic and intellectual mobility and epistemic freedom. The CT could position science educators and pre-service teachers in the colleges of education to be aware that the reproduction of cultural gender stereotype is deliberate and can be challenged and dismantled. This may pave the way for moral ideals, change and transformation of education sector and the entire society. Critical theory may also guide educators and pre-service teachers to question the dominant capitalist economic agenda in the college that subjugate men and women in education and the social world. It has also triggered a model of critical feminist reproduction theory with counter-hegemony teaching as political activism. This is because, counter-hegemony is an organised political and democratic movement that could afford science educators, pre-service teachers and other science students alike the opportunity to navigate and re-negotiate science education classrooms for intellectual engagement to regain their human existence. This act of classroom power sharing has the potential to bring about intellectual and social transformation of science educators and pre-service teachers. It may change or transform female educators and pre-service teachers paid or unpaid work, as advocated by critical feminist reproduction theorists.

3.2 CRITICAL FEMINIST REPRODUCTION THEORY

Critical Feminist Reproduction Theory (CFRT), the pillar for this study, is concerned with the way schools and social world perpetuate and reinforce gender inequality and oppressive practices that dehumanise women/girls in education. These stereotype and subordinate females in both unpaid and paid labour. CFRT was chosen because of its central elements of organized collective political struggle, moral and democratic negotiation, and renegotiation to emancipate women, science educators and pre-service teachers in science education and the social space from subjugated consciousness. If emancipatory knowledge is possible, then educators and pre-service teachers in the college may be liberated and transformed from marginalization, then contribute to socio-economic development, peaceful sustainability and social justice in the world.

Critical feminist reproduction theorists, drawing form critical theory, posit that power relations exist within race, class, and gender in social processes such as schooling through intersection of cultural production and reproduction of subversion and gender stereotyping (Butler, 2011; hooks, 2010). Critical feminist reproduction theory is concerned with the way schools' function to reproduce gender divisions and oppressions. In response to this emphasis on reproduction, oppression and class hierarchy, a growing body of work has emerged that employs the concepts of resistance and cultural production to look at the lived experience of women/girls in schools. This theory has emphasised the ways in which schooling reproduce existing gender inequalities with reference to the ideological function of texts and classroom practices in reinforcing patriarchal hegemony. Thus, because much of the feminist work is grounded in Marxist class analysis, it has focused on the connection between schooling and women's paid work force (Butler, 2012; hooks, 2010; Weiler, 2017). Therefore, in this study, a feminist approach may help educators and pre-service teachers in the college, to understand the limitations of Marxist theory that has failed to consider human beings as agents who can contest and redefine the ideological messages they receive in schools and in the economic world.

In response to these short comings, feminists have begun to examine girls' and women's experiences in schools from perspectives of resistance and cultural production theories. Hence, they have argued against the traditional concept of resistance, which has been perceived as counter school or antisocial action. They aver that this definition is inadequate to explain or understand the lived experiences of girls or women as intersection of family, school, and wage

labour. This is because some feminist theories argue that resistance has different meanings for boys and girls and that girls' resistance can only be understood in relation to both gender and class position. These theorists insist that women as well as men can resist domination and oppression and they, as well as men, negotiate social forces and possibilities to meet their own needs. But because they are oppressed by sexism as well as class and gender, the form of their opposition will be different from that of men. Moreover, schooling may have different meanings for them than it has for boys of their same class or race (Ashenden et al., 2020; Davies, 1983; Kessler et al., 1985). Of course, girls of different class and race subjectivities will be met with varying expectations on the part of white and black, male and female teachers, depending on these teachers' own views of what is gender appropriate. Most recently the concept of counter-hegemony has been introduced as a way of approaching the politically conscious work of teachers with a focus on interrogating different experiences of girls and women in schools linked to power relations. Inspired by critical feminists' view on resistance, I perceive that transformative resistance is vital in education and particularly in science education space. This is necessary because transformation is likely to reclaim humanity from oppressive practices in the world (Cammarota, 2017; Masta, 2018). How then can science educators and pre-service teachers appropriate CFRT? The perspective may be achieved through peaceful organised activism, workshops on gender oppression and marginalization, media and internet platform awareness and associations' struggle such as religious, tribal and student body discussion on gender domination and stereotype reproductions. Both academic and non-teaching staff associations could be vital in this struggle and awareness. In addition, our advocacy to college administrators and managers may create awareness of gender inequality issues during their regular executive meetings.

In this study, I perceive that oppositional resistance advocated by CFRT, if articulated, may help science educators and pre-service teachers to reject curriculum and college ideology that disempowers them morally, intellectually and politically. I believe that science educators and pre-service teachers in Nigeria college of education with a resistance consciousness may question economic, intellectual domination and oppression linked to neoliberalism.

3.2.1 Relevance of Critical Feminist Reproduction Theory (CFRT)

Critical feminist reproduction theory is relevant in this study because it will enable science educators and students to be aware of the historical and cultural power relations that has hitherto affected their lives. What science educators know about gender stereotype reproduction is

partially and outwardly reflected but inwardly engendered because their knowledge is inadequate and their approach traditional and inflexible. Thus, critical feminist awareness will allow science educators and pre-service teachers to appropriate change and transformation praxis in a gendered society with stereotypical contradictions (hooks, 1989; La Velle, 2020).

This perspective will conscientize science educators and pre-service teachers that they have personal powers and can negotiate and re-negotiate classroom gender dynamics to gain control of their lives. While science educators use personal powers to control the perceived negative behaviours of students, I perceive that the male pre-service teachers may not be aware of their use of exploitative powers to dominate and oppress the girls. Also, the girls could use their personal powers in the form of reluctance in the class to gain control of their humanity. Moreover, girls' submissiveness and passivity are neither ignorance nor fear but acts of oppositional consciousness to exercise personal and cultural power to liberate themselves and gain self-determination. The effects of schooling are to mould women into the economic paid or unpaid labour force, ignoring their individual consciousness and humanity that could alter the oppressive conditions. The theory will afford science educators and male pre-service teachers in the college the opportunity to realise that they sometimes collude together to oppress and dominate women pre-service teachers in the science classes. Assuredly, both science educators and pre-service teachers may have insight, hence, avoid conflicts of power in the class for effective and peaceful learning (Arnot, 1982; Kessler et al., 1985; Weiler, 2017).

This theoretical lens will enable science educators and pre-service teachers to recognise that science classrooms are complex, political and democratic spaces for teaching and learning that need political and democratic critical feminist skills for change and transformation (Desaxe, 2012; James, 2017; Spivak, 1978). Critical feminist theory, when appropriated by science educators and pre-service teachers, is likely to evoke critical gender consciousness that could reposition them for reasonable intellectual, political and democratic decisions that affect their lives. This consciousness re-awakening could further help educators and PSTs realise that the historical and cultural perpetuation of gender stereotypes is due to the power of hegemony that can be disrupted and dissolved for freedom and transformation.

Science educators and PSTs may be aware that science classrooms can embody moral ideals as an antidote to oppression and domination by teachers' harassment and structural school constraints. Thus, morally sound students and science educators will not succumb to sexual

seduction and harassment in the oppressive school space and the total society. Thus, CFRT may empower science educators and pre-service teachers to be mutually supportive during classroom engagements. Such an ethical orientation is similar to that of the Iwa in Nigeria and Lokeja in Zimbabwe (Idowu, 1962; Kanu & Ndubisi, 2018). This is because, vital to genuine transformation, is the idea that higher education needs a workable policy guide that could redress the issue of prevalence of sexual assault in education that results from imbalances of wealth, substance abuse and entrenched domestic violence (Mazibuko & Umejesi, 2015; Singh, Mabaso, Mudaly, & Pillay, 2016).

This perspective will conscientize female pre-service teachers that they suffer triple oppression in the science classrooms. This is because while male pre-service teachers dominate them by taking leadership of intellectual activities in the class, women unconsciously support men in carrying science equipment for demonstration, because they believe that male pre-service teachers can do it better than them. Science educators consciously watch and consent to the false oppressive model of the male pre-service teachers as they perceive the male students to be physically and intellectually better. For instance, Bickerstaff reports that educators sometime encourage males students with follow up questions and comments, while females are complimented for their looks and neat class work (Blickenstaff, 2005, p. 12). In this sense, females are deprived from intellectual engagement; they need feminist critical consciousness to interrogate, negotiate and re-negotiate gender constraints enacted by boys, science educators and themselves to regain their humanity for growth and development. In this study, I perceive that the perspective may impel science educators and pre-service teachers' critical gender consciousness that the gender stereotypes and discriminatory tendencies of historical and cultural norms are mere social hindrances that will continue to oppress and dominate women if left undisrupted. The dominant ideology of the elites that seek to oppress and dominate females and the minority can be subverted and repositioned using political and autonomous power for civic and democratic development (Freire, 2000).

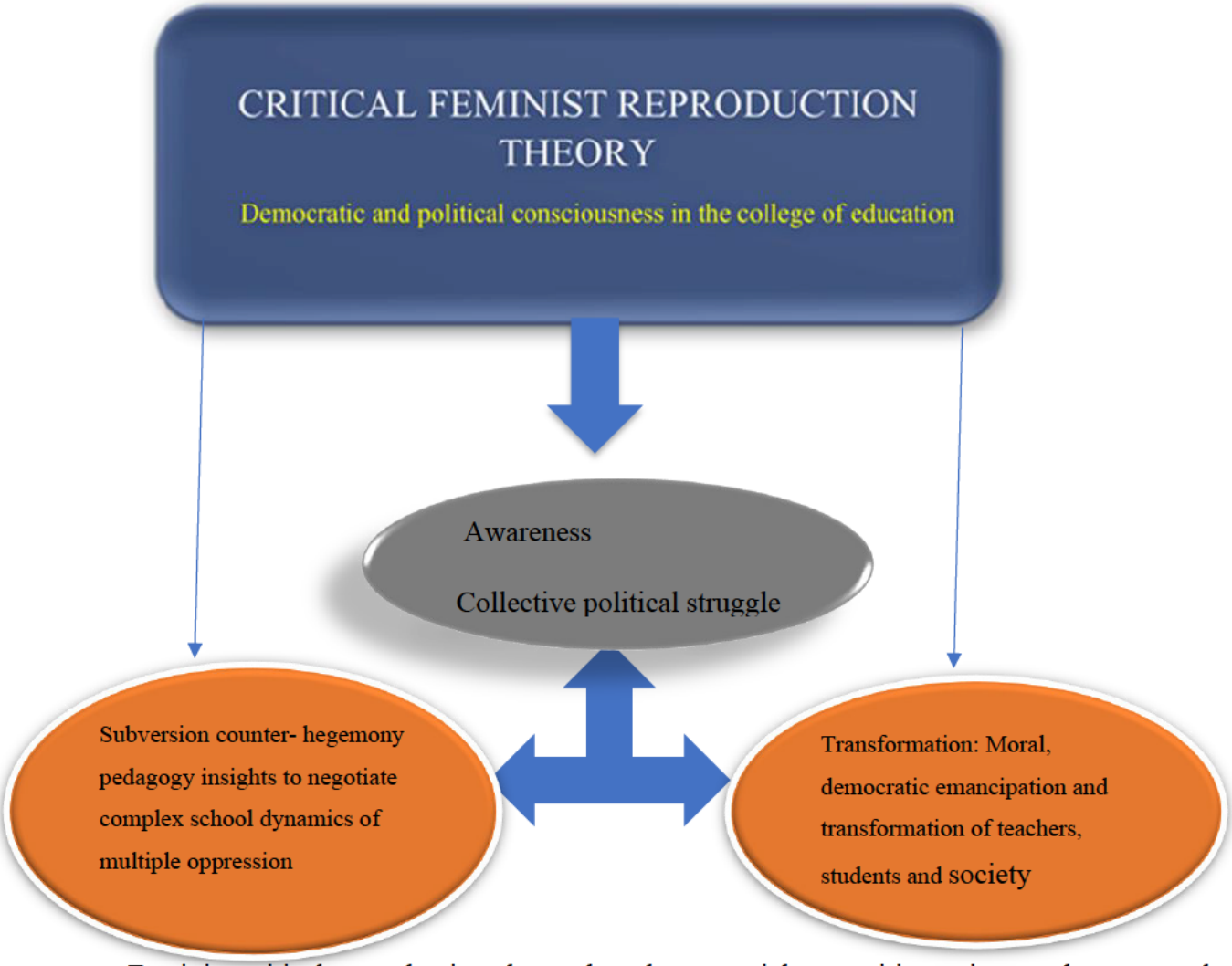
The critical feminist reproduction model may evoke the critical realisation by science educators and pre-service teachers that colleges of education, schools and science classrooms are contradictory and complex terrains for the teaching and learning of science. Yet, the schools have relative autonomy that could enact democratic and moral tenets for effective teaching and learning to locate gender possibilities. Further, the theory may equip the educators and pre-service teachers in Nigeria to see themselves as agents of transformation, to navigate and be

cautious with time and space in the college, enabling them either to challenge sexism and patriarchy, to gain control of their lives, or to further serve oppression when they reject gender equality intellectual ideas. This self-oppression could be possible when both male and female pre-service teachers with autonomous power, decide to learn or not to learn in the class and outside the class. Because the private and professional lives of educators and pre-service teachers in the college intersect with one another, the theory may influence their personal and professional development trajectory and identity construction. More so, it may reposition them to transform themselves and the science classrooms and the society for social justice environment, because both science educators and pre-service teachers have the power for change and transformation in a capitalist society with hegemonic tendencies (Jalil, Sbeih, Boujettif, & Barakat, 2009; Neeleman, 2019; Princewill et al., 2017).

The critical feminist reproduction perspective may allow science educators and pre-service teachers in the college to envision that they should enact and have discursive power to challenge entrenched oppression and marginalization. Peaceful and collective political power can resist inequality in colleges of education and social space. Therefore, I perceive the awareness created through CFRT may enable educators and pre-service teachers to critique societal inequality normalized as truth and to create knowledge that embodies the liberatory power for emancipation, change and transformation. Therefore, CFRT is likely to empower educators and pre-service teachers that all forms of knowledge or reality are social constructions that depends on the interest and positionality of the producers of the knowledge that can be challenged for epistemic freedom.

Furthermore, the knowledge produced from the understandings of CFRT may assist educators and pre-service teachers to see the sexism, patriarchy, and ideological culture that seep into the science classroom and impact on their learning engagement, identity and social space. Of course, this will show to science educators and pre-service teachers that production of science knowledge in the colleges of education in Nigeria and elsewhere is contingent on access, accuracy, analysis, and application of available information. In this sense, male and female pre-service teachers in physical and life sciences classes will be aware that they are likely marginalized and oppressed. Thus the dire need to empower themselves with feminist research political, moral skills and gender knowledge in coming out of the false consciousness (Atwater, 1996). Next is the feminist critical reproduction model for political, democratic, and moral transformation in the college of education.

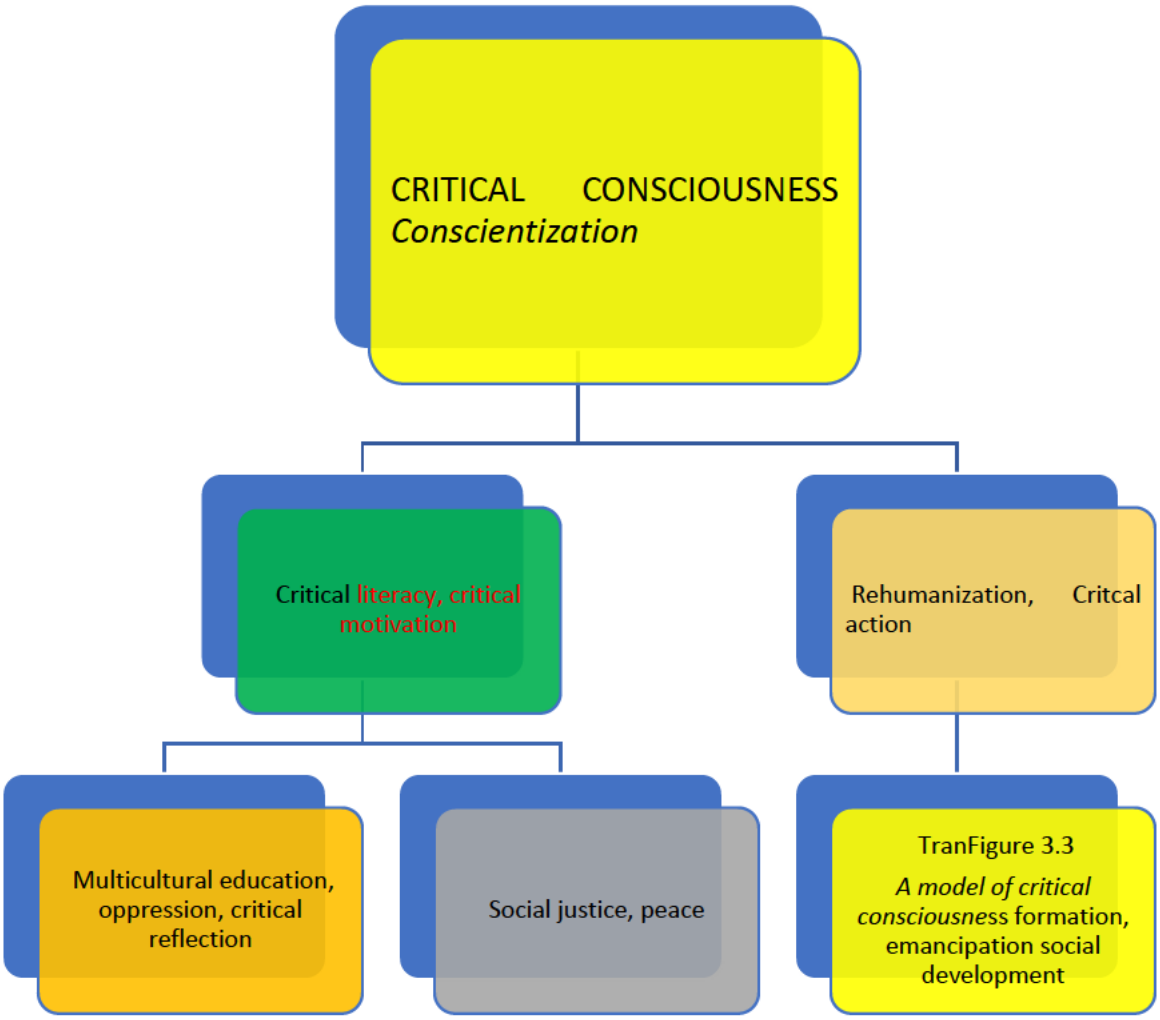
Figure 3.2 Model Showing Critical Feminist Reproduction Theory for Autonomy and Liberation



Feminist critical reproduction theory has the potential to position science educators to be conscious of the complex web of patriarchy, gender, class, capitalism, and sexuality within schools and social spaces. CFRT will also help students, particularly women pre-service teachers, with counter-hegemony insights, to interrogate and illuminate new possibilities for critical intellectual skills, economic transformation, and social development. Transformative resistance and counter-hegemony co-exist to produce new possibilities for a gender order linked to personal power, democracy, and revolutionary politics. This may likely drive women's critical consciousness as they navigate and renegotiate oppressive challenges in the social world (Diemer et al., 2016; Gramsci, 2006; Jemal, 2017). Therefore, I perceive that woman with lived experiences coming from multiple contexts who are working in science education and globally

can acquire conscientisation and critical literacy, to rehumanise themselves for transformation. This is elaborated in figure 3.3 on the critical consciousness model

Figure 3.3 A model of Critical Consciousness



3.3 CONCEPTUALISING CRITICAL CONSCIOUSNESS

Critical consciousness is a philosophical framework, a social way of questioning assumptions about the realities produced in social world, and a continuous but active critique of knowledge production (Freire, 1973; McDonough, 2015). It is the theoretical construct undergirding critical literacy, multicultural education and teaching for social justice. Critical consciousness is sometimes described as a tool or a framework that can be developed, sparked, acquired, and achieved. In the science education space, critical consciousness is likely to be conceptualised as knowledge for change and transformation of science engagement (Diemer et al., 2016; McDonough, 2015; Mustakova-Possardt, 2004).

Critical consciousness has its conceptual roots in the critical theory of the Frankfurt School and the work of the Brazilian educator Paulo Freire. Freire, a Brazilian educator, and philosopher was one of the major proponents of critical consciousness. Paulo Freire's conceptualisation of critical consciousness has three levels, namely, critical reflection, critical motivation, and critical action. Critical reflection is a way of questioning the structural and social processes that marginalise and promote prejudices among group of people. Critical motivation means the perceived ability, capacity, and commitment to challenge these injustices and prejudices and critical action refers to individual and collective efforts to dismantle the observed discrimination and stereotypes. Thus, critical consciousness, underpinned by critical theory, aim at critical thinking for transformation. Critical pedagogy denotes the classroom teaching strategies and skills inspired by Paulo Freire to transform student intellectual engagement for critical skills. These perspectives focus on marginalized or oppressed people, including, in the case of this study, educators and pre-service teachers. It promotes the analysis of physical and life science classes and societal inequities and their motivation and persistent actions to redress such inequities and oppression (Freire, 1972b; Giroux, 2017b; McDonough, 2015).

Freire believed that pedagogy should be designed to liberate the oppressor and the oppressed from social systemic oppression, such as inequities and inequalities through consciousness raising strategies. In this case, CC may equip and liberate science educators and their pre-service teachers from marginalization, reproduction of gender stereotype and subordination within the college structural arrangement. Critical consciousness pedagogues such as Freire and Giroux posit that the thinking people do not exist in isolation but, rather, in relationship to others in the world they live in (Giroux, 2010a; Kumagai & Lypson, 2009). Critical

consciousness involves a reflective awareness of the differences in power and privilege and the inequalities that are embedded in social relationships, an act that Freire calls “reading the world” and that fosters commitment to social justice (Freire, 1985, p. 33). Still yet, the development of this type of consciousness which Paulo Freire calls “conscientisation” is both cognitive and affective and leads to engaged discourse, collaborative problem-solving, and a re-humanisation of human relationships (Leonard & McLaren, 2002). Critical consciousness, or conscientisação, refers to “learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality” (Alfaro, 2019, p. 196). In this study critically conscious science educators and pre-service teachers are those who may acquire equality awareness, have the voice and the courage to stand up against injustices and inequities. In this way, the individual consciousness of educator and pre-service teachers may help end the "culture of silence” (Freire, 1973, p. 55) in which the socially dispossessed and marginalized, such as the educators and students, internalise the negative images of themselves created which are then propagated by the oppressor in situations of stereotyping and discriminations. Liberating science educators, PSTs and other students from this power of hegemony of the powerful, and the emotional and social problems of self-defeat, inferiority and stereotyping, is a major goal of critical consciousness. As Diemer et al. (2016) argue, critical consciousness is an antidote to the oppressive tendencies in teaching and learning science. This is because critical consciousness has the potential to remake science educators in Nigeria, who are otherwise reduced to high level technicians, the persistent objects of educational reforms. If they embrace criticality and are able to teach critically, they will produce critically conscious pre-service teachers with equity and equality perspectives in mind. This consciousness can be achieved through organised resistance and peaceful political struggle.

Therefore, applying critical consciousness in education and particularly science education means I undoubtedly need to echo what Freire calls “liberatory and democracy education” (1972b, p. 2) between students and science teachers, in which both learn, both question, both reflect, and both participate in meaning-making, through critical collaboration and dialogue, that could foster the emergence of critical intervention in reality. In this study, educators and pre-service teachers with CC may collaborate, build coalitions and dialogue on gender stereotype and domination in the college by reflecting and questioning marginalization and inequality for transformation. Furthermore, conscientisation means engaging in praxis, in which one both reflects and acts on social reality to break through prevailing mythologies and

reach new levels of awareness of oppression from being an "object of the oppressed rather than a focused self-determining subject" (Freire, 1972b, p. 33). Yet, the process of conscientisation involves identifying contradictions in experience through dialogue and collaboration and through becoming part of the process of changing these contradictions in the social world we live in. This resonates with Freire and Macedo who describe this idea as "read the word as well as reading the world" (Freire & Macedo, 2005, p. 22). That is, people should study and observe the world of inherent construction of inequities, discrimination and stereotyping caused by the social world and culture of science which have hindered their "personal, institutional, and work career progress" (Diemer et al., 2016, p. 55). Thus, both individual and collective science educators and their pre-service teachers who embrace a conscientisation perspective will be positioned to read themselves, institutional structures, and the social world of inequality through the lens of critical consciousness and take a stance to challenge oppression. Therefore, I perceive that the researcher in collaboration with science educators and pre-service teachers in the college may attain critical consciousness through social activism, conferences, religious, staff and student associations' conscientisation.

The researcher, educators and the pre-service teachers through workshop, coalition and seminars will create awareness on the prevailing gender stereotyping and dominations in the college. In addition, I, science educators and pre-service teachers with gender emancipatory consciousness will negotiate and renegotiate the political space in Nigeria to invoke the legislators and politician's consciousness through individual and collective advocacy to promote equality and feminism through statue documents.

3.3.1 Why Critical Consciousness Theory?

Critical consciousness is needed in the 21st century science teaching and learning of science because inequity, like disease or poison, is likely to impact on the performance, motivation, and interest of students. Critical consciousness, then, may be the course of action or prescription to break the vicious circle of inequality in education. It is an antidote to oppression, an internal resource to draw upon in coping discrimination and stereotyping. For justice to flourish in education and specifically science education, we must challenge oppression (Jemal, 2017).

There has been increased emphasis by researchers, feminist scholars, and methodological constructionists on the underrepresentation, discrimination and women subjectivity and their lived experiences. Until recently, there has been neglect of educators, boys' and girls'

subjectivity and everyday experiences of gender stereotypes reproduction and subversion in science classrooms (Amon, 2017; Palaganas, Sanchez, Molintas, & Caricativo, 2017; Weiler, 1988). Until now, the consciously and unconsciously superficial interrogation of deep-seated root causes of gender reproduction has affected educators and students in the science classes. Therefore, self-conscious reflexivity that embeds critical consciousness is likely to give more insights into the reproduction of gender stereotyping and subversion, an issue that causes the underrepresentation of women in science classes. This will promote a balanced or equitable science classroom engagement. Therefore, in this study, it is likely that in a democratic science classroom, the educator and the pre-service teachers can challenge gender stereotype consciousness, understand how it impacts on intellectual engagement and co-produce transformative knowledge as a team in the class (Baker, 2016; Pescarmona, 2017).

The researcher sees critical consciousness as a process and an action of awareness, aimed at disrupting social inequalities to liberate human beings from the power that continue to oppress and marginalized them, in actualising their full potentials. In this sense, this study is aimed at emancipating science educators and undergraduate pre-service teachers, but particularly women educators and pre-service teachers who experience culturally and institutionally entrenched stereotypical beliefs and power relations that dehumanise them and draw them away from science classes. The outcome is that they reproduce or not subvert gender stereotypes in PS and LS classes and fail to deliver equitable teaching practices to both male and female pre-service teachers. Similarly, when science educators are critically conscious of the prevailing inequalities, specifically gender stereotypes reproduction, they may acquire reflective awareness on how they stereotype pre-service teachers in science classrooms that affect enrolments, performance, and emotional well-being (McGarry, 2019). Science educators with critical consciousness, interacting with pre-service teachers, will pursue the agenda of subverting gender stereotype beliefs and views for the overall interest of their pre-service teachers. It is my belief that the critical consciousness framework will expose and equip the science educators and pre-service teachers' acquisition of critical skills, knowledge, and strategies on how to equitably navigate their teaching and learning spaces as they engage with students in PS and LS classes for transformation and socio-economic development. This could possibly reduce the problem of gender stereotyping and lack of inclusive socioeconomic representation of women in the society in general and specifically in education. Critically conscious physical and life sciences educators will be able to guide pre-service teachers into

heightened awareness of socio-cultural stereotypical oppression and cultural inequality. This can be done through engaging students in relevant dialogues and workshops including activism to critically examine the historical, social, economic and political relationships between culture and science education beyond the school spaces, the community and across borders (Alfaro, 2019; Feinstein, 2017). This means that science educators and their pre-service teachers should engage in critical analysis of their community, neighbourhood, and families where oppressive gender cultural practices are produced and reproduced which can be identified and action taken for the purpose of curriculum development and implementation. Also, the driving force of critical consciousness rests on the science educators to examine their stereotypical oppressive practices and recognize the differences in power relations and issues of inequities in classrooms, between students, teachers, families, and communities that are affecting them.

When science educators embrace critical consciousness, they will involve their pre-service teachers in a conscious critical process, with knowledge, skills and actions to subvert or challenge gender stereotyping in physical and life sciences classes (Alfaro, 2019, p. 198). As Valenzuela puts it "a critically conscious teacher can no longer hide in the comfort zone that they only teach subjects as opposed to students" (Valenzuela, 2016, p. 88). Evoking this cognitive consciousness makes both science educators and pre-service teachers critically conscious of their institutional and socio-political environment by raising critical questions about the nature of their historical, and social situations and the hegemonic power that marginalise, stereotype and deprive them from institutional and socio-economic mobility.

Resonating with Diemer et al. (2016), I perceive that marginalization and stereotyping could make people believe that their voices and knowledge are irrelevant and are powerless. Hence, they should remain silent to discrimination and stereotyping. Thus, re-awakening and re-imagining science educators' critical consciousness endeavours in this 21st century are crucial. This is likely to make educators and pre-service teachers believe that underdevelopment and lack of progress in science education is intentional and can be subverted using the critical consciousness model in multicultural groups context such as in Nigeria and elsewhere (Luter, Mitchell, & Taylor, 2017; Spiel & Schober, 2018). Since both science educators and students come from diverse cultural groups, the theoretical framework of critical consciousness also has the potential of addressing cultural gender issues in Nigeria that can be divisive. In this study, it is anticipated that this culturally diverse group of educators and pre-service teachers will then critically dialogue together and thus embrace unity in diversity.

Critical consciousness theorists argue that people's perspectives can be used to break the culture of silence and increase awareness of social issues that stereotype and marginalise them. It is anticipated that critical consciousness perspective will bring about democratic and political dialogue where female and male educators and students in Nigeria and other social spaces redress reproduction stereotypes and inequalities in science education to reclaim their humanity for equity and social justice (Freire, 1973, 2000; Giroux, 2010a). Even though it is good to promote equity and social justice generally, it is even better to educate and engage pre-service teachers in the science class on inequality, equality and intellectual transformation issues. This is because in educational institutions from lower to higher levels, students co-exist, co-learn, and co-engage in science classes. These pre-service teachers will as well continue life outside the school environments and even pursue science careers in higher education. Therefore, it reminds me of researchers' assertion that education is a crucial element for men and women's ethical living and transformation and help them to appropriate a conscious life in the social world they interact with (Freire & Macedo, 2005; Tabassum, 2019). In this research work, knowledge theorisation on reproduction and subversion beliefs and views can bring about personal and collective development and empowerment of educators and pre-service teachers for transformation in Nigeria and the world. Also, critical consciousness as an anti-oppressive social force is likely to redress the feeling of isolation and self-blame amongst educators and the pre-service teachers in the college. This is because most marginalized people, stereotyped educators and female pre-service teachers are sometimes silenced, thus they become isolated and blame themselves for their dehumanized conditions. Drawing from Freire's idea, true liberation primarily lies with the oppressed. Since the oppressor, who is himself dehumanized, because he/she dehumanizes others, is unlikely to lead the struggle for emancipation and transformation, it is only the oppressed who, by emancipating themselves, can free their oppressors by acquiring critical consciousness as an antidote to oppression for genuine change and peace (Armstrong, 2020; Freire, 1973).Therefore, I suggest that it is only the science educators and pre-service teachers can validate their oppression and inequality and challenge it for freedom and peaceful co-existence in the college of education where the study was conducted. Further, I perceive that critical consciousness is vital in this study due its potential to challenge and create awareness on inequality, patriarchy and reproduction of gender stereotypes. It may drive development of science identity, an empowering tool, a process of

acquiring critical intellectual skills and basis for moral and political transformation. These are discussed in the next section.

3.3.2 Critical Consciousness an Antidote to Inequity and Inequality for Change

Critical consciousness is perceived to be a prescription to gender inequities and inequality. Since inequity is perceived as the processes that facilitate inequality (Jemal, 2017; Patel, 2019). Therefore, I perceive that critical consciousness may equip educators and pre-service teachers with knowledge to be aware of socio-cultural gender stereotype production and reproduction and be able to subvert the oppressive practices in the college to regain their humanity. The awareness created through seminars, organised movements and religious advocacy may position them not to reproduce history of inequalities, gender stereotypes and the present domination alone but imagining and offering new gender possibilities for the future that will not reproduce the present inequalities. Consequently, in this study CC has the potential to empower science educators and pre-service teachers to ask likely ignored questions such as: What is the role of science educators, pre-service teachers and academics as public intellectuals to foster gender equity? Public and higher education serves whose interest in redressing gender inequality and stereotyping? Is it possible to integrate and critically dialogue with different gender cultures that produce and reproduce gender stereotyping in science education? Does education, and especially science education, offer any benefit in articulating and redressing gender stereotypes for the public good? How can knowledge produced from critical consciousness be made meaningful so it can be critical, subversive and transformative for common good? Educators and pre-service teachers immersed in gender critical consciousness will need to question the deep-seated assumptions and myths that are archaic norms and disempower gender social practices (El-Amin et al., 2017; Giroux, 2010a; Jefferson & Anderson, 2017). Therefore I, the six educators and pre-service teachers through organized collective political actions, workshops and other intervening strategies may be educated on the need to critically analyse, reflect and take responsibility to challenge stereotypical practices in the college and some other places. This may develop their power and voice to challenge injustices in the world they live, as in the college, to make it a better place for living. More so, critical consciousness will help both educators and pre-service teachers to become aware of the prevailing forces of discrimination, gender stereotyping and power relations that have hitherto ruled their lives and shaped their consciousness at home and which has also infiltrated physical and life science classes in Nigeria. This could help set conditions for a rejuvenated life by

acquiring power from the knowledge produced from critical consciousness in transforming themselves, science education and the social world for citizenship and gender empowerment for sustainable growth.

3.3.3 Critical Consciousness as Empowerment Tool

Critical consciousness as a tool to challenge marginalization, when internalised, is likely to emancipate and empower science educators and students with anti-oppressive models in their daily interactions with the social world and specifically, gender engagement in the science classes teaching and learning (Dawson, 2017; Feinstein, 2017; Herrenkohl & Bevan, 2017). This is because, in the social and institutional spaces, emancipation means freedom from marginalization, discrimination, and gender stereotyping. Empowerment connotes the ability of men and women, boys, and girls to take effective control of their lives. Thus, prioritising their own agenda, gaining skills, building self-confidence, solving problems, and becoming self-reliant. Therefore, in this study, I perceive those educators and pre-service teachers grounded in gender critical consciousness will be able to create gender equality awareness in their respective institutions and communities in Nigeria for their existence. This is to be accomplished by evoking peoples' critical cognitive consciousness on the prevailing gender inequalities in the social world and science education space. It is imperative therefore, that educators, students, and parents acquire critical consciousness regarding global gender inequalities of the 21st century. This will help attain both equity and equality in the long run. Equity is a process of treating men and women and pre-service teachers fairly, while equality connotes equal sharing of economic resources in social world and in their institutions of learning, these inspired by the arguments of researchers that, if we need equality, we must put effective equity systems and processes in place to achieve equality. So, one of the processes and a cognitive and social tool for achieving gender equality and empowerment is critical consciousness, which if substantially acquired through collaboration and group discussion or meeting, workshop and conferences can position educators and pre-service teachers to challenge injustice without fear or being silent (Diemer et al., 2016; Freire, 1973; Jemal, 2017).

3.3.4 Critical Consciousness as Developmental Asset

Critical consciousness could be a developmental asset to educators and pre-service teachers identity construction (Diemer et al., 2016). Thus, critical consciousness is likely to allow educators to engage in pedagogical tasks that enable them to be physically and emotionally prepared and mentally motivated for personal development. Critical consciousness exposure

can alter the developmental trajectories of science educators and their pre-service teachers. It can also change perceptions and develop the entire community in which they live in. It will also facilitate interest and performance to study science education. It uses strategies that will help educators, male and female pre-service teachers to become aware of inequality issues, specifically gender stereotyping reproduction, driven by beliefs, practices and experiences as represented in text materials and conveyed in social space that threaten their human existence (Sirén, 2018). In this study, critical consciousness is a vital knowledge that can be used in reading, teaching, and learning in individual lives in tandem with the social world. This means that critical consciousness is a construct that could tie educators and pre-service teachers together to be aware of oppression and discrimination in science education. More so, it is a perspective that may gauge how educators and pre-service teachers in the college of education engage in subversive action, thus facilitating the development of individual and collective identity of the marginalized group of pre-service teachers in physical and life science classes in Nigeria college. Critical consciousness will promote higher academic achievement, enrolment, and more career development. This means that it is likely that science educators and pre-service teachers could attain higher status occupations in their social world due to motivation, academic engagement, and achievement consciousness created through critical pedagogy (Diemer et al., 2016; McDonough, 2015).

Researchers also argue that critical consciousness will likely shape one's identity through experience and engagements leading to career choice and progress. This means that science educators and pre-service teachers in the college of education, may acquire enhanced cognitive ability and process skills, thus developing, strengthening, and changing their professional identity. This aligns with researchers' argument that identity re-construction could promote higher thinking for equitable science education engagement (Adams et al., 2018; Diemer & Blustein, 2006).These ideas resonate with Albert Einstein's declaration and is source of inspiration to me, that: "No problem can be solved from the same level of consciousness that created it" (Einstein, 2018). This implies that for someone to create higher conscious knowledge he/she must have had experience; nuanced understanding and change his/her identity and be aware of the prevailing gender discrimination and stereotype. Thus, if educators and pre-service teachers are embedded in theoretically, empirically, and consciously situated cognitive experiences, that will allow them to realise the persistent discrimination, stereotypes, and silences in science classes. This might help counter the normative beliefs and entrenched

historical practices/ engagements embedded in science and science education. It is the transformation of these gender normative oppressive and canonical beliefs that critical consciousness seeks to challenge, by unmasking cultural and institutional false claims, that education provides equal opportunity, access and participation to boys and girls, male and female pre-service teachers during the schooling process (Giroux, 2017b). Therefore, science educators and pre-service teachers can be developed and empowered through engaging in participatory action research (PAR) workshops. This entails planning the procedures for reflecting and acting to challenge gender stereotype and patriarchy issues in the college, thus creating awareness for transformation. PAR, if articulated properly, may help equip them with the intellectual capacity to dismantle discrimination through solidarity and building coalitions.

3.3.5 Critical Consciousness as a Process

Resonating from critical theory and critical pedagogy, critical consciousness ties these two constructs together and supports the notion that knowledge is produced within historical and cultural contexts by reading the social world (Diemer et al., 2016; Giroux, 2017a). It is this cultural and historical space that provides knowledge, life and meaning to human experience. Therefore, in this study I perceive that critical consciousness will position science educators and pre-service teachers in the college of education in Nigeria to appropriate processes, knowledge, and skills in creating equitable gender opportunities that students can come to discover and learn and to realise that there are no cultural and historical realities that are not produced by humans. These constructed realities could be contested by educators and pre-service teachers through the process of critical thinking and transformation models. Therefore, critical consciousness may provide the educators in the college with a process for not only critiquing educational curricula, texts, and practices but also develop an ethical basis that informs their production. In this light, critically conscious educators and pre-service teachers will come to perceive themselves as enmeshed subjects in the history and cultural gender ideology that has oppressed them. More so, they will come to recognise that conditions of injustice, marginalization, discrimination and stereotype, and hegemonic power relations, although historically, culturally, politically and economically constructed by human beings, can also be stripped off and transformed by human beings. This will situate science educators and pre-service teachers to understand that the seeds of domination are a continuous process, yet can be overcome and challenged through a process of continuous transformative resistance, critique and social action (Freire, 1972b, 2000; Giroux, 2017a). Critical consciousness may

also help educators to engage equitably with their culturally diverse students. It is anticipated that pre-service teachers after graduation will gain more insight on criticality as they prepare to work with diverse students with diverse cultures in their various institutions in Nigeria. Thus, I argue that engaging and evoking critical consciousness will benefit all educators, pre-service teachers and other science students. This will foster equity, attract empowerment, transformation, emancipation, and social mobility of marginalized and disfranchised pre-service teachers as science educators enact critical consciousness in their science education classes (Dawson, 2017; Tabassum, 2019).

More so, critical consciousness does not exist outside of our writing, reading, and talking about it. However, it does not sit outside of us but "cognitively embedded in us awaiting discovery and a push or re-awakening and has to be created in every domain" (Deleuze 1995, p. 126). This means that it is a stance, an investigative tool, an ongoing process, that is useful for worthwhile exploration of gender beliefs, experiences, and stereotyped practices by educators and pre-service teachers for transformation in education, as it is politically and democratically contextual (Grace, 2009; McDonough, 2015). The empowering process may be achieved through feminist advocacy and campaigns, workshops and group discussions on gender stereotype and equality.

3.3.6 Critical Consciousness Foregrounds Transformative, Political, and Democratic Awareness

Critical consciousness illuminates institutional, historical, and entrenched systemic forces that limit or do not facilitate opportunities for diverse marginalized groups due to oppression (Alexis, 2016; Freire, 1973; Ginwright & James, 2002). It could provide a lens to educators and pre-service teachers in the college of education for understanding how individuals are entangled in a web of internalised and structural oppression and marginalization, so as to emancipate and transform themselves for political and intellectual participation. Thus, it could explore and create awareness for college science educators and pre-service teachers on family and historical beliefs that support oppressive elements, behaviours and practices. Therefore, as individuals, such as female science educators and pre-service teachers, acquire critical consciousness, they will become increasingly gender critical, and then move from a position of passivity, pessimism, victimisation, and acceptance of the status quo to a role of collaboration, intellectual, moral, political and economic empowerment. This can be accomplished by actively and democratically creating classroom gender discussions, workshops and seminars on the

awareness of gender inequalities and the impact on their career developments and science identity construction. This may create situations that are more just, liberating, and loving for equality and a sustainable environment (Jemal, 2017; Sargis, 2008; Sharma, 2018). In this study, transformative workshops and conferences may empower educators and pre-service teachers with anti-oppressive strategies such as organised collective campaigns against oppression to redress and dismantle the structural and historically internalised oppression they experience. Also, science educators and pre-service teachers enmeshed in critical consciousness pedagogy can appropriate and enact healthy social activism in a safe environment free from gender violence that could promote equitable teaching and learning engagements (Bussey, Jemal, & Caliste, 2021; Jemal & Bussey, 2018). I perceive that political and democratic awareness can be acquired through equality campaigns, workshops and visits to college provosts, private and public offices in parliament to challenge gender stereotype and to assert the need for women and the marginalized to be transformed through equality strategies laws for development. The aspects of critical consciousness discussed previously are summarised in developing a critical pedagogic consciousness model that I designed that is presented in 7.5 Next is the research methodology and the underpinning procedures.

CHAPTER 4
RESEARCH DESIGN AND METHODOLOGY

INTRODUCTION

In this chapter, I describe the research paradigm with its philosophical assumptions, the research design and the approach taken, the case study. In this chapter, I present the methodology, sampling and sampling procedure and selection of participants and context. The instruments for data generation and thematic data analysis are provided. Also, ethical issues that concern participants, the researcher's positionality and integrity are highlighted to strengthen the credibility of the study. Then there follows a discussion on trustworthiness linked to credibility, transferability, dependability, conformability, and the validity of the research work.

4.1 RESEARCH PARADIGM

Research paradigms are world views or a basic set of beliefs that guide actions. That is, they provide a general philosophical orientation about the nature of research that a researcher brings to investigate a phenomenon. They also convey the philosophical dimensions of social sciences and are a set of central assumptions and core beliefs as to how the world is understood and constructed (Creswell, 2014; Lincoln, Lynham, & Guba, 2011; Mertens, 2010). However, researchers contend that qualitative paradigms in educational research need to have their own epistemology, ontology, and axiology in knowledge production (Freshwater & Cahill, 2013, p. 44). In this sense, a methodological approach can form the foundation of a paradigm that leads not only to choices in methods but also responses to experiences and understanding of epistemology, reality and the nature of the phenomenon being investigated (Freshwater & Cahill, 2013; Wahyuni, 2012).

Paradigms are viewed as the foundation or philosophical frameworks that describe assumptions about ethics, reality, knowledge, and systematic enquiry. Some scholars view paradigms as useful tools, a stance or mental representation during the research process. They should rather not be conceptualized as static perspectives but constructed entities that can change with time and it is fluid. The fluidity of paradigm has generated tensions, hence some researchers argued that paradigm should be a continuum of generalization (Freshwater & Cahill, 2013; Shannon-Baker, 2016). That is, a paradigm should be perceived as a model that can be applied for

knowledge generation in different studies. This may illuminate the inherent contradictions thus, redress epistemological tensions related to qualitative research (Freshwater & Cahill, 2013, p. 44). The researcher sees a paradigm as world toolbox, mental representations and accepted models that direct researchers' behaviours in social sciences to make sense of the world in order to produce knowledge.

Therefore, educational paradigms are used to help explain the methodology and methods that drive researchers' understanding of the phenomenon. There need to be a link between the paradigm and the knowledge, reality, and nature of phenomenon under investigation. Researchers generally link paradigm/s with several basic philosophical assumptions to clarify knowledge production connected to ontology, epistemology, and axiology (Cohen, Manion, & Morrison, 2007, 2017)**.** These philosophical concepts are discussed as follows.

4.1.1 Ontology

Ontology is traced to the nature of truth embedded in a phenomenon in the social world. That is, the researcher wants to understand and identify what is the nature of truth in the phenomenon being investigated? This is because, in the society, politics and interests shape multiple reality, beliefs and values. These beliefs and values are socially constructed, privileging some views and truth, and underrepresenting others. This resonates with Creswell and Creswell's (2017) examination of ontology as the pathway to understanding the nature of reality. They argue that ontological issues relate to the nature of reality and its characteristics. When researchers conduct qualitative research, they are embracing the idea of multiple realities traced to the nature and subjective truth of individuals' lived experiences in the context linked to the phenomenon under investigation. Of course, different researchers hold different realities, as do the individuals being studied and likewise the readers of a qualitative study. When studying individuals, qualitative researchers usually conduct the study with the intent of producing converging data and reporting these multiples realities. Multiples realities in this sense includes the use of different forms of facts or data representing the valid words of the different individuals with different perspectives (Cohen, Mannion, & Morrison, 2018; Creswell & Poth, 2017).

In this study, the nature of how science educators reproduced, and subverted cultural gender stereotyping is revealed and discussed. Herein, the study, science educators reproduced gender stereotype in form of cultural dominance by giving preference to male students during

intellectual engagements than females in science classes. But science educators sometimes subverted cultural gender stereotype by resisting curriculum ideology and school structural elements that oppressed them. These educators exhibit resistance at home in the form of opposition to parents but consciously transfer these understanding to students in the class by boosting their confidence to learn. More so, the science educators some time collude with male undergraduate pre-service teachers to stereotype the female pre-service teachers. This evident when they watch the male students reproduced cultural baggage's in form dominance to females. Yet remain resistive and sluggish to change by taking control of the physical and intellectual class activities to avoid being labelled as females. On the other hand, the female students reproduced gender stereotypes by triggering submissiveness in form of resistance to school ideology and learning. This highlights the nature and epistemology of gender stereotypes embedded in phenomenon under investigation which characterizes physical and life science classes in Nigeria college of education.

4.1.2 Epistemology

Epistemology can be understood as the nature of knowledge production and how we come to know the multiple realities. This is usually influenced by communities of practice who define what counts as acceptable ways of knowing. Knowledge co-produced also depends on the relationships between the researcher and individuals who are being researched. In this sense, collaborations are formed through dialogue based on equality of power sharing and self-esteem (Cohen, Manion and Morrison, 2018; Poth and Creswell, 2017). Therefore, when I conducted the study, I tried as much as possible to get close to the participants being investigated, hence allowing their voice and opinions to count. This I suspect allowed them to set out evidence that is based on their views and experiences. Another assumption made is that knowledge that is produced depends on the way individuals narrate their lived subjective experiences, and participants live and work in the context where the phenomenon is being investigated (Al-Saadi, 2014). It becomes vital then to conduct studies in the field where the participants live and continuously interact with each other. These assumptions will allow for understanding of what the participants are saying in context. Therefore, the longer the researcher stays in the field or gets to know the participants, the more he or she will 'know what they know' from first-hand information. These assertions influenced me to conduct the research on site with science educators with lived experiences and who worked in the college of education for ten to fifteen years. This context allowed me to be closer but somewhat 'aloof' to the participants in

relating meaningfully with them during the questionnaire and interviews encounters which lasted for three months. Creswell and Poth (2017) counsel that a qualitative researcher should minimize the distance between herself or himself and those being researched. This is because bias may distort the data generation process.

In this study, the researcher used qualitative approaches and case study design to produce knowledge and construct theory regarding the phenomenon through questionnaires, interviews, collective reflections and classroom observations to get their subjective experiences about the phenomenon under investigation. The knowledge co-produced will inform and possibly change and transform science educators' views and beliefs on gender stereotyping and subversion in science classes.

4.1.3 Axiology

Axiology relates to moral principles and meanings in conducting research, and the ethics that govern it. This means welfare, respect and the promotion of social justice and morality as it relates to research participants (Bertram and Christiansen, 2014; Creswell and Poth, 2017). All researchers bring values to a study, but qualitative researchers make their values and worth known in a study by ensuring participants are respected, protected, and valued. Here the researchers admit the value-laden positive and negative opinions regarding the nature of the study and allow for equality of views to be expressed. Researchers also actively report their values and biases as well as the information gathered from the field. They position themselves by identifying their positionality in relation to the context and phenomenon under investigation. In this sense, the researcher describes his or her social positions, for example, gender, age, bias, and race. Also, the researcher describes his status, personal experiences, political and professional beliefs to convince readers of his positionality in relation to the study (Berger, 2015; Bertram & Christiansen, 2014).

In this study, I explain my positionality and biasness, status and gender from the outset. I also discussed my working experience of twenty-five years teaching boys and girls in physical and life sciences. Ethical issues were adequately adhered to. This was done by collecting ethical clearance permission from the University of KwaZulu-Natal, gate-keeper's letters from the college of education authority in Nigeria, and participants' consent letters. While on the field, I respected and valued the participants' positive and negative views, beliefs and created

affordances for equal opportunities and enabling conducive environments for participation during data generation.

4.2 RESEARCH DESIGN FOR THE STUDY

Research design describes the logical rather than logistical matters – meaning, it concerns the total blueprint rather than pieces of 'nuts and bolts' of how to carry out that plan in a logical manner (Yin, 2011, p. 3). Researchers argue that research design "precedes decisions on the data but does not indicate that data". However, it indicates the kind of evidential relationship for the study to address the research purpose, objectives, and questions (Cohen et al., 2018, p. 179). I perceive research design as a blueprint that directs researchers to collect data, analyse and produce knowledge in line with the phenomenon under investigation.

The research design serves as "logical" plans, not the "logistics" plans often referred to by researchers (Yin, 2015, p. 75). To him, logistics plans are still important, but they entail the coordination of research, in the form of the planning and organisation of the work for efficient outcome. The logical plans require the connections among the research questions, the data to be produced, and the specific plan for analysing the data. This means that the study findings should speak to the intended research questions, objectives of the study, theoretical framing, and conclusion. Thus, credibility, in the form of trusted and honest data produced, and reliability, such as consistency of the data collected from different sources, were needed to ensure the strength of the study.

The knowledge produced by the researcher through the three methods: questionnaire, interviews, reflective journals and observation, resonates around philosophical assumptions, data sources and participants' lived experiences of gender stereotyping and subversion in physical and life sciences classes. In agreement, O'Neil and Koekemoer (2016) suggest that a research design is a plan or strategy that connects philosophical assumptions with selection of participants, data production methods and analysis. They suggest that the choice of research design depends on researchers' skills and practices linked to ontology – what is the nature of reality, and epistemology -what knowledge is produced or what do you know that you know in producing the knowledge? In this study the philosophical assumption highlighted earlier guided me with skills and insights on the nature, knowledge, and ethical orientation on how the study was conducted about gender stereotype reproduction and subversion. In this study, the research design is case study. A case study explores a real-life experiences and beliefs of individuals

occurring in contemporary system as a case or multiple bounded system, such as cases over a period of time. For instance, six educators engaging with pre-service teachers in biology, chemistry and physics in the college informed the case study. This is explained further in the study (see section 4.5).

Next discussed is the critical interpretivism paradigm that further illuminated the study for emancipation and transformation.

4.3 CRITICAL INTERPRETIVIST PARADIGM

Critical interpretivism, an integration of the critical and interpretive paradigms, aims at empirical theorizing that connects the socio-political conditions of the oppressed with power control dynamics in education and the social space (Ryan, 2018; Willis, Jost, & Nilakanta, 2007). This perspective promotes a better understanding of qualitative research data that is linked to a higher degree of subjectivity in individuals' social-cultural context. In some cases, the interpretive and critical research paradigms could be reduced to the category of 'alternative' because some researchers view these paradigms as conceptually weaker than the traditional positive approach linked to quantitative styles (Maroun, 2012, 2014). However, it is vital in qualitative educational research that it focuses on issues aligned with subjectivity and the realities of individuals regarding its educational findings. Researchers argue that the critical interpretive perspective linked to qualitative research should aim at improving practices in the social world, especially in education (Maroun, 2012). As a result of such perspectives widening in qualitative research, there have been various institutional research breakthrough in teaching and learning, particularly in science education. Therefore, applying critical interpretivism will not only allow for the interrogation of the phenomenon but also improve science education gender practices towards change, intellectual and moral transformation (Maroun, 2012). In this regard, Apple argues:

> There is a repositioning, that the world must always be seen from the perspective of the dispossessed; and that the world should be seen in a relational way, that is, to seek to analyse and understand the relations of power and the contradictions that structure institutions and societies (Apple, 2017, p. 11).

In this sense, applying the critical interpretive paradigm in this study allowed for the oppressed and dispossessed science educators' experiences and views to be explored, examined and understood for transformation (Ryan, 2018). To be critical, as Farias and Rudman (2016) argue, is to question the hidden assumptions, theories, and existing form of practices that support oppression and injustice, by giving rise to new possibilities.

In this study, using the critical interpretive paradigm, I explored the lived experiences, beliefs and views of the science educators in the college of education science classes. How were they reproducing and subverting gender stereotypes? This made me not only understand how gender stereotypes are reproduced but how they should be challenged through critical work for transformation and morality, in a social justice environment (Cannella & Lincoln, 2011; Farias, Rudman, Magalhães, & Gastaldo, 2017). I moved away from views of some researchers locally and globally who sometime slightly focus on gender transformation and power relations but emphasize on understanding the gender oppressive world, with little attempt in transforming and changing it (Atwater, 1996; Ekine, 2016 & Ellemers, 2018). This was done by fusing the critical and interpretive paradigms to illuminate and provide deeper understanding about gender stereotype and reproduction for emancipation and liberation. I believe that change, freedom, and peace can only be achieved if injustices in the social space and in education are challenged through understanding and interrogating the world embedded with entrenched power relations (Adesola et al., 2013).

Moreover, these transformations of gender discrimination challenged my own traditions, beliefs and views to attempt to change and transform while interacting in the context in which I found myself. This emancipatory gender reproduction model motivated me to research using the paradigm. I believe that, as global citizens and critical science educators, we are no longer called to just interpret the world, which was the mandate of traditional qualitative inquiry but called to change and transform the world and to change it in ways that resist injustice while celebrating freedom, inclusivity, and participatory democracy (Denzin, 2017, p. 99). Also, in this study, using the paradigm allowed me to make sense of how and why science educators reproduce and subvert gender stereotyping in physical and life sciences classes. The data produced in this study was analyzed, and the findings reveal patriarchy and power relations discussed using a critical perspective. This strategy further provided a nuanced understanding of the phenomenon under investigation, leading to deeper insights for change and transformation. Therefore, I perceive that, the choice of critical interpretive paradigm is in line

with transformative consciousness, which deviates from constructivists' viewpoint. This is because the constructivists theorists seek to understand and interpret the world they live and work in, ignoring transformation and freedom. Thus, the awareness developed by constructivists is likely not to constitute deeper, more penetrating knowledge to unravel epistemic freedom for emancipation and transformation, which is the goal of critical interpretivism. This resonate with Creswell and Poth (2017) who argue that, a transformative worldview aims at helping people who are marginalized and disenfranchised overcome oppression and societal injustices.

The research questions, critical interpretive paradigm and the underpinning philosophical assumptions foregrounded, provided deeper insights in choosing the research approach for the study.

4.4 RESEARCH APPROACH

Creswell (2014) views research approach as a plan and the procedures for research that covers detailed steps from broad assumptions to comprehensive methods of data production, analysis, and interpretation. This plan involves several decisions taken on which approach to be used to make sense and direct the logical presentation of the whole process. The selection of a research approach is also based on the nature of the research problem or issue being investigated, the researcher's personal experiences, and the audiences for the study. This planning stage is not a mechanistic exercise but depends on serious consideration and thought about the purpose and phenomenon being investigated, premised on a paradigm which helps in the planning and conduct of the research (Cohen et al., 2018). In this study I made careful consideration, of the purpose, objectives, research questions and participants involved and based on the phenomenon being investigated, to identify the research approach suited for this study.

Therefore, the research approach employed in this study include descriptive questionnaire, narrative strategy for selection of participants and a qualitative approach as it is used for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures, and data generated in the participants' setting. Then, data analysis is inductively positioned, building from particular or specific to general themes, and the researcher makes interpretations of the meaning of the data. The final written report is not rigid but has a flexible structure that can be adjusted to make complexity of the situation understandable. Though qualitative research has

been criticized for excessive flexibility and lack of scientific rigour, it is still widely used in the social sciences and is vital in this study because it concerns participants' lived experiences. It also allowed me to modify and add concepts when data generation and analysis was done. More so, in this study I drew evidence from the data collected, from participant's observation, interviews and questionnaires, to produce knowledge and this made the complex phenomenon under investigation to be better understood (Creswell, 2014; Denzin & Lincoln, 2011).This is in line with a qualitative study which provides tools for researchers to study complex phenomenon within their contexts.

Researchers argue that the qualitative approach facilitates the exploration of the phenomenon being investigated within its context using a variety of data sources, and allowing for multiples facets of the phenomenon to be revealed and understood (Baxter & Jack, 2008; Stake, 2013). Thus, the approach highlighted a deep and nuanced understanding about the phenomenon under investigation, which aims at revealing how science educators reflected on their gender experiences, beliefs, views and behaviour with regards to gender stereotypes and subversion as they naturally occur in the college setting (Merriam, 2009; Stickler & Hampel, 2015). Also, Levitt (2018) argues that qualitative research is a set of approaches that analyse data in the form of natural language such as words, expressions and images of experiences of social interactions. In this sense, this approach also enabled me to see, and highlight stereotypical gender words and images represented in texts material that impact on learning engagements of students, particularly females in science classes.

4.5 CASE STUDY DESIGN

4.5.1 Introduction to Case Study Design

Case study is a 'contested terrain' (Yazan, 2015), an instance that sometimes illustrate a general principle of study and a single occurrence that translate into action (Adelman et al 1980). Although there is no consensus definition of a case study, it has been criticized to have limited generalisability and the method is perceived to be the weakest method of knowing, since studying individual cases, careers and communities has little effectiveness due to biases and subjectivity linked to patterns and historical ideas (Cohen et al., 2018; Yin, 2009).

Therefore, researchers perceive different definitions of case study as argued by different scholars. They conceptualise case study as a qualitative design in which the researcher explores a real-life situation of real people occurring in contemporary bounded system as a case or

multiple bounded system, such as cases over time. The unit of analysis in the case study might be multiple cases in the form of a multisite study or a single case within the site study. This makes ideas and abstract principles that are tied together to be clearer (Cohen et al., 2018; Creswell & Poth, 2017; Yin, 2009). Researchers' working with case study can also establish cause and effects phenomena by looking at how and why questions could provide in-depth understanding of the situation in the real context, because context is a powerful determinant of causes and effects (Cohen et al., 2018, p. 376). This is done through comprehensive in-depth data production involving the researcher and participants as co-producers of knowledge from different sources of information. For example, observation, interviews, audio-visual material, documents and reports, and reports of case description and case themes.

In this study, I explored how the case of six science educators reproduced and subverted gender stereotyping in a real situation in a bounded system, the college of education, within each unit of analysis, such as biology, chemistry, and physics classes in a college setting in Nigeria. This allowed me to co-produce data and in-depth knowledge with the participants from questionnaires, observation, individual, and focused interview sources. This also allowed for deep insight of the reproduction and subversion of gender stereotype, because, I was able to interpret in-depth, the uniqueness of each participating science educator's beliefs, views and notions on gender stereotypes and subversion in the form of themes during the data production and analysis in the biology, chemistry and physics classroom interview engagements (Cohen et al., 2018; Rule & John, 2011).

The choice of the case study enabled me to make sense of a complex phenomenon of gender stereotype and subversion under investigation that was premised on the interrogation of what, how and why research questions guiding the study. Thus, researching on the phenomenon provided me a nuanced understanding and illuminated some features such as the dominance and submissiveness of students as resistance to school and curriculum ideology to gain control of their humanity. The clarity of data and knowledge production could have been difficult and blurring when using only large-scale quantitative survey data production. This is an advantage to the case study research. The use of case study with multiple data sources demonstrated to be possible due to methodological flexibility, by providing space for different methods such as interviews, observation and questionnaire as sources of data and critical interpretive paradigm that served as pillars for the study. In support, researchers argue that case study research provides methodological flexibility through the incorporation of different paradigmatic

positions, study designs, and methods. In fact, it is often called a pragmatic bridge between post-positivists and constructivists (Cohen, Mannion, & Morrison, 2018). However, whereas flexibility can be an advantage, numerous different interpretations have resulted in critics questioning the use of case study as a methodology linked with flexibility. There is a risk that flexibility of the approach could result in haphazard reporting and would limit its global application. While it is valuable, in some instances it is a theoretically supported design that cannot be rigorously applied across all disciplines and fields. Therefore, to mitigate this limitation, I used questionnaire, classroom observation and interviews for data generation, a form of triangulation.

Therefore, in this study I had direct interface with the six science educators who responded to the questionnaire and had face to face interviews with the participant science educators in individual settings, further used focused group interviews and classroom observations. Thus, I explored and understood reproduction and subversion of gender stereotype in the life and physical science classes from the different views, experiences and beliefs of the science educators located in the specific college context. This knowledge could then provide a framework that will be extended to other research and analyses in institutions, policies, persons, events and projects (Baxter & Jack, 2008; Cohen et al., 2018).

Therefore, case design in a qualitative study aims at exploring lived experiences and beliefs of participants in a bounded context with units (Stake, 1995). Case study design can be of multiple units as discussed herein with the study conducted.

4.5.2 Multiple cases

In this study, I used multiple case and reflexive case types as identified by Stake (1995) and Hamilton and Corbett-Whittier (2013a) to further clarify and understand the phenomenon being investigated. Creswell and Poth (2017) define a multiple-case type or multisite as sites that are selected for the case and might be at different geographical locations. The multiple case study design has assisted me to explore and understand the phenomena under study from different groups of individuals for nuanced understanding. However, multiple-case study is perceived to be time consuming and difficult (Yin 2011). In this sense it assisted me to research six science educators individually to gain a fuller or a general picture of the phenomenon of reproduction and subversion of gender stereotypes in physical and life sciences classes.

Therefore, in this study multiple cases provided me with a nuanced understanding of the views, experiences, and beliefs of six science educators in biology, chemistry and physics on how they reproduced and subverted gender stereotyping in the college context. Baxter and Jack (2008), caution that researchers should return to the global issue of concern after analysing at individual level so as not to fail in addressing the main issue of the research. I perceive that Baxter and Jack (2008) view on multiple case design suggest that it is risky for the researchers to put all the eggs in one basket hence this multiple case study with multiple sites and units of analysis did provide a nuanced understanding and knowledge of the gender reproduction and subversion in science classes. I now turn to research methodology.

4.6 RESEARCH METHODOLOGY

Scholars argue that methodology and methods are inextricably interwoven. In this sense, research methodology suggests theories behind the methods embedded in the methodology. Methodology connotes how we find out about the phenomenon, the approach to be used, the principles that underpin it and the justification for using the kind of research approach adopted, the instrumentation and sampling linked to trustworthiness. Methods are concerned with instrumentation, how data are collected and analyzed with the ethical issues embedded therein, whilst methodology justifies the methods used (Cohen et al., 2018; Creswell & Poth, 2017). Methodology refers to procedures and how we research complex and multiple realities of human endeavours. It is influenced by communities of practices who define what counts as acceptable ways of researching and producing knowledge (Baxter & Jack, 2008, p. 5)**.** Therefore, this study is guided by qualitative methodology procedures that serves as pillars to understand the complexity of the phenomenon. Therefore, getting deep and nuanced insights from the lived experiences of science educators and the students' views on the reproduction and subversion of gender stereotypes. This is because the study facilitates a qualitative dialogue to be established between the participants and the researcher. The procedures of qualitative research are characterized with inductive reasoning, emerging from data collection to theory generation and are shaped by the researcher's experience in analysing the data. That is, a logic or reasoning that the qualitative researcher generally follows is inductive, combining, in this case, classroom observation with experiential data to reach a conclusion, rather than moving from general assumptions to the specific theory of the inquirer as deductive reasoning. Sometimes the research questions may change in the middle of the study to reflect better types of questions needed to understand the research problem. Therefore, the data production

strategy, planned before the study, needs to be modified to accompany the new questions which I changed during validation of the instruments – questionnaire, classroom observations, interviews, reflective journals and collective journals – with postgraduate students, experienced staff, and my supervisors as discussed herein. In this research work, I ensured that the data from individual science educators was analyzed based on specific classroom observations, analysis of data and reasoning to general theorisation, to develop an increasingly nuanced knowledge of the topic being studied (Cohen et al., 2018; Creswell & Poth, 2017). In this study, I used questionnaires, interviews, classroom observations, reflective journals and collective journals as instruments to produce the data guided by philosophical assumptions such as ontology – the nature of their stereotypical practices, epistemology – what the science educator understands and views about gender stereotype and subversion, axiology – morality and ethics I followed to accord respect to the participants during the conduct of the research, and methodology – procedures involved to produce knowledge. In this study, I followed an inductive approach to data generation where I collected data from each of the six participants and built up the data based on their views and beliefs on the reproduction of gender stereotypes. The specific data from individual science educators was analyzed, sorted into categories and coded. The latter process informed the gender production and reproduction themes explained herein (see section 5.1) and illuminated the phenomenon being investigated. Then a general conclusion was made about gender stereotype reproduction and subversion. That is, from specific reasoning about views and beliefs about gender stereotype to generalization and theories in form of cultural reproduction assertions. These assertions and themes (see section 6.1) resonated around power relations, gender, patriarchy and sexuality about physical and life sciences educators' and pre-service teachers' engagement in the college of education life and physical science classes. Next are the participants and context sampling methods discussed herein.

4.6.1 Sampling Procedures

In this section, sampling of participants, college context and participants' selection procedures were discussed.

*4.6.1.1**Purposive sampling of the participants***

Purposive sampling or a non–probability sample is when the chances of members of the wider population being selected for the sample are unknown (Cohen et al., 2018). Concurring, some researchers argue that purposive sampling is a non-probability sampling technique that a researcher uses to choose individuals/units from a wider population to form his sample

(Creswell & Poth, 2017). Therefore, I perceive purposive sampling as a strategy that enable researchers to pick participants that could provide useful and comprehensive information about the phenomenon under investigation (Cohen et al., 2018). Therefore, in this study, purposive sampling enabled me to pick the six participants with gender characteristics and comprehensive knowledge about stereotypic beliefs that facilitated the conduct of the study. Therefore, in this study I purposefully selected six participants from a population of 48 science educators who indicated interest to participate in the study. Non-probability sampling has a lot of limitations. Some of these limitations includes the subjective nature of choosing the sample and inadequate representation of the larger population, especially when randomisation is not possible due to large population (Creswell & Poth, 2017). I perceive that bias is possible in using this sampling strategy, including low level of applicability, replicability and generalization. However, it is very important when resources are few and the researcher is constrained by time and workforce. Therefore, in the college I had the problem of timing, due to science educators' responsibilities such as lectures workload / examinations invigilation, and college committee's assignment. Many colleges of education are found in the six geo-political zones of Nigeria, namely, North/West, North/East North/Central, South/East, South/South and South/West. In this study, I purposefully selected a college of education in North-Central Nigeria as it was convenient to access data, and it is an active college regarding gender workshops and conferences.

4.1.3.1 Context of the Selected College for the Study

In this study, I selected a college of education based on access and/ or availability of participants and its closeness to me amongst other colleges of education in Nigeria. Also, the college held conferences and organised workshops on gender issues in which most of the staff participated. Its strategic location in the North-Central region of Nigeria and conducive safety environment amongst other colleges of education also informed the choice. It is a public federal college of education established in 1975, owned by the Nigerian Government, and it is where I lecture. The institution is known for academic excellence such as national science awards as researcher of the year in chemistry, second position in national academic **e**xhibitions, gender awareness, and scholastic output in research from other departments. The college of education, with the past and current national female presidents of national women association, held 'Women in Colleges of Education in Nigeria' (WICE) conferences on science education linked to gender inequality, gender stereotypes and teachers' professional development over the years. The main purpose was to create awareness on the need to emancipate and transform women from

marginalization and subordination. This realisation seemed to have little effect in that few women were appointed into responsibilities in the college – the posts held by women included registrar, director of health, deputy provost, deans of schools and heads of departments amongst others. My view is that these conferences and their proceedings possibly had little impact on the marginalization of women and how they can negotiate and regain their freedom and be transformed, based on oppressive tendencies produced by the institutional powers that created them, as I observed that gender discrimination was still rife. Hence, the status quo remains in form of subjugated knowledge about women and pre-service teachers, which led to my study in this context.

In the college of education and school of science, there are seven departments, namely, biology, chemistry, computer, integrated science, mathematics, physical and health education, and physics. I chose only physical and life sciences classes from the biology, chemistry and physics departments based on the research topic that resonate around core science courses. This helped me to build up the purposive sampling. Therefore, in this study, purposive sampling regarding the selection of classes was applied; the life and physical science classes were selected based on convenience, different socio-cultural backgrounds educators and students belong to and rich information the participants provided during the questionnaire (Appendix 2) session about gender stereotype reproduction and subversion.

4.1.3.2 Participants' Selection Procedures

The participants selected eventually were based on their responses about gender stereotypes reproduction and subversion beliefs in science classes from the questionnaire (Appendix 2) and who were willing to contribute to the study. Only science educators teaching 200, 300 and 400 level undergraduate pre-service teachers offering biology, chemistry and physics courses were considered. The procedures for the final sample selection are as follows.

First, I had a meeting with all 54 science educators teaching biology, chemistry, and physics undergraduate courses at 200, 300 and 400 level were approached and those willing to participate were given the questionnaire to respond to. I informed them that they can withdraw at any time without any negative consequences. They were also told to be free to ask the researcher any question concerning the study phenomenon when the need arises. Only 48 agreed to fill the questionnaire.

Secondly, I then gave questionnaires to the 48 science educators who participated in completing the questionnaire. Only 11 returned their completed questionnaire due to security challenges such *as Boko haram and kidnapping, work schedules, timing, and educators' reluctance to complete the questionnaire, associations meetings and college committees' engagement.* The low response rate was due to Covid-19 and strike action too. The challenge of low response rate was rectified by ensuring that more open-ended questions were asked during the interviews and the lesson observations increased, to elicit views, actions and beliefs of participants. Incentives and a consensus agreement on timing, dates and venues were arranged for the six participants for ease and to enhance their participation. Using narrative strategy, I analyzed the 11 questionnaires for depth of feedback, then I selected six science educators based on age, teaching experience, gender awareness and who responded comprehensively and provided insights and heightened awareness about gender stereotyping reproduction and subversion. I intended to interview and observe twenty-five to thirty participants but because of the poor response rate and lack of comprehensive gender information about beliefs and classroom practices given by some science educators, I interviewed and observed only six participants

Thirdly, I selected two who had little awareness about stereotypic practices and subversion, from the remaining five educators whose questionnaire narration was done. The two were added to the six educators selected for interviews and observations making eight. However, the two science educators were kept on standby should in case there were logistics reasons such as sickness etc. I then interviewed six science educators, four were males and two females. Four males and two females' participants were selected to reflect different gender stereotype and subversion views and beliefs. Also, the number of males-*eight* was more than females-*three* totalling *eleven* science educators. The reason being that only three female science educators completed and returned their questionnaire due to fewer females in the population, N=11, while males N=37. Therefore, four males and two females' participants were finally selected because they provided rich and thick information about beliefs, views and practices, were consistent and accurate in their responses from the three sections (A, B & C) of the questionnaire schedule, which foregrounded insightful information about the inequality and equality issue in the college. They also attended workshops and seminars on gender issues and came from different socio-cultural backgrounds in Nigeria.

In this study, I applied purposive and convenience sampling in selecting the eight teachers. Convenience sampling can be used when the site and participants for the study easily accessible

due to time and space constraints (Cohen et al., 2018, p. 219). Therefore, in this research work, it was vital and convenient for me to choose three departments and finally six participants (as two were dropped off) for the study due to ease of accessing them (Creswell & Poth, 2017). In this study I intentionally selected the three departments from the larger population and so eliminated some departments and science educators that I may not reach easily to provide in-depth information about the phenomenon under investigation. This is because I am a science educator in the school of science where the three departments for the study and the participants are situated. Purposive sampling is when the chances of members of the wider population being selected for the sample are unknown. In addition, it is the one whose characteristics are defined for a purpose that is relevant to the study (Cohen et al., 2018). Therefore, in this study, I used purposive sampling because, based on prior theoretical understanding of the topic being studied, certain categories of departments and/or science educators with characteristics that have unique differences such as gender consciousness, rich gender insights, different socio-cultural information and consciousness of stereotypic beliefs that were diverse from other educators which facilitate the conduct of the study. This further increased the likelihood of the findings that reflected thick and rich perspectives and understanding of the phenomenon under investigation, an ideal strategy in qualitative research (Cohen et al., 2018; Creswell & Poth, 2017).

The purposive sampling and convenience sampling techniques ensured the selection of the eight science educators due to some critical insightful information on gender stereotype reproduction and subversion beliefs, views and their ability to be comprehensive and coherent. This preliminary information guided me and hence I included them in the study and excluded those that I thought that will possibly not share with me vital insights about the phenomenon being investigated for data.

4.7 METHODS OF GENERATING DATA

The data generating instruments used in the study were questionnaire, interviews, classroom observations, reflective journals and collective journals. I and the participants used field notes to jot down vital information during the interview sessions. In this study, 1 used the field notes to write down events, patterns of stereotypic and subversive beliefs and practices of educators. Then, I read the field notes, sorted and picked the relevant information that helped me during the construction of qualitative themes and assertions for the study. The data from the field notes

were also vital evidence that gave deeper meaning and facilitated the understanding of the phenomenon. These instruments were appropriate for the study as they helped me to produce rich, in-depth data from the participant science educators. Most qualitative researchers utilise classroom observation, interviews, reflective journals, collective journals and questionnaire for data generation. Prior to implementing the study, I had to pilot the questionnaire by giving it to four students and academic staff of the department to validate whether the questions would help to investigate the phenomenon. Then the semi- structured interview was undertaken with 3 postgraduate students and 2 experienced lecturers from the department. Also, the observation schedule was validated by four individuals including staff and students. This ensured that the verbal and nonverbal-cues were observable during video- recording. These instruments are discussed in detail, (see section 4.7.1 to 4.7.3) herein.

4.7.1 Questionnaire

A questionnaire is the heart of any survey study (Krosnick, 2018, p. 1). Therefore a questionnaire is what scripts the questions and conversations to produce valid data and results that reveal the phenomenon being investigated (Patten, 2016). In this study, I used a Likert scale questionnaire that comprised both open and close-ended questions. While the open questions informed probing questions for science educators, the close-ended questions provided positionality of participants' responses hence, answers *what and how* research questions (Appendix 2). This account resonates with Cohen, Manion & Marrison (2018) argument that open-ended questions allow the interviewer to probe information during interviews and focus group discussions. Therefore, the open-ended questions were more than close-ended questions to allow for expression of the nature of reproduction and subversion of gender stereotypes beliefs and views. In addition, the Likert scale questionnaire and its descriptive analyses answer what and how research questions due to it descriptive nature (Armstrong, 1999; Siedlecki, 2020; Sidel, Bleibaum & Toa, 2018).

First, a questionnaire, made up of three parts: A, B & C: A-*background and gender of educators*, B-*Reproduction of gender stereotypes*, C-*Subversion beliefs of gender stereotypes*, was administered to forty-eight science educators teaching biology, chemistry, and physics subjects and who were willing and accepted to participate in the study. Through purposeful and convenient sampling techniques, which allowed the researched to be reached on time and for unique characteristics, such as gender insights, sociocultural orientations and in-depth

understanding of gender reproduction information from the participants, I sampled six science educators who provided me with rich and thick data about gender stereotype production and subversion different from others that I "dropped or deleted" (Cohen, Manion & Morrison, 2018, p. 275) who could not provide in-depth information about gender stereotype, reproduction and subversion beliefs and views. To get the six participants, two each were selected from the three subjects mentioned earlier for the interviews, lesson observation, reflective and collective journals. Integrating the questionnaire, classroom observations, reflective journals and collective journals with interviews as sources of data generation allowed me to produce rich and thick data that facilitated a holistic understanding of the phenomenon being studied (Baxter & Jack, 2008). In this study, all the data that I collected from different sources were individually looked at, sorted, then converged/synthesized and triangulated that informed the process of analysis which provided a nuance understanding of the phenomenon-*gender reproduction and subversion beliefs and views.*

In this study, I used descriptive questionnaire, narrative insight, lesson observations, interviews and journal reflections that informed the qualitative study. The diverse perspectives provided a deeper understanding of stereotypic beliefs and practices of educators in the college. In addition, descriptive research described categories of information such as gender or patterns of engagement which aimed at providing answers to *what, where and how* research questions. Hence, do not answer why questions nor test hypothesis (Siedlecki, 2020) but ensured data production through surveys, interviews and/or observation and project-based learning (Ekoh & Owen, 2000; Tippetti and Milford 2017). Therefore, in this study I used descriptive design that provided insights into gender stereotype beliefs which facilitated the conduct of qualitative data. Hence, it is not a mixed study. Other similar studies were conducted like this study in STEM and English using survey questionnaire, observations and interviews to generate data and were regarded as qualitative studies (Atmowardoyo, 2018; Madden and Beyer, 2016; Tippetti and Milford 2017). I perceive that only when the data were statistically analyzed using statistical procedures then it can be qualified as quantitative study which seek to test significance value-P= 0.05, which researchers have raised concerns about the importance and replication value that is still being debated (Amrhein, Trafmow & Greenland, 2019; Gigerenzer, 2018; Rafi & Greenland, 2020).

Therefore, the Likert scale questionnaire with open and close-ended form of questions was designed but not suitable to conduct mixed-method research nor inferential statistics which aim

to test hypotheses, effects, correlation, and relationships of variables in a population and sample. This is because, the number of participants (eleven) who completed and returned their questions for data analysis was small (N=11) on the field, against anticipated number (N=25-30) Also, the number of six participants chosen for interview, lesson observations collective and reflective journals (N=6) was not statistically suitable for a test of statistical significance, effects, and correlation relationships, hence hypotheses were not formulated which informed the use of descriptive quantitative questionnaire analyses.

Also, the motivation to use descriptive quantitative analysis was not only based on small size but premised on the concerns raised by researchers about the construction of inferential statistics as a norm, due to "overconfidence" and perception of individuals in research space (Amrhein, Trafmow & Greenland, 2019 p. 4). Hence, these researchers suggested that a deliberate focus of any research should be on describing accurately how the study was conducted, what problem was recorded (limitations), what data were obtained, what analysis method was used and why, and what thick and rich data those instruments produced, rather than perceiving inferential statistics as a norm and certainty that describes a single way of testing P- value that does not only test hypotheses but countless assumptions and the entire environment which the study was conducted (Armhein, et' al., 2019). In response to the uncertainty and unknown assumptions surrounding P-value, some researchers consider inferential statistics as a ritual entangled with replication crisis and should be perceived as highly unstable and subjective local descriptions of relationships between assumptions and data, rather than providing generalizable inference about hypothesis that produces *P-value (*Gigerenzer, 2018; Rafi & Greenland, 2020). Because, *P-value* is a statement about probability of data assuming the null hypothesis is true. Further, that no *P-value* can reveal the plausibility, presence, truth or the very importance of an association, relationships or effects adequately, but can only simplify models of reality surrounding a complex phenomenon such as reproduction and subversion beliefs (Gigerenzer, 2018, p. 9).

Therefore, in this study, I used descriptive statistics to capture simple models of the complexity of reproduction and subversion of gender stereotype beliefs and views rather than test of P-value that connote statistical significance which was not meant to test scientific importance, truth and actual reality. The dichotomization level of statistical significance has over the years continued to attract academic debates surrounding P-value, its certainty, replication delusion,

compatibility and supposed validity in Likert scale quantitative research (Wassertein, Schirm & Lazar, 2019; Rafi & Greenland, 2020).

Instead, the Likert scale questionnaire served four purposes. Firstly, the Likert scale questions provided a platform for narrative analysis of all the eleven educators who completed the questionnaire and returned them. Secondly, it served only to inform selection, identification and description of characteristics nature of educators for quantitative descriptive analyses and also a boundary for qualitative research that helped in probing more questions on gender stereotype beliefs, views and practices during interviews, observations, reflections and focus group discussion (Young, 2019; Kenny, et al., 2001). Thirdly, it was a guide, censor, or scanner model to ensure a general overview, educators' positionality and deeper understanding of the phenomenon of reproduction and subversion beliefs and views of science educators before conducting interviews and lesson observations. Fourthly, the Likert scale questionnaire was designed for coherence/logical flow of educators' responses when compared and triangulated with interviews, observation, reflective and collective journals data that elicited different or same beliefs, views and actions. Therefore, the use of Likert scale questionnaire with interviews and lesson observations revealed the disconnect, similarities and differences between questionnaire data and interviews, collective journals and practices recorded during lesson observations.

In this study, while some questionnaire responses provided by the six participants were similar, some were different from what they said in response to being interviewed and actioned when observed on gender stereotype and reproduction beliefs, practices and views. In this sense, contradictions or complexity of responses were elicited. For instance, questionnaire data revealed that some educators do not discriminate but engage equally with pre-service teachers, but during lesson observations and interviews they do stereotype consciously and unconsciously. Also, collective reflections revealed that they discriminate explicitly and implicitly during class engagement. Further scrutiny of questionnaire data show educators' position that most of the time they challenge gender stereotypes during science engagement. In contrast, interviews, lesson observations and reflections show that educators overtly do not subvert beliefs and are not aware of discriminatory actions of male pre-service teachers during engagement. This has revealed boundary and disconnection between beliefs, views and what they practiced in the classroom. This has transformed insight and nuances into qualitative study due to open and closed form of questions.

While the open-ended questions elicited further data and helped in collecting deeper and more qualitative data that could have been missed by a close-ended question, the close-ended questions allowed for the participants to make decision and then take a position before they were interviewed and observed in the classroom. The data was then triangulated with interviews, lesson observations, reflective and collective journals data. This strategy also allowed for a critical awareness, change and transformation of science educator's views and practices about gender stereotypes reproduction and subversion beliefs and practices in the college (Mills, 2008; Mama, 2005; Oberhauser, 2019; Weiler, 2017). Change and transformation occurred when educators reflected on their responses from Likert scale questions, interviews and lesson observations.

4.7.2 Injecting Quantitative Descriptive Analysis into Qualitative Study

This is qualitative study not mixed study. I only injected descriptive questionnaire to ensure integrated, complexity of responses and deeper understandings of gender stereotypes beliefs and views from multiple data sources. This was informed by low response rate obtained from the study field.

In this study, a mixed-methods approach was not adopted as stated earlier, but a fusion of quantitative descriptive analysis of the Likert scale questionnaire with a qualitative approach. This was necessary because of the small number of questionnaires that were completed and returned for the study. Initially, a large number of (N=25-30) was anticipated but when on the field of study, the number was not realizable due to challenges such as security alerts about book haram, kidnappings and banditry, including strike action, workshops, college committee's responsibilities, examination invigilation's and reluctant attitude of educators. These limitations were mitigated during interviews, reflections and lesson observations by adjusting timing, informing educators about liberation model, providing refreshment and incentives. Therefore, quantitative descriptive analysis was adopted.

Quantitative descriptive analysis is a strategy for describing, summarizing, perceiving, analyzing and interpreting characteristics of respondents such as biographies, years of experience, age, frequency (Kem, Joanne & Hollowood, 2018; Cohen, Manion & Morrison, 2018). Yet, this method captures the analysis of individual and consensus beliefs, opinion or views (Sidel, Bleibaum & Toa, 2018). This method supports ***what*** research question and was developed in response to the need for injecting descriptive quantitative analysis into statistical

analysis of qualitative data (Armstrong, 1999; Sidel, Bleibaum & Toa, 2018). Neither quantitative nor qualitative methods are sufficient to capture and reveal the trends and details of a situation, hence, descriptive quantitative analysis provides general understanding of the phenomenon thus complementing qualitative data and findings (Creswell & Creswell, 2017; Ivankova, Creswell & Stick, 2006).

The injection of quantitative descriptive analysis into qualitative study was done using insight from the listwise deletion method. The listwise deletion method is used in descriptive analysis where the number of cases is reduced considerably due to exclusion of every case or person that provided incomplete responses (Cohen, at al., 2018). In fact, the listwise deletion technique only takes or considers one missing value or data to exclude or remove an entire case/ person but uses only those cases which are complete and responded to all the variables of interest. (Cohen, et al., 2018).

Therefore, four stages were applied for data analyses. The first stage of data *analysis* which was *minor, but complementary* revealed the narrative analysis of eleven educators who completed the questionnaire and returned them for selection of six participants. The purpose was to get general overview, censoring and scanning of all the data for adequacy and comprehensiveness. Then, the second stage which was *complementary to qualitative analysis*, shows descriptive quantitative analysis of six individual participants. Also, the third phase which was the cross analysis was complementary to qualitative analysis. The purpose was to identify, compare and ascertain educators' positionality, based on coherence and similarities and differences of responses. The fourth stage - *the major phase* revealed qualitative data analysis of the six participants that produced themes and assertions which provided deeper insight into the three research questions stated in this study.

In this study, the narrative analysis- *phase one the minor stage* was done for all the eleven educators who completed the Likert scale questionnaire and returned them. The Likert scale descriptive analysis- *phase two which is the complementary stage to qualitative analysis* was premised on what Cohen, et al. (2018) call listwise deletion method discussed earlier. This strategy allowed for exclusion of five science educators in phase 1 who did not respond to some Likert scale questions on reproduction and subversion of stereotypic beliefs, views and practices. Thus, the five excluded educators provided incomplete or missing value or data on constructs such as gender stereotype, reproduction and subversion beliefs, practices and views.

Then, six participants were selected for the descriptive analysis-*phase two*, cross analysis – *phase three* and then interviews, lesson observations, collective and reflective journals based on complete, comprehensive and thick responses they provided for all the variables of interest such as reproduction and subversion beliefs, views, age, teaching experiences, gender and sex that were related to the study. Then *phase four* which is the major stage of the study focused on qualitative data analysis that produced themes and assertions. Herein *stage four*, I ensured that only six educators- *participants* that provided thick and rich information were interviewed, observed in the classroom then reflected on stereotypic and subversion beliefs, which facilitated holistic, rich and thick data for the qualitative study. After the questionnaire, next was the classroom observations of educators' engagement with pre-service teachers which lasted for six weeks

4.7.3 Classroom Lesson Observations

Observation is a process where a researcher engages with participants by looking and having an open-minded approach, recording everything in the classroom but paying attention to specific things related to the phenomenon being investigated (O'Leary, 2016). Therefore, in this study I only observed six educators and focused on gender events that occurred naturally by recording stereotypical reproduction and subversion practices as they occurred in their classrooms as the educators engaged with pre-service teachers (Angrosino, 2012). With this perspective in mind, I adopted an unbiased position by being neutral because I sat at the back seat in the class and informed the pre-service teachers to ask and respond to educators' questions during classroom observations before the video recording. The educators were also told to freely engage with the pre-service teachers without fear or favour, since I was not going to interfere with class interactions. This position ensured their confidence and trust while I was present in their classes. Classroom observations also allowed me to watch, listen and record the activities of the science educators as they taught and expressed their experiences, beliefs and gender practices concerning reproduction and subversion of gender stereotyping. Qualitative naturalistic observations ensure trustworthiness and participants' confidence to voice out their beliefs freely and display their actions and/or inactions and are particularly helpful for the collection of data during and after the conduct of qualitative research (O'Leary, 2020). Using classroom observations, however, as a sole research method for data generation has limitations. This is because it is time consuming, and the researcher could be subjective in interpreting the data. To minimise bias, I reduced my subjectivity by using other instruments to triangulate the

data, such as questionnaire and interviews in addition to the classroom observations as sources for data production, analysis, and interpretations of findings. This process further ensured the credibility of the data produced as data from the three instruments supported the finding, thus reducing researcher bias and ensuring research rigour (Patton, 1990, 1999).

In this study, the classroom observations were conducted using video-recorder devices such as two cameras and two cell phones as backups, should in case any of the device fails. The process of lesson observations took one hour and was held every week, for six weeks for each of the science educator, totalling six weeks. During the observation process, I and video recording experts did both audio and video recording of verbal, non-verbal cues and actions of the six science educators and the pre-service teachers from biology, chemistry, and physics classes. This session afforded me the opportunity to observe how the educators engage with the pre-service teachers in relation to their stereotypic gender practices (Cohen, Manion & Morrison, 2018). For instance, I observed the nature of stereotyping such as dominance, resistance and passiveness of pre-service teachers and which of the gender sex is most likely side-lined during class engagement (see Appendix 4 for details). The classroom observations were guided by a protocol that provided nuances about the phenomena of production and reproduction in gender education as the science educators interact with the pre-service teachers.

4.7.4 Interviews

Cohen, Mannion, and Morrison (2011) note that interview is a powerful and flexible tool for data production that may involve multiple channels that needed to be considered. These channels could be verbal, nonverbal, spoken, and heard. Interview is a constructed instrument and uniquely planned event instead of a situation that happen naturally. It is completely different from everyday conversation because it is driven by principles and the researcher must abide by the multiple rules of the game. Interviews enable the researched and interviewer to dialogically exchange views together to interpret the world in which they live to express and negotiate their lived experiences. This shows how an interview not only produces data about life, but it is part of life itself (Doody & Noonan, 2013; Yin, 2011). This is because both participants and the researcher are immersed in it. In this study, I used interviews which afforded me the opportunity to engage with educators dialogically and then probed further questions on reproduction and subversion beliefs. In this sense, I strongly perceive that the interviews afforded the science educators too, the opportunity to describe their views, beliefs, opinions, understanding and experiences about the phenomenon being investigated when I

engaged them (Cohen, Manion & Morrison, 2018). Therefore, in this study, bulk of qualitative data was obtained from interviews data. Data produced through descriptive questionnaire, lesson observations, narrative insight, reflective and collective journals were used to support interview findings and assist in triangulation. Also, in this study I probed the educators and was flexible in accommodating the participants' production of data and knowledge by listening to them as they narrated their experiences and beliefs on gender stereotypes. That is, knowledge on how gender stereotypes are reproduced and subverted and the possible consequences for physical and life sciences in the college of education. Also, the science educators' responses created a nuanced understanding of the phenomenon that enabled me to theorise.

A protocol is a framework and a set of guideline that illuminate events and provide the study with deeper insights (Wang, 1999). Wang framed the acronym SHOWeD to help understand and interrogate concepts better. Here, the letters represent: What do you See and observe here? What is really happening here? How does this relate to Our individual lives? Why does this problem or this strength exist in science classes? What can we Do about it now? (Wang, 1999, 2006). The interviews protocols guided the researcher and provided questions to enable the six science educators to describe their opinions, beliefs and experiences about the phenomena being investigated. This step also deepened the understanding of cultural reproduction and subversion of gender stereotype as the phenomena being researched. Having conceptualised and validated the interviews protocols, I conducted the individual interview with the six science educators.

i) Individual Participant's Interview

I interviewed each science educator separately to elicit individual views and beliefs about reproduction and subversion. This was done two times a week for 25-30 minutes, for two weeks, to get their views, beliefs and experiences on gender stereotypes and subversion in PS and LS classrooms. The interview engagement afforded me with deep insights on how entrenched cultural reproduction of gender stereotype and subversion are reproduced in science classes and the social world. After the individual interviews, I then commenced the focus group interviews to get more nuances of the phenomenon under investigation.

ii) Focus Group Interviews

Focus group interview conversation is perceived as a group discussion that allow individuals in the group to think and contribute to the debate by allowing active interaction among the participants (Sanders, 2020). In this study, due to time constraints, college responsibilities and the intended strike action of staff and pre-service teachers, two focus groups consisting of three participants, one each from biology, chemistry and physics, participated in the interviews involving in-depth conversations that lasted for forty-five minutes for each of two sessions making ninety minutes. This was necessary because it allowed me to observe group dynamics because responses from one participant could help elicit further responses from other participants which would have been difficult during individual conversation (Cohen, Manion & Morrison, 2018; Sanders, 2020). During the focus group, research participants dialogically, democratically and freely made their voices heard about gender stereotype reproduction and subversion beliefs. It provided opportunities for clarification of responses and for follow up questioning and probing of responses (McLafferty, 2004; Sanders, 2020). I also took along note or memos and jotted down some relevant information on the reproduction of gender stereotypes that allowed for thick and rich data. After the focused group interviews there was a need for me and the participants to engage in 'reflective moments' using their reflective and collective journals to elicit rich and thick information about the phenomenon being investigated. This discussion allowed for deeper insights about stereotypic practices of educators, potentials for subversion, transformation of identity, political actions for liberation and equality.

4.7.5 Reflective journals

Reflective journals are diaries where people jot down positive and negative life experiences or events and what and how they learnt from it. These reflective journals assisted the researcher to corroborate his data sources with the participants. In this sense, reflective journals in the form of diaries and notebooks helped me and the participants to keep records of experiences and events that occurred during the research process. This also assisted the researcher and the participants to corroborate data generated through triangulation and member checking (Patton, 1999; Yin, 2018a). The six science educators reflected on their gender experiences and practices in teaching science over the years. They commented on gender inequity, inequality and stereotypes experiences they had during teaching and learning of physical and life sciences. Here, I the researcher, declared my positionality; hence, I reflected on my teaching experiences and how I unknowingly had been gender biased over the years. My positionality and their reflection illuminated the possible entrenched historical, socio-cultural beliefs and gender

stereotypes, reproduction and subversion experiences in science classes and the social world. Science educators were also asked to reflect on the questionnaire, classroom observations and interviews conducted. This seems to have deepened their reflection on the reproduction of gender stereotypes, inequity and inequality and paved the way for the possibilities of transformation regarding gender practices. Although the reflection was vital, some educators complained that the exercise was too long, using questionnaire, interviews and classroom observations. After reflection, the next step we engaged in was collective reflection.

4.7.6 Collective Reflections

Collective reflection is where the researcher and the participants meet as a group to reflect and discuss the collective meaning of the phenomenon being investigated (Foong, Binti, & Nolan, 2018). In this case, I and the participants met, reflected, and discussed on the reproduction and subversion of gender stereotypes beliefs, views and practices in science classes. The science educators then shared their experiences with the researcher in the group before and after the interview, questionnaire and classroom observation processes. The group reflection was necessary because it provoked critical consciousness between me and the science educators due to dialogic and democratic conversations and deepened the understanding of data obtained from the individual and group interviews. The discussion with participants provided me with the opportunity to have a deeper understanding of how stereotypic explicit and implicit beliefs and practices were reproduced and subverted (Cohen, Manion & Morrison, 2018). In addition, the discussion revealed that educators as agents with power could re-negotiate and resist stereotypic practices and beliefs for transformation, liberation and equality (Giroux, 2020; Weiler, 2017). This conversation process also provided deeper insights into how and why the science educators reproduce gender stereotypes beliefs and practices in science classes and perhaps also the consciousness of changing their gender practices. After this description of the data generation process, I discuss next how the instruments were piloted.

4.7.7 Piloting the Questionnaire and Interview Schedule

A pilot interview is what Wahyuni (2012) calls a mock interview. Mock interviews enable the researcher to fine-tune the research instruments with his colleagues or with experts in the study area. Researchers argue that it is of benefit to try out different types of questioning and interviewing methods before conducting the main study. A pilot study is crucial because it allows the researcher to have a sense of direction in the study and to adjust the instrument such as questionnaire and interviews if necessary (Yin, 2011). Therefore, when I drafted the

questionnaire and interview schedules, a pilot study was conducted with two male and two female PhD students on the Edgewood campus of the University of KwaZulu-Natal. My two supervisors also critiqued some questions in providing suggestions to explore more nuanced knowledge of gender stereotype and subversion. The piloting process strengthened my instruments. Firstly, it helped me to develop and refine the questionnaire, classroom observations schedule and interviews. Secondly, the pilot study assisted me to determine whether rich-in-depth and interesting, coherent, and significant information would be obtained from the participants. Thirdly, the original draft had questions as 'What do you understand by the terms gender and sex?' Another question was 'Do you experience gender stereotypes and challenge them in the physical and life science classrooms?' What are gender practices of science educators in class? These questions were rephrased to read as 'What comes to mind about the terms gender and sex? Explain some of the gender practices in the classrooms that affect the teaching of physical and life sciences. What is the nature of stereotypical practices observable in the class? Do science educators' stereotype and favour pre-service teachers during engagement? How do you subvert these practices?' Also, comments led me to restructure these questions to align with the phenomenon under investigation. Always I bore in mind the research questions and objectives.

Due to the comments made by the validators, piloting with the four science education PhD students and my supervisors, I had a deeper sense of direction. This because I went back, reflected and changed the questions that did not cohere with beliefs and views related to the reproduction of gender stereotypes. As a novice researcher in qualitative analysis, the pilot study helped me develop probing interviewing techniques and ways of generating reliable data prior to the main study. The pilot study also helped me engage in logical reasoning and prepare clearer and in-depth interviews. I was able to manage the interviewing process and participants confidently regarding the time, listening skills and follow up questions, mainly due to the experience and knowledge I gathered during the pilot study conducted. Having gathered some experiences because of the pilot study, I then embarked on data generation process with conviction and confidence prior to the data generation process (Kim, 2011; Sampson, 2004).

4.7.8 Data Generation Process

The data generation process did not go as smoothly as had I anticipated. To commence data generation, I sent a permission to conduct research to my Provost in the College of Education, and permission was granted. The same permission was granted by the Dean, School of Science

and all the three head of departments of biology, chemistry, and physics. After which I travelled to Nigeria, visited the provost, Dean and the three heads of departments in 2019 to thank them and commenced the data production process. On this note, I introduced myself and the research topic to the provost, Dean and the three heads of departments as a reminder of the signed consent letters. I then sought for permission to organise a meeting for all the 54 science educators who had 5-15 years' experience teaching biology, chemistry, and physics in the college and permission was granted. In the meeting I told the participants that they can choose to participate, not participate, or withdraw from the research process any time. They consented to participate. I then informed them that they should fill in the questionnaire within one week, the short time was rejected by many of them, hence democratically I suggested a time of three weeks to one month. During the second visit, I distributed the questionnaire to the willing forty-eight science educators teaching biology, chemistry, and physics in the school of science. Some four science educators completed the questionnaires and returned them before the stipulated date, and ten science educators lost their questionnaires. I, again gave ten questionnaires to those who misplaced their questionnaire but were willing to participate. Out of the ten science educators only two returned their completed questionnaire. Therefore, due to work pressure, examination supervision, and college committees' responsibilities, only eleven out of forty-eight science educators completed their questionnaire and returned them. At this stage, narrative analysis of the eleven science educators was done, which informed the selection of six participants for the study. This was necessary to elicit more understanding about cultural gender stereotype and subversion beliefs from the participants' thick and rich responses. After the narrative analysis of eleven science educators who completed the questionnaire, the first five science educators were dropped based on scanty gender information provided that would not facilitate the conduct of the study. Hence, the five science educators were neither interviewed nor observed. The six science educators- *participants* herein were purposefully selected, interviewed and observed in the classroom that produced thick and rich data for the study. The six science educators were selected because of the comprehensive and adequate information they provided that facilitated the conduct of the research work. The six participants responded in line with stated criterion discussed earlier especially based on their preliminary gender awareness responses and position taken before the interviews and lesson observations. The selection was also premised on honest, accurate and adequate information given about their age and teaching experiences and gender awareness experiences they had acquired. The

meeting with the Provost, Dean and heads of department including the distribution of forty-eight questionnaires and the collection of eleven questionnaires responded to by the science educators, lasted for 35 days (five weeks of 14 hours). This is captured in the data generation timeline herein. See table 3 below.

Furthermore, I added two educators to the six participants already selected for the study. The two participants as my sample for the interview aspect of the study. The two educators served as standby should in case there could be logistics reasons such as sickness or absenteeism totalling eight participants as my sample for the interview aspect of the study. I invited them for a meeting and explain to them that they were chosen based on age, accurate, positionality, coherence, adequate gender stereotype and subversion awareness experiences acquired for the study. I assured them of their confidentiality. Having informed them on the study, I discussed the interview timeline. Also, I and the participants liaised with the Dean and their various heads of departments and arranged to conduct the individual interviews and focus group discussions. They agreed and we met the Dean and their head of departments to arrange for suitable classrooms, date and time. All the individual and focus group interviews took place over four weeks, using four hours per week, totalling 16 hours. After the individual and focused group interviews, I then arranged with them regarding the individual and focus group interviews for a discussion session. The dialogic discussion lasted for four hours each week, from introduction to interviewing process to reflect on their prior participation and any more relevant issues pertaining to gender discrimination. This process allowed more time for reflection as they narrated their views, experiences, and beliefs about the reproduction of gender stereotyping and subversion in science classes. The process of collective reflection took place over three weeks, with three hours for each focus group, making nine hours in total. Both individual interviews and focus group interviews were audio/video recorded with the informed consent of the participants. The interviews were completed and transcribed verbatim for data analysis. Next is the data (Table 4.1) generation timeline schedule.

Table 4.1 Timeline for the Data Generation

Weeks	Activities scheduled	Timing/days
1, 2, 3,4 & 5 30/7/2019	Briefing of science educators, administration and distribution and collection of questionnaires from forty-eight science educators and sampling process	35 days-**five weeks**

to 10/9/2019		
***7 & 8*, 5/9/2019 To 27/10/2019**	Individual and focus group Interview (conversation with two groups of 3,3)	Four hours each week for four weeks twenty-eight days -**four weeks**
9 & 10, 5/11/2019 to 30/ 11/2019	Collective reflections with the two focus groups	Three hours for each focus group - three weeks
11,12,13, 14,15, 16 & 17 1 /12/2019 to 24/2020	Classroom observations	I hour each week for six educators six weeks

Next to follow is the account of eleven educators' characteristics who completed the questionnaire and then returned them for selection of participants for the study.

4.7.8.2 Narratives of Eleven Educators' Characteristics

This section provides narratives of eleven educators' characteristics who completed the Likert scale questionnaire and return them to me.

Only eleven educators from the forty-eight science educators in Biology, Chemistry and Physics departments completed the Likert scale questionnaire and returned them to me. This was due to timing, security challenges, educators' reluctance to complete questionnaire, college committees' responsibilities and scheduled laboratory practical, strike action and examination invigilation. The low response rate was rectified by adjusting the timing for interviews and lesson observations, giving them incentives, and motivating the science educators to believe that the knowledge produced and acquired from the study will emancipate and transform them

from historical, economic, social-cultural work, religious and educational oppression. This consciousness has rekindled hope in them and ensured their confidence.

After a careful narrative analysis of eleven educators' who returned their questionnaire to me, the first five educators (Domi, Kari, Lama, Loza & Mofa) amongst the eleven science educators were dropped. This is because, the questionnaire the five educators completed and returned to me did not provide complete basic biographic information, comprehensive data and their positionality about reproduction and subversion of gender stereotyping beliefs and views that could help during interviews, collective and reflective journals and classroom observations. But six educators were selected, interviewed, observed and reflected on gender beliefs, views and practices during collective and reflective journals engagement. The six educators were selected based on rich biographic information such as years of teaching experience/cultural setting, geographical locations, their positionality, awareness on gender equity, adequate and comprehensive data they provided about reproduction and subversion of gender stereotypes beliefs, views and practices that assisted and facilitated data production. Therefore, the selection and data analysis of the six educators reflects the Likert scale questionnaire that complemented the interviews data, classroom observations data, reflective journals, and collective journals data. The narrative account of educators' stories and descriptive questionnaire data analysis, fostered deeper and integrated understanding of stereotypic beliefs, views and practices during interviews, lesson observations and reflection moments. The data from different sources provided thick, rich and a nuance understanding of science educators' reproduction and subversion of gender stereotyping for the analysis, codes, and themes. My engagement with the six participants took place in Biology, Chemistry and Physics classrooms as they have engaged with pre-service teachers in the college.

Below are the eleven educators' narratives starting with five educators who were not interviewed, observed in the class and do not reflect on their beliefs, views and practices, based on scanty gender information provided. But six participants were selected, interviewed, observed and reflected through collective and reflective journals for the study. They were selected due to their commitment, and positionality in giving me rich and nuance understanding about the phenomenon.

The detail narrative account of the eleven educators' is captured in chapter five, (section 5.1).

1. Domi, a male science educator, has Master's in Science Education (MSc. Ed). His teaching qualifications are Grade 11 Teachers Certificate (GTC) Nigeria Certification in Education (NCE) Bachelor of Science Education (BSc. ED) and Master's in Science Education (MSc. ED). Domi has taught for 29 years in the college. He teaches Physics 124 introduction to fluid physics to 86 pre-service teachers 52 males and 34 females.

2. Kari, a male science educator, has masters in science education (MSc. Ed). His teaching qualifications are: Nigeria Certification in Education (NCE) Bachelor of Science Education (BSc. ED) and Master's in Science Education (MSc. ED). He is currently doing his PhD in Science Education. Kari has taught for 8 years in the college. He teaches Chemistry 222- analytical chemistry to 46 pre-service teachers 30 males 16 females.

3. Lama**,** a female science educator, has masters in science education (MSc. Ed). His teaching qualifications are Grade 11 Teachers Certificate (GTC) Nigeria Certification in Education (NCE) Bachelor of Science Education (BSc. ED) and masters in science education (MSc. ED). Lama has taught for 23 years in the college. She teaches chemistry 122 to 88 pre-service teachers -52 males 36 females.

4. Loza, a male science educator, has masters in science education (MSc. Ed). Her teaching qualifications are Grade 11 Teachers Certificate (GTC) Nigeria Certification in Education (NCE) Bachelor of Science Education (BSc. ED) biology and Master's in Science Education (MSc. ED). Loza has taught for 15 years in the college. He teaches Zoo 211 lower invertebrates to 97 pre-service teachers -65 males and 32 females.

5. Mofa, a male science educator, has masters in science education (MSc. Ed). His teaching qualifications are: Nigeria Certification in Education (NCE) Bachelor of Science Education (BSc. ED) and master's in science education (MSc. ED). Mofa, has taught for 6 years in the college. He teaches physics 112- general physics to 86 pre-service teachers 52 males and 34 females.

6. Tengo**,** a female science educator, 50 years old at the time of the study has PhD in science education. Her teaching qualifications are Nigeria Certificate in Education (NCE), Bachelor of Science Education (BSc. Ed), Master's in biology education (MSc. ED). She is a registered science educator with Teachers Registration Council of Nigeria (TCRN), belong to Science Teachers Associations of Nigeria (STAN) and Association of Women in Colleges of Education

(WICE) in Nigeria. Tengo is married and has a family of 6, a husband and 4 children -2 females and 2 males who pray every night before going to bed. She belongs to Mangwali social cultural group that promote small-scale business in the community and embraces peace, morality and accommodate diverse cultures. Tengo has taught biology for seventeen years in the college. She teaches Zoology 323- animal ecology to 148 pre-service teachers - 80 males and 68 females and Biology 211 - genetics to 371 pre-service teachers -211 males and 160 females. Tengo supervises pre-service teachers' thesis and teaching practice in the college. She was a treasurer of project construction committee of the department and became the head of Biology department. She has attended workshops, and conferences on gender, science teaching and professional development of educators in Nigeria.

7. Zima**,** a female science educator, 55 years old at the time of the study has PhD in science education. Her teaching qualifications are Grade 11 Teachers Certificate (GTC), Nigeria Certificate in Education (NCE), Bachelor of Science Education (BSc. Ed), and Master's in Science Education (MSc. Ed). She is a registered science educator with Teachers Registration Council of Nigeria TCRN, belong to Science Teachers' Association of Nigeria (STAN) and Association of Women in Colleges of Education (WICE) in Nigeria. She is currently the deputy provost of a federal college of education. She is from north-central geo-political zone of Nigeria, where the study was conducted and a leader of women group in the church who led women to the Vatican City in Rome for conference on religious empowerment. She belongs to a culture that embraces diverse people with multicultural orientations. Zima was born into a polygamous family of 15 members that comprises her father, mother three women married to the father and ten children. She got married to her husband when she was 20 years old and a mother of 6 children, 2 females and 4 males. Due to entrenched social cultural orientations the male children are sometimes respected than the females' children. She subverted cultural norms hence decided to treat the boys and girls equally by distributing roles such as cooking food, washing clothes, and ironing her clothes in the house. Zima has taught biology for twenty-one years in the college. She teaches Zoology 399 fisheries to 207 pre-service teachers -137 males and 70 females and Zoology 203- reproduction and growth to 21 pre-service teachers-13 males and 8 females. She was departmental examination officer who calculated and kept records of all student results in the department and became the head of department, dean school of science and now the deputy provost. She has attended workshops, seminars and conferences on teacher professional developments and gender equality issues.

8. Boko**,** a male science educator is 65-years old at the time of the study has masters in chemistry. His teaching qualifications are General Certificate in Examination (GCE), Post Graduate Diploma in Education (PGDE), Bachelor of Science (BSc), and Master's in chemistry (MSc). He is a registered member of Colleges of Academic Staff Union in Nigeria (COEASU), Teachers Registration Council of Nigeria (TRCN), Science Teachers Association of Nigeria (STAN) and Chemical Association of Nigeria (CAN). Boko is from South-South geo-political zone of Nigeria and has a family of 5 members (Boko, wife, 2 boys and 1 girl). He belongs to southern social political group that are educated. Based on entrenched social cultural norms and stereotype, he has socialized the male children to men roles while working in the house and in the farm and the girl into female roles of washing plates and cooking for the "big boys" in the house. Boko has taught chemistry for 33 years from secondary school through college of education. He teaches Chemistry 112 -inorganic chemistry to 50 pre-service teachers -43 males and 7 females. He was teaching practice coordinator, adviser to pre-service teachers and then the head of department. He has attended workshops, seminars and conferences on teacher and student mentoring relationship, management of science classrooms and supervision of students teaching practice and gender issues.

9. Nagam**,** a male chemistry educator, is 47 years old at the time of the study has master's degree in chemistry and currently studying PhD in chemistry. His teaching qualifications are: Postgraduate Diploma in Education (PGDE), Bachelor of Science Education (BSc. Ed), Master's in chemistry (MSc) with specialty in organic chemistry. He has registered with Teachers Registration Council of Nigeria (TRCN), Science Teachers Association of Nigeria (STAN) and Chemical Association of Nigeria (CAN). He is a registered member of Colleges of Education Academic Staff Union (COEASU) and came from north -central Nigeria and belongs to Garik social-cultural group who are brave warriors, hardworking people and give preference to men than females in the community farm work and political offices. He has a family of five that comprises his wife and 3 children - 2 females and 1 male. He belongs to different committees such as staff and student welfare committees, students' disciplinary committee and examination malpractice committee of the college. His is currently the examination level coordinator in the department. Nagam has taught chemistry for fifteen years. He teaches Chemistry 123 organic chemistry to 160 pre-service teachers -100 males and 60 females.

10. Bodam, a male science educator, 48 years old at the time of the study has Masters in Physics. His teaching qualifications are Nigeria Certificate in Education (NCE), Bachelor of Science Education (BSc.Ed), and Master's in Physics (MSc). He has registered with Teachers Registration Council of Nigeria (TRCN), belong to Science Teachers Association of Nigeria (STAN) and Association of Physics Teachers in Nigeria (APTN). He is a registered member of Colleges of Education Academic Staff Union (COEASU). He is currently the examination officer in physics department and belongs to college committees such as welfare committee, students' disciplinary committee, examination malpractice committee and secretary to the finance committee of the department. He belongs to Ngok social cultural group that is peace loving, hardworking, politically conscious and educated. He has a family of 6, Bodam, wife and 4 children 2- males' 2-females and prefer to work on the farm with the boys due to entrenched cultural norms of male preference. Thus, he allows the females in the house to cook food and bring to family members and hired workers on the farm. Bodam has taught for ten years in the college. He teaches physics 402- electricity to 150 pre-service teachers -60 males and 90 females. He was level coordinator of the department at the time of the study. Bodam has attended workshops and conferences on teacher professional development and gender awareness. He supervises student projects, teaching practice exercises and belong to college admission committee.

11. Dula**,** a male science educator, 49 years old at the time of the study has Master's in Physics. His teaching qualifications are Nigeria Certificate in Education (NCE), Bachelor of science (BSc) in Physics and Master's in Physics. He is registered member of Teachers Registration Council of Nigeria (TRCN), belongs to Science Teachers Association of Nigeria (STAN) and Association of Physics Teachers in Nigeria (APTN). He has registered with Colleges of Education Academic Staff Union (COEASU). He is a member and secretary in various committees of the college such as teaching practice committee, students 'welfare and disciplinary committee and college admission committee. Dula has a family of 4, himself, wife, 2 boys and one girl and belongs to a social cultural group that embraces peace and justice. He participates in political leadership negotiations in his community and likely to be a parliamentarian in future. Dula has taught for 10 years in the college. He teaches physics 121 general physics 111 to 108 pre-service teachers 66 males and 42 females. He supervises students teaching practice exercises and projects. He was a level coordinator to pre-service teachers in the department and student's adviser in the school of science.

4.7.9 Data Analysis

The data was analyzed using descriptive questionnaire, narratives and qualitative research insights. The open questions in the questionnaire, addressed views and beliefs, while closed questions addressed positionality and opinions within a limited range and educators' background. In addition, descriptions obtained from a Likert scale rating: The analysis was done to find out how science educators' teaching experience, age, qualifications, and gender could have an influence on student enrolment in Physical Science (PS) and Life Science (LS) (see table 5.1). The analysis was first done on the number of courses for all physical and life sciences with regards to male and female undergraduate pre-service teacher courses. Secondly, the analysis was done for science educators' sex, age, qualifications, and experience as it could influence student's enrolment, career status and motivation. I perceive that age, sexual orientation (*educator's personality*) and gender could influence enrollment in the classroom if students perceive that either the old or younger male and female educators engage with them democratically rather than as autocrats. As students have a choice in modules selection and the choice of which lecturer's class to attend, they will prefer someone that they can relate to, motivate them and enhance their interest to learn. Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD), were analyzed to produce inference, deductions, summary and findings of notions, beliefs and views of science educators about gender stereotype and reproduction as they experienced the phenomenon in the context where the data was generated (see section 5.2) for details). In this study, the Likert scale was not meant for mixed method research nor inferential statistics, but served as general insights, educators' positionality on reproduction of gender stereotype and subversion beliefs and views. It also helped and complemented in answering research question one. *What is the nature of science educator's reproduction and subversion of gender stereotype beliefs and views in science classes?* This enabled selection of six participant's that were interviewed, observed and reflected on the study. In addition, I used narrative technique to capture the eleven educator's questionnaire responses. In this study, I perceive narrative as a technique for analysis hence, I used it for general scanning- *detecting,* analyzing and then selecting six participants out of eleven educators who completed the questionnaire. That is, observing eleven educators' questionnaires to detect valid and comprehensive information about their responses and then for the selection of six participants who provided adequate information about gender stereotype

beliefs and views. Then I deleted five educators who had missing data hence could not provide me with comprehensive data about stereotypic beliefs.

For the interviews, I used thematic analysis which resonated around critical theory, critical feminist reproduction theory and critical consciousness perspective that underpinned change, emancipation, and transformation of marginalized individuals especially females. This involves organizing, accounting for and making sense of data in terms of the participants' definitions of the situation by noting patterns, themes, categories and regularities (Cohen, et al, 2018). In this sense I employed a qualitative descriptive analysis technique that involves reading through the interview transcript, jotting down notes and comments, selecting the richest and thickest portions of the interview transcripts, listing the emerging themes and clustering, and encoding them. For instance, coding was done in this manner, female biology science educators one and two (ZIMA & TENGO), male chemistry science educator one and two (BOKO & NAGAM) and male physics science educator one and two (BODAM & DULA). Also, I identified the major themes and sub-themes from the available data and analyzed categories of the sub-themes to illuminate what they meant. Therefore, having jotted down notes and comments and selecting the riches and thickest but most meaningful portions, I analyzed within case analysis. Within case analysis, as described by Creswell and Poth (2017), the researcher analyzed the case embedded with units such as each single science educator for themes and cross-checked across sites such as the different departments with each science educator.

As this study has multiple cases, the researcher may compare individual case themes across multiple cases to compare the data for analysis. This allowed for sorting, coherence, thick and rich data to be picked for analysis, themes and knowledge theorisation. Therefore, when data were produced by the six-science educators from questionnaire, I firstly analyzed the data individually in three parts A, B & C based on Likert scale rating by noting observations, summary, deductions and findings of the notions and beliefs of science educators about reproduction and subversion of gender stereotypes**.** This informed coding, themes, assertions and knowledge theorisation, conclusion, and implications for educational practice. The results, deductions and observations obtained from the Likert scale are tabulated (see section 5.1). This was followed by the qualitative data analysis of interviews, classroom observations, reflective journals and collective journals for themes by initial coding for clarity. I then compared and synchronised the data generated from all the instruments to observing how they flowed, formed links, or were in coherence with one another. This allowed me to generate the main themes for

findings and engaging in the discussion of the nature, how and why science educators reproduce and subvert gender stereotypes the way they do.

4.8 ETHICAL CONSIDERATIONS

Ethical orientation entails that the researcher has the moral and professional obligation to be ethical, even when the participants may not be aware of research ethics (Powell, Fitzgerald, Taylor, & Graham, 2012). The typical form of research ethics has been questioned because ethics in an African context could be different from ethical research in a western context linked to cultural differences (Lee, 2018; Ngozwana, 2018). However, in this study, ethical standards as required by the university were followed and adhered to strictly by ensuring confidentiality and participants' consent during and after the research process. In addition, the consent letter captured other ethical issues that were relevant to this study. For instance, participants were informed and offered the opportunity to withdraw from the process at any stage. They were obliged to ask questions, seek clarification on all issues involved in this study. The college of education in Nigeria where the data was generated, and research conducted had been contacted and permission sought from relevant authorities as the Provost, Dean and heads of departments and necessary approval obtained from them. The researcher argues that professional uprightness in ethics depends on academic honesty, change and morality. Yin (2015), shifting his opinion from other researchers' perception on ethics, argues that an aspect of integrity and ethics that is relevant to qualitative research in education concerns the willingness of researchers to be proven incorrect and have their ideas challenged throughout research process. Hence, I informed the participants to ask questions and challenge me on any areas they do not understand for clarity, as guided by research ethical guidelines (Bertram & Christiansen, 2014).

As a pre-condition to obtaining ethical clearance from the University of KwaZulu-Natal, the gatekeepers' letters from the Provost, Dean, and heads of departments and participants' consent letters were obtained from the college where the research was conducted. To conduct the main research, an ethical clearance certificate (Appendix 1) was obtained from the University of KwaZulu-Natal through the relevant authority.

Also, participants were informed of their voluntary participation and withdrawal at any time if they so wish. The participants were given all the necessary information needed concerning the conduct of the study and the ethical issues involved before they participated, to avoid litigation thereafter. The participants were also assured that the data they provided was kept confidential

throughout the research process and no information in any form was disclosed to and discussed with anyone else except the participants themselves and the researcher. Thus, the participants were also assured that the interview recordings (audio/video) were kept in the Science and Technology Cluster, University of Kwazulu-Natal, South Africa for safety. They were also told that the actual names of the college of education and participants were not disclosed anywhere in the study thesis. Anonymity of the college of education and participants was assured, and they were given pseudonyms to protect their identities. As a moral obligation, I ensured that the questions asked during the interviews did not cause any harm to the participants and respected their identity and dignity to ensure the trustworthiness and credibility of the research work (Yin, 2015; Creswell & Creswell, 2017).

4.8.1 Positionality of the Researcher

The researcher's positionality concerns the stance and bias of the researcher in collecting data, analysing the data and negotiating to produce knowledge. Arguably researchers' views on positionality show that neutral and objective observation on children or participants is likely to be difficult, because a researcher's positionality may impact students. There is the possibility that as the researcher generates data with participants their ontological and epistemological beliefs will influence the research process and production of knowledge (Holmes, 2020; Mwambari, 2019).

Positionality concerns personal reflections, the different methods used, differing views and beliefs of the researcher and ethical considerations with reference to colleagues and students during the research process (Hamilton & Corbett-Whittier, 2013b). In addition, researchers are in the world and of the world they research as they bring their own biographies, values, biases, politics, beliefs and world views to the research process and participants behave in a particular way in their own presence. Thus, qualitative inquiry is not a neutral activity and researchers are not themselves neutral because they interpret the already interpreted world of the participants (Cohen et al., 2018, p. 302). In this sense, I reflected on my personal experiences and beliefs as a science educator over the years and how biased I was with regards to gender engagements in science classes and how unethical and unequal due to intellectual dominance when interacting with students and colleagues within and outside science classrooms. Therefore, during the study, I was cautious to minimise any biased influence of values, gender, race, sexuality and knowledge. This is done by considering and respecting the multiplicity of views and beliefs in addition to triangulation of different data sources. Also, I was sensitive and allowed room for

power sharing amongst science educators and who participated in the study during data generation and knowledge production to guarantee trustworthiness (Berger, 2015; Cohen, Manion, & Morrison, 2018).

4.9 TRUSTWORTHINESS LINKED TO RESEARCH RIGOUR

Trustworthiness in qualitative research connotes validation in quantitative data, which means that the data generated, and the knowledge produced must be worthy and of merit**.** Therefore in qualitative studies, trustworthiness is linked to the following criteria: credibility, transferability, dependability and confirmability, which are suggested by researchers to be essential criteria in a qualitative study that a researcher must consider (Creswell & Poth, 2017; Guba & Lincoln, 1985). Guba and Lincoln (1985) maintain that trustworthiness in a qualitative study is substantial in evaluating its worth and rigour. The skills and training of the interviewers and participants are crucial for maximising trustworthiness. Trustworthiness is achieved through triangulation and member checking to minimise bias and errors (see section 4.3.2.5). When I started this study, I conducted a pilot study to check whether the data production tools, questionnaire and interviews would provide the desired information that would align with the research topic, research questions and objectives. This was very helpful, because it enabled me to improve on the questionnaire and interview schedule in preparation for conducting the main research. In addition, I carefully and logically recorded each interview and transcribed the interviews to ensure accuracy and provide insightful, thick, and rich knowledge on the phenomenon being investigated. The accounts of each criterion linked to the concept's trustworthiness are given as follows.

4.9.1 Credibility

Credibility refers to multiple data sources that researchers use to ensure trust in the research work. It deals with the accuracy of multiples of data that reflect the observed social phenomenon. That is, whether the study actually measures what it intends to or ought to measure (Creswell & Poth, 2017). Researchers also argue that credibility refers to the confidence one may have in the findings and whether these findings are correct or inaccurate. In other word, are the results in accordance or not with the phenomenon under investigation? Therefore, credibility is a vital factor in ensuring the true value of the research, which could be achieved through triangulation of the data generated by collecting quality and complicated data from the behaviours and lived experiences of human beings. This is done through different data

sources, thus adding strength and rigour to the research process (Cohen et al., 2007; Guba & Lincoln, 1985; Liao & Hitchcock, 2018). Drawing from Creswell and Poth (2017) and Guba and Lincoln (1985), the researcher sees credibility as the 'hallmark'' of qualitative research, since credibility depends on the correctly chosen theoretical framework, the paradigm, methods, data generation process, and triangulation of the data. In addition to ensuring credibility of the study findings and knowledge produced, I sampled participants who had little understanding and knowledge about inequality and gender stereotype reproduction and subversion in teaching physical and life sciences in the college context and interaction in social space. That is, participants who supplied the researcher with honest, accurate, adequate, and insightful information about the phenomenon. Their different perspectives afforded me the opportunity to get different views, experiences, and beliefs about gender inequality reproduction and subversion.

Also, to ensure credibility of the findings, I employed multiples sources of data in the form of questionnaire, classroom observations, collective reflections and interviews to strengthen the study. Data was then analyzed in tables, themes and codes in accordance with the procedures employed in similar previous studies as methods of data analysis. More so, to ensure confidentiality and honest responses from the participants when producing data, science educators who participated were given the opportunity to withdraw from the study at any point during the research process. This ensured that the data was generated only by those who were willing and participated and hence had confidence to produce the data publicly without fear. In addition, confidentiality and assurance were possible because, from the outset of the research process, I provided an enabling environment by providing refreshments and encouraged the participants to be free and open minded. This action established a good relationship and gained their confidence as well. I further built their trust, when I informed them that there were neither wrong nor right answers for the questions (Moon, 2019; Patton, 1999; Yin, 2015).

To ensure further support to credibility of the findings of the study, I triangulated the data through validating the data produced from different sources (Guba & Lincoln, 1985; Yin, 2018b). This was done by organising a meeting with the participants and listening to the recorded interviews and classroom observations to check that nothing was missed out during the interviews and observations. At the end of the data production session, the six participants were asked to read the questionnaire and the transcribed data and to check if their words reflected what they had narrated concerning gender stereotype, notions, beliefs and views. They

were happy and had confidence in me because what they wrote down and narrated was what I had captured during the transcription moments.

4.9.2 Transferability

This means making sure findings are easily transferable between the researcher and the readers due to thick description of the study data. Also, transferability refers to the level of applicability into other settings or situations (Creswell & Poth, 2017; Guba & Lincoln, 1985). This means the findings have the potential of applying or transferring to other contexts. This resonates with Marshall and Rossman (2014), who argue that transferability refer to the relevance of the research findings and its applicability. Therefore, transferability as a criterion was relevant in this study and was ensured because the methods, design and theoretical framework used are consistent with the current qualitative research discourse that produced the knowledge on gender stereotype and reproduction. The findings of this study can be transferred, applied and generalised in other contexts. This is possible because I used both numerical and qualitative data which informed the thick and rich elements of data embedded in the study that are consistent with trustworthiness framework which could guarantee its applicability and dependability.

4.8.2 Dependability

Researchers contend that dependability refers to the consistency of the findings in the context or different sites. This implies that should the study be repeated in a similar context, would the researchers obtain the same results, if the same research methodology, methods, and instruments were adopted? Can future researchers depend on the design and methods used to produce data? This criterion was enhanced through step-by-step explanation of the research process undertaken (Cohen et al., 2018; Creswell & Poth, 2017). Therefore, to ensure dependability of the study results, I discussed and reported the processes within the research discourse in a detailed manner to enable future researchers to repeat the study should the research needed to be repeated in the same or different context. In this sense, I described in detail and validated the instruments used, the research questions and data generation process.

4.9.4 Confirmability

Confirmability is the extent to which the results of the study are the sole ideas, experiences and narratives of the participants and not of the researcher's interest (Creswell & Poth, 2017). This entails that the results should be guided by the participants rather than by the bias, influence,

and motivation of the researcher. This implies that more power be given to the participants to narrate their lived experience with confidence devoid of intimidation or fear. Confirmability refers also to the extent to which other researchers can confirm the findings to ensure that results reflect the understandings and experiences from observed participants rather than the researchers' own preferences (Patton, 1999). In this study and during data generation, I allowed the participants to appropriate more power by allowing them to complete the questionnaire and respond to the interviews, while I listened, co-ordinated the discussion, and controlled the timing. The distribution and collection of questionnaires lasted for five weeks, while interviews, and collective reflections lasted for seven weeks**.** Also, confirmability was achieved through member checking and triangulation of the data sources of this study. On member checking, the data or results of the study were returned to the participants to check for accuracy and whether the findings resonated with their lived experiences, what they narrated during the interview process, observation of classroom engagements and their questionnaire responses. Also, during the study, I allowed for knowledgeable and experienced scholars from science and technology clusters of the University of KwaZulu-Natal, besides my two supervisors, to member check and validate the research work to strengthen the study. More so, during different PhD cohorts, experienced senior lecturers, professors, and researchers from the School of Education with speciality in chemistry, biology, and physics education and some from the curriculum and psychology education departments validated aspects of the work on a regular basis to ensure its rigour. These intellectuals critically examined some aspects of the research work, hence made their inputs from chapter one to the last chapter eight to ensure credibility and trustworthiness. On triangulation, I ensured that the different sources that I generated data from converged together to ensure coherence and comprehensive understanding of the gender stereotype reproduction and subversion as the phenomenon of the study and this was also validated by experienced science education scholars that ensured its thoroughness (Patton, 1999).

4.10 CONCLUSION SUMMARY

In this chapter, the qualitative methodology and case study approach were discussed, then the purposive sampling approach, that linked convenient technique. I used questionnaire, interviews, and lesson observation, collective and reflective journals to generate data for the study. The population for the study was forty-eight science educators, from which I sampled six. Four male and two female educators were selected based on the convenience for access to

them, to engage them with questionnaires and interviews. In addition, convenience sample is the one that is drawn from a source that is conveniently accessible to the researcher. The science educators were colleagues with whom I had previously interacted in the college during seminars, school meetings and committee's work in the college. Herein, the positionality of the researcher, trustworthiness and philosophical assumptions underpinning the research work were accounted for. The context chosen was a college of education in the North Central Nigeria, due to its proximity to me. More so, the choice of the institution was made due to the frequent gender workshops and conferences held in the college.

CHAPTER 5
DESCRIPTIVE QUESTIONNAIRE DATA, QUALITATIVE DATA ANALYSIS, SUMMARY AND FINDINGS

UNDERSTANDING THE NATURE AND HOW GENDER STEREOTYPE BELIEFS AND PRACTICES WERE REPRODUCED AND SUBVERTED IN SCIENCE CLASSES

INTRODUCTION

Chapter 5 is divided into two sections A & B. While section A comprises of stages one and two, Section B has one stage. The chapter presents the first section as the narrative analysis which captures a written account of eleven science educators' stories-*stage one.* This first stage, provided a platform for selection of six educators as participants based on their positionality, gender awareness and compressive responses that facilitated the conduct of the study. Then the section summarizes description of gender frequencies, ratings and charts. Stage two provided a cross analysis of educator's gender, sex and reproduction and subversion of stereotypic practices. Therefore, narrative analysis that allowed for *likewise-deletion technique* and selection of participants added value to the qualitative study data as stated earlier at methodology section (Cohen, Manion & Morrison, 2018). This complemented and enabled a corroboration then triangulation of interviews, lesson observations, collective and reflective journals data that holistically produced thick, rich and nuance understanding and findings for the study

Then section B presents findings developed through descriptive questionnaire analysis- *stage two* of the six participants which were complementary and then the major qualitative data analysis-*stage three,* which produced themes and assertions to answer research question two and three.

Next is the account of the narrative analysis-*stage one,* descriptive questionnaire analysis and cross analysis-*stage two* and qualitative analysis- *stage three which is the major phase*.

SECTION A

5.1 NARRATIVE DATA ANALYSIS AND DESCRIPTIVE QUESTIONNAIRE ANALYSIS-*Stage One*

This section provides the background, analysis of descriptive questionnaire data and narrative analysis of Likert scale questionnaire of eleven science educators amongst the forty-eight science educators who indicated interest. It also illuminated the research question one stated in this study.

*With regard to **"what"** aspect, these categories of data description of reproduction and subversion of gender stereotype beliefs and views were elicited*:

1**.** Domi's responses based on Likert scale questionnaires rating

On the following questions asked what comes to mind when you come across the concept sex, gender, and stereotype? Domi, said sex is biological organs of either males or females, gender means male and female category and stereotype means stigmatization of people in the society (see part B Q1a & Q1b).

On cultural reproduction of gender stereotypes Domi said what comes to mind is "women producing young children in the community and culture" (see part B 2.2 Q1).

The following Likert scale questions and responses depict what Domi responded to about reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On the question, do you intentionally bring beliefs and assumptions concerning pre-service teachers during science engagement? Domi was neutral that he intentionally brings views and assumptions about male and female pre-service teachers to the science classroom (see Q2a). On the question do you unintentionally bring to science classroom assumptions concerning pre-service teachers? Domi disagrees that he unintentionally brings beliefs and views about male and female pre-service teachers to the physics classroom without providing how he does it Q2b).

On the question do you allow male pre-service teachers to head group work during science interactions. He disagrees he allows male pre-service teachers to head class activities during physics teaching and learning (see Q2d). Questions 2e &2f do you not and do you interact

equally with pre-service teachers? Domi disagrees that he interacts equally with male and female pre-service teachers, (see Likert scale part B 2.1, Q2a, Q2b, Q2d, Q2e, and Q2f) on the intentionality of assumptions, engagement with group work, equal and unequal participation with male and female pre-service teachers.

With reference to the following questions, do text materials represent more men images than females. He was neutral in responding to texts representation of male and females' images (see liker scale Part C, Q1 Q2 & Q3) on representations of images of men and women.

On reproducing some gender beliefs in science education, the following questions reflect his responses

Do you ask male pre-service teachers difficult questions and females simple questions? Domi disagrees that he asks male pre-service teachers difficult questions in the classroom and female pre-service teachers simple questions because (see part CQ5 & Q7).

Do you ask male pre-service teachers to set experiment while females pre-service teachers watch? He disagrees that he asks male pre-service teachers to set experiments while the female pre-service teachers watch during interaction in the science classroom (see Q9). Do you cite examples with female role models than male role models during teaching? He was neutral about citing examples with female role models than male role models (see Q10).

Do male pre-service teachers perform better than female pre-service teachers? He disagrees that male pre-service teachers perform better than female pre-service teachers in physics 124-introduction to fluid physics at the time of the study (see Q11). Do you help female pre-service teachers more often than male pre-service teachers during classroom activities? He strongly disagrees that he helps female pre-service teachers more often than male pre-service teachers in the science classroom (see Q12).

On the statement educators assign female pre-service teachers to lead project work/field work more often than male pre-service teachers. He disagrees that he allows female pre-service teachers to lead project work than male pre-service teachers during physics engagements (see Q13). Do you cite negative examples with female pre-service teachers and negative examples with male pre-service teachers (see Q14 & Q15)? He disagrees that he cites negative examples with females and positive examples with male pre-service teachers during classroom engagements, (see Likert scale Part C, Q5, Q7 Q9, Q10, Q11, Q12 & Q13) on difficult and

simple questions, setting experiments, role models, educators' assistance, performance of male and female pre-service teachers and field work activities and negative/ positive remarks on pre-service teachers.

Do you respect and praise male pre-service teachers more than female pre-service teachers? Domi disagrees that he praises and respects male pre-service teachers more than female pre-service teachers (Q16 & 17). Do you consider male pre-service teachers intelligent and female pre-service teachers dull during classroom interactions? He disagrees that he considers male pre-service teachers intelligent, and female dull during science engagements (see Q18). Do you watch the pre-service teachers when the females ask male pre-service teachers to lead group activities and respond more to questions? He was neutral on watching the male pre-service teachers dominate activities, asking and responding to questions in the classroom (see Q19).

Subversion of Gender Stereotypes in the Science Classroom

On subversion of gender stereotypes in the Physics classroom, Domi did not say anything about subversion in the science class. Do you subvert or rebuke pre-service teachers during science engagements? He agrees that he rebukes male pre-service teachers who lead and dominate science activities during teaching without giving reasons how he subverts the students in the classroom (see Likert scale part C, Q14, Q15, Q16, Q17, Q18, Q19 & Q20) on educator's respect and praises, intelligence of male and dullness of female pre-service teachers, male pre-service teachers' asking and dominating classroom questions and subversion of educators.

Summary

Domi has limited biographic data and understanding of gender stereotypes reproduction and subversion. Therefore, he was not selected, interviewed and observed at the time of the study due to scanty information and responses provided when completing the questionnaire. Domi responses on Likert scale rating on cultural reproduction of gender stereotypes, beliefs and subversions show that he does stereotype and has no understanding of gender stereotypes. Though, Domi said he subverts stereotype in the science class, has no idea about subversive strategies that may likely reduce pre-service teachers' stereotypic practices in the classroom**.**

2. Kari's responses based on Likert scale questionnaire rating

On the following questions asked what comes to mind when you come across the concept sex, gender and stereotype? Kari said sex is male and female, gender means social roles ascribe to

male and female in the society and stereotype means “not the original copy” (see part B Q1a & Q1b).

On cultural reproduction of gender stereotypes, Kari said what comes to mind is “replica of gender” (see part B 2.2 Q1).

The following Likert scale questions and responses depict what Kari responded to about reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On the question, do you intentionally bring beliefs and assumptions concerning pre-service teachers during science engagement? Kari strongly disagrees that he intentionally brings views and assumptions about male and female pre-service teachers to the science classroom (see Q2a). On the question do you unintentionally bring to science classroom assumptions concerning pre-service teachers? Kari strongly agrees that he unintentionally brings beliefs and views about male and female pre-service teachers to the chemistry classroom without providing reasons how he brings the beliefs and views (Q2b).

On the question, do you allow male pre-service teachers to head group work during science interactions. He strongly disagrees that he allows male pre-service teachers to head class activities during chemistry teaching and learning (see Q2d). Questions 2e &2f do you not and do you interact equally with pre-service teachers? Kari strongly disagrees that he interacts equally with male and female pre-service teachers, because “they are treated equally in the class” (see Likert scale part B 2.1, Q2a, Q2b, Q2d, Q2e, Q2f) on the intentionality of assumptions, engagement with group work, equal and unequal participation with male and female pre-service teachers.

With reference to the following questions, do text materials represent more men images than females. He strongly disagrees that texts materials represent male images more than female images (see liker scale Part C, Q1 Q2 & Q3) on representations of images of men and women.

On reproducing some gender beliefs in science education, the following questions reflect his responses.

Do you ask male pre-service teachers difficult questions and females simple questions? Kari strongly disagrees that he asks male pre-service teachers difficult questions in the classroom

and female pre-service teachers simple questions because “I ask them the same questions” (see part CQ5 & Q7). Do you ask male pre-service teachers to set experiment while females pre-service teachers watch? He strongly disagrees that he asks male pre-service teachers to set experiments while the female pre-service teachers watch during interaction in the science classroom (see Q9). Do you cite examples with female role models than male role models during teaching? He strongly disagrees that he cites examples with female role models than male role models (see Q10).

Do male pre-service teachers perform better than female pre-service teachers? He strongly agrees that male pre-service teachers perform better than female pre-service teachers in chemistry 222 -analytical chemistry (see Q11). Do you help female pre-service teachers more often than male pre-service teachers during classroom activities? He strongly disagrees that he helps female pre-service teachers more often than male pre-service teachers in the science classroom because “both have the privilege to ask questions and answer questions” in the class (see Q12).

On the statement educators assign female pre-service teachers to lead project work/field work more often than male pre-service teachers. He strongly disagrees that he allows female pre-service teachers to lead project work than male pre-service teachers during chemistry engagements (see Q13). Do you cite negative examples with female pre-service teachers and negative examples with male pre-service teachers (see Q14 & Q15)? He strongly disagrees that he cites negative examples with females and positive examples with male pre-service teachers during classroom engagements, (see Likert scale Part C, Q5, Q7 Q9, Q10, Q11, Q12 & Q13) on difficult and simple questions, setting experiments, role models, educators’ assistance, performance of male and female pre-service teachers and field work activities and negative/positive remarks on pre-service teachers.

Do you respect and praise male pre-service teachers more than female pre-service teachers? Kari strongly disagrees that he praises and respects male pre-service teacher’s more than female pre-service teachers his comment – “None” (Q16 & 17). Do you consider male pre-service teachers intelligent and female pre-service teachers dull during classroom interactions? He strongly disagrees that he considers male pre-service teachers intelligent, and female dull during science engagements, His comments- “Why? No” (see Q18). Do you watch the pre-service teachers when the females ask male pre-service teachers to lead group activities and

respond more to questions? He strongly disagrees that he watches the male pre-service teachers dominate activities, asking and responding to questions in the classroom (see Q19).

Subversion of Gender Stereotypes in the Science Classroom

On subversion of gender stereotypes in the chemistry classroom, Kari said is "giving equal treatment to boys and girls".

Do you subvert or rebuke pre-service teachers during science engagements? He strongly disagrees that he rebukes male pre-service teachers who lead and dominate science activities during teaching and learning. His comments- "the boys and girls all have equal opportunity to learning" (see Likert scale part C, Q14, Q15, Q16, Q17, Q18, Q19 & Q20) on educator's respect and praises, intelligence of male and dullness of female pre-service teachers, male pre-service teachers' asking and dominating classroom questions and subversion of educators.

Summary

Kari has limited biographic data and understanding of reproduction and subversion of gender stereotypes. Therefore, he was not selected, interviewed and observed at the time of the study, due to little information and responses his provided when completing the questionnaire. Kari responses on Likert scale rating on cultural reproduction of gender stereotypes, beliefs and subversions show that he does stereotype and has no understanding of what, how and why he stereotypes pre-service teachers in the classroom. However, he has little awareness of subversion of gender stereotyping without applying the concept properly**.**

3**.** Lama's responses based on Likert scale questionnaires rating.

On the following questions asked what comes to mind when you come across the concept sex, gender and stereotype? Lama did not write down anything about sex, gender and stereotype (see part B Q1a & Q1b).

On cultural reproduction of gender stereotypes, Lama could not write down anything about the concept's reproduction of gender stereotypes (part B 2.2 Q1).

The following Likert scale questions and responses depict what Lama responded to about reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On the question, do you intentionally bring beliefs and assumptions concerning pre-service teachers during science engagement? Lama strongly disagrees that she intentionally brings views and assumptions about male and female pre-service teachers to the science classroom (see Q2a). On the question do you unintentionally bring to science classroom assumptions concerning pre-service teachers? Lama disagrees that she unintentionally brings beliefs and views about male and female pre-service teachers to the chemistry classroom without providing how she does it Q2b).

On the question, do you allow male pre-service teachers to head group work during science interactions. She disagrees that educators allow male pre-service teachers to head class activities during chemistry 122-organic chemistry, teaching and learning, meaning she does not allow male pre-service teachers to head activities (see Q2d). Questions 2e &2f do you not and do you interact equally with pre-service teachers? Lama disagrees that she interacts equally with male and female pre-service teachers (see Likert scale part B 2.1, Q2a, Q2b, Q2d, Q2e, Q2f) on the intentionality of assumptions, engagement with group work, equal and unequal participation with male and female pre-service teachers.

With reference to the following questions, do text materials represent more men images than females. She was neutral in responding to texts representation of male and females' images (see liker scale Part C, Q1 Q2 & Q3) on representations of images of men and women.

On reproducing some gender beliefs in science education, the following questions reflect his responses. Do you ask male pre-service teachers difficult questions and females simple questions? Lama disagrees that she asks male pre-service teachers difficult questions in the classroom and female pre-service teachers' simple questions (see part CQ5 & Q7). Do you ask male pre-service teachers to set experiment while females pre-service teachers watch? Lama disagrees that she asks male pre-service teachers to set experiments while the female pre-service teachers watch during interaction in the science classroom (see Q9). Do you cite examples with female role models than male role models during teaching? She strongly disagrees that she cites examples with female role models than male role models (see Q10).

Do male pre-service teachers perform better than female pre-service teachers? She strongly disagrees that male pre-service teachers perform better than female pre-service teachers in

chemistry 122 -organic chemistry, at the time of the study (see Q11). Do you help female pre-service teachers more often than male pre-service teachers during classroom activities? She disagrees that she helps female pre-service teachers more often than male pre-service teachers in the science classroom and reasons were provided (see Q12).

On the statement educators assign female pre-service teachers to lead project work/ field work more often than male pre-service teachers. She strongly disagrees that she allows female pre-service teachers to lead project work than male pre-service teachers during chemistry engagements (see Q13). Do you cite negative examples with female pre-service teachers and negative examples with male pre-service teachers (see Q14 & Q15)? She disagrees that she cites negative examples with females and positive examples with male pre-service teachers during classroom engagements, (see Likert scale Part C, Q5, Q7 Q9, Q10, Q11, Q12 & Q13) on difficult and simple questions, setting experiments, role models, educators' assistance, performance of male and female pre-service teachers and field work activities and negative/ positive remarks on pre-service teachers.

Do you respect and praise male pre-service teachers more than female pre-service teachers? Lama disagrees that she praises and respects male pre-service teachers' more than female pre-service teachers (Q16 & 17). Do you consider male pre-service teachers intelligent and female pre-service teachers dull during classroom interactions? She strongly disagrees that she considers male pre-service teachers intelligent, and female dull during science engagements (see Q18). Do you watch the pre-service teachers when the females ask male pre-service teachers to lead group activities and respond more to questions? She was neutral on watching the male pre-service teachers dominate activities, asking and responding to questions in the classroom (see Q19).

Subversion of Gender Stereotypes in the Science Classroom

On subversion of gender stereotypes in the chemistry classroom, Lama could not write down anything. Do you subvert or rebuke pre-service teachers during science engagements? She agrees that she rebukes male pre-service teachers who lead and dominate science activities during teaching and learning without giving reasons how she subverts stereotypic practices in the classroom, (see Likert scale part C, Q14, Q15, Q16, Q17, Q18, Q19 & Q20) on educator's respect and praises, intelligence of male and dullness of female pre-service teachers, male pre-service teachers' asking and dominating classroom questions and subversion of educators.

Summary

Lama has limited biographic data and little awareness of gender stereotype reproduction and no understanding of subversion. Therefore, she was not selected, interviewed, and observed at the time of the study due to scanty information and responses she provided when completing the questionnaire. Lama responses on Likert scale rating on cultural reproduction of gender stereotypes, beliefs and subversions show that she does stereotype and has no understanding stereotypic practices in the classroom. However, she has no awareness of subversion of gender stereotyping in the class based on her responses.

4**.** Loza's responses based on Likert scale questionnaires rating.

On the following questions asked what comes to mind when you come across the concept sex, gender and stereotype? Loza said sex refers to sets of boys and girls in a learning environment, gender is group of boys and girls in a learning system of institution of higher learning and he could not say anything about the concept stereotypes (see part B Q1a & Q1b).

On cultural reproduction of gender stereotypes Loza did not write anything about reproduction of gender stereotyping (see part B 2.2 Q1).

The following Likert scale questions and responses depict what Loza responded to about reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On the question, do you intentionally bring beliefs and assumptions concerning pre-service teachers during science engagement? Loza strongly agrees that he intentionally brings views and assumptions about male and female pre-service teachers to the science classroom based on their abilities. His comments "If the boys are brighter, I use them to encourage the girls to wake up" (see Q2a). On the question, do you unintentionally bring to science classroom assumptions concerning pre-service teachers? Loza agrees that he unintentionally brings beliefs and views about male and female pre-service teachers to the biology classroom without providing reasons how he does it Q2b).

On the question do you allow male pre-service teachers to head group work during science interactions. He was neutral on how educators allow male pre-service teachers to head class activities during biology teaching and learning (see Q2d). Questions 2e &2f do you not and do you interact equally with pre-service teachers? Loza strongly disagrees that he interacts equally

with male and female pre-service teachers (see Likert scale part B 2.1, Q2a, Q2b, Q2d, Q2e, Q2f) on the intentionality of assumptions, engagement with group work, equal and unequal participation with male and female pre-service teachers.

With reference to the following questions, do text materials represent more men images than females. He strongly agrees that texts materials represent men images than females' images such as "scientists working in the biology, chemistry and biology laboratories and men in construction industries" (see liker scale Part C, Q1 Q2 & Q3) on representations of images of men and women.

On reproducing some gender beliefs in science education, the following questions reflect his responses. Do you ask male pre-service teachers difficult questions and females simple questions? Loza disagrees that he asks male pre-service teachers difficult questions in the classroom and female pre-service teachers simple questions, but you can apply different methods of teaching to solve their problem (see part CQ5 & Q7).

Do you ask male pre-service teachers to set experiment while females pre-service teachers watch? He disagrees that he asks male pre-service teachers to set experiments while the female pre-service teachers watch during interaction in the science classroom (see Q9). Do you cite examples with female role models than male role models during teaching? He strongly disagrees that he cites examples with female role models than male role models (see Q10). Do male pre-service teachers perform better than female pre-service teachers? He agrees that male pre-service teachers perform better than female pre-service teachers in Zoology 211-lower invertebrates at the time of the study without reasons to support his claim (see Q11).

Do you help female pre-service teachers more often than male pre-service teachers during classroom activities? He strongly disagrees that he helps female pre-service teachers more often than male pre-service teachers in the science classroom. That, he helps them based on the types of experiments being conducted. His comment- but "it depends on the experiment that I am giving them," if the boys are not bright, I will help them and if the girls are not bright, I help them" (see Q12).

On the statement educators assign female pre-service teachers to lead project work/field work more often than male pre-service teachers. He agrees that he allows female pre-service teachers to lead project work than male pre-service teachers during biology engagements if they are

brighter and understands the concept more than the males' pre-service teachers (see Q13). Do you cite negative examples with female pre-service teachers and negative examples with male pre-service teachers (see Q14 & Q15)? He strongly agrees that he cites negative examples with females and positive examples with male pre-service teachers during classroom engagements, without providing how he does it (see Likert scale Part C, Q5, Q7 Q9, Q10, Q11, Q12 & Q13) on difficult and simple questions, setting experiments, role models, educators' assistance, performance of male and female pre-service teachers and field work activities and negative/ positive remarks on pre-service teachers.

Do you respect and praise male pre-service teachers more than female pre-service teachers? Loza disagrees that he praises and respects male pre-service teachers' more than female pre-service teachers (Q16 & 17). Do you consider male pre-service teachers intelligent and female pre-service teachers dull during classroom interactions? He disagrees that he considers male pre-service teachers intelligent, and female dull during science engagements (see Q18). Do you watch the pre-service teachers when the females ask male pre-service teachers to lead group activities and respond more to questions? He strongly disagrees that he watches the male pre-service teachers dominate activities, asking and responding to questions in the classroom (see Q19).

Subversion of Gender Stereotypes in the Science Classroom

On subversion of gender stereotypes in the biology classroom, Loza said it's the challenges government will have and trying to resolve them. Do you subvert or rebuke pre-service teachers during science engagements? He strongly agrees that he rebukes male pre-service teachers who lead and dominate science activities during teaching and learning but did not list how he does it. (See Likert scale part C, Q14, Q15, Q16, Q17, Q18, Q19 & Q20) on educator's respect and praises, intelligence of male and dullness of female pre-service teachers, male pre-service teachers' asking and dominating classroom questions and subversion of educators.

Summary

Loza has limited biographic data and little understandings of reproduction and subversion. Thus, he was not selected, interviewed and observed at the time of the study due to scanty information and responses provided when completing the Likert scale questionnaire. Loza responses on Likert scale rating on cultural reproduction of gender stereotypes, beliefs and subversions show that he does stereotype pre-service teachers in the classroom based on ability.

He also encourages male and female pre-service teachers to learn boosting their morale. I perceive his lack of understanding of subversion can also be traced to limited knowledge of the term subversion as he linked it to government challenges and also, inability to mention some subversive strategies used in the biology classroom

5**.** Mofa's responses based on Likert scale questionnaires rating.

On the following questions asked what comes to mind when you come across the concept sex, gender and stereotype? Mofa, said sex is boldness of men and women, gender means good in knowledge acquisition, and nothing was written about the concept stereotype (see part B Q1a & Q1b).

On cultural reproduction of gender stereotypes Mofa said what comes to mind is "curiosity & captivating attention for learning" (see part B 2.2 Q1).

The following Likert scale questions and responses depict what Mofa responded to about reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On the question, do you intentionally bring beliefs and assumptions concerning pre-service teachers during science engagement? Mofa agrees that he intentionally brings views and assumptions about male and female pre-service teachers to the science classroom (see Q2a). On the question, do you unintentionally bring to science classroom assumptions concerning pre-service teachers? Mofa strongly agrees that he unintentionally brings beliefs and views about male and female pre-service teachers to the physics classroom without providing how he does it Q2b).

On the question do you allow male pre-service teachers to head group work during science interactions. He was neutral on how educators allow male pre-service teachers to head class activities during physics teaching and learning (see Q2d). Questions 2e & 2f do you not and do you interact equally with pre-service teachers? Mofa strongly disagrees that he interacts equally with male and female pre-service teachers. His comment- "I don't," (see Likert scale part B 2.1, Q2a, Q2b, Q2d, Q2e, Q2f) on the intentionality of assumptions, engagement with group work, equal and unequal participation with male and female pre-service teachers.

With reference to the following questions, do text materials represent more men images than females. He was neutral in responding to texts representation of male and females' images (see liker scale Part C, Q1 Q2 & Q3) on representations of images of men and women.

On reproducing some gender beliefs in science education, the following questions reflect his responses. Do you ask male pre-service teachers difficult questions and females simple questions? Mofa disagrees that he asks male pre-service teachers difficult questions in the classroom and female pre-service teachers simple questions because "it does not make sense" (see part CQ5 & Q7). Do you ask male pre-service teachers to set experiment while females pre-service teachers watch? He strongly disagrees that he asks male pre-service teachers to set experiments while the female pre-service teachers watch during interaction in the science classroom (see Q9). Do you cite examples with female role models than male role models during teaching? He strongly disagrees that he cites examples with female role models than male role models (see Q10). Do male pre-service teachers perform better than female pre-service teachers? He strongly disagrees that male pre-service teachers perform better than female pre-service teachers in physics 112-general physics at the time of the study (see Q11). Do you help female pre-service teachers more often than male pre-service teachers during classroom activities? He strongly disagrees that he helps female pre-service teachers more often than male pre-service teachers in the science classroom "No, I help both genders without bias" (see Q12).

On the statement educators assign female pre-service teachers to lead project work/field work more often than male pre-service teachers. He disagrees that he allows female pre-service teachers to lead project work than male pre-service teachers during physics engagements (see Q13). Do you cite negative examples with female pre-service teachers and negative examples with male pre-service teachers (see Q14 & Q15)? He strongly disagrees that he cites negative examples with females and positive examples with male pre-service teachers during classroom engagements, (see Likert scale Part C, Q5, Q7 Q9, Q10, Q11, Q12 & Q13) on difficult and simple questions, setting experiments, role models, educators' assistance, performance of male and female pre-service teachers and field work activities and negative/ positive remarks on pre-service teachers.

Do you respect and praise male pre-service teachers more than female pre-service teachers? Mofa disagrees that he praises and respects male pre-service teachers' more than female pre-

service teachers (Q16 & 17). Do you consider male pre-service teachers intelligent and female pre-service teachers dull during classroom interactions? He strongly disagrees that he considers male pre-service teachers intelligent, and female dull during science engagements (see Q18). Do you watch the pre-service teachers when the females ask male pre-service teachers to lead group activities and respond more to questions? He was neutral on watching the male pre-service teachers dominate activities, asking and responding to questions in the classroom (see Q19).

Subversion of Gender Stereotypes in the Science Classroom

On subversion of gender stereotypes in the physics classroom, Mofa said it means "feeling bad and highly discriminated". Do you subvert or rebuke pre-service teachers during science engagements? He strongly agrees that he rebukes male pre-service teachers who lead and dominate science activities during teaching and learning if the student exhibit bad habits and show discrimination. His comments, "I rebuke both gender that is an offender" (see Likert scale part C, Q14, Q15, Q16, Q17, Q18, Q19 & Q20) on educator's respect and praises, intelligence of male and dullness of female pre-service teachers, male pre-service teachers' asking and dominating classroom questions and subversion of educators.

Summary

Mofa has limited biographic data and little awareness about subversion and reproduction of gender stereotypes in science classes. Thus, he was not selected, interviewed and observed at the time of the study, due to scanty information and response his provided when completing the questionnaire. Mofa's responses on Likert scale rating on cultural reproduction of gender stereotypes, beliefs and subversions show that he does stereotype and has no understanding of stereotypic discriminatory practices in the classroom. However, he has little awareness of subversion of gender stereotyping without applying the concept properly in the physics classroom**.**

6. Tengo's responses based on Likert scale questionnaires rating.

Tengo responding to the question what comes to mind when you come across these terms sex gender and stereotype? She said what comes to mind concerning sex is male and female, gender is societal roles giving to men and women and stereotype is bias towards teachers and students (see questionnaire part B section 1.2, Q1a & Q1b).

On cultural reproduction of gender stereotypes in the life science class, she said what comes to mind is “giving birth to young ones and socializing the children with cultural ideology to be agents. That is reproducing ideology in children in the society and students in science classrooms due to parental influence (see Part B 2.2 Q1).

The following Likert scale questions and responses depict what Tengo responded to about reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On responding to the Likert scale rating on intentionality of stereotypic practices that asks the following questions in part B 2.1, Q2a, do you intentionally bring to the science class, assumptions or beliefs concerning male and female pre-service teachers? Tengo strongly disagrees that “she intentionally brings to science class assumptions or beliefs concerning male and female pre-service teachers. Q2b, do you unintentionally bring to the science class assumptions or beliefs concerning male and female pre-service teachers? She strongly agrees that unconsciously she brings stereotypic beliefs and views concerning pre-service teachers by allowing boys to lead and dominate intellectual activities during biology engagements. Q2d, do you allow boys to head group activities during teaching and learning of biology. Tengo strongly disagrees that she allows male pre-service teachers to head group work during intellectual engagements. Classroom observations show that she allowed male pre-service teachers to head and lead classroom activities such as dissection of rabbits during lesson engagement.

Q2e and Q2f do you interact equally with boys and girls in biology classroom? Tengo strongly disagrees that she interacts equally with male and female pre-service teachers in biology classroom but sometimes does engage and assist the pre-service teachers equally in the classroom to learn by distributing intellectual activities and encouraging male and females because, they have equal opportunity to learn. At home sometimes, we pray together, as a family, the boys and girls wash my clothes, cook and sweep the compound- interviews excerpts. I perceive that Tengo had equity awareness, socialized her children at home and then extended to the college. Classroom observations also show that sometimes, she encouraged both male and females’ pre-service teachers to learn by calling on male and female pre-service teachers to participate during activities and sometimes she keeps silent. To be sincere to you researcher and my colleagues, the study exercise is good and has opened my eyes. If science teachers can

find time watch their video classroom engagements and reflect on teaching and learning they may identify strengths and weaknesses on how they interact with boys and girls in the science classroom- collective journals. On representation of male and females in science textbooks, she strongly disagrees that more men than women images are represented or transmitted in science textbooks used for teaching biology (see part B, 2.2 Q2). On the question, do you allow male pre-service teachers to set experiments while female pre-service teachers watch? Tengo strongly disagrees that she often asks male pre-service teachers to set activities and lead females during class engagements while she watches (see Q9**).** Question 10, do educators cite examples with female role models than male role models? **S**he strongly disagrees that educators cite more examples with female role models than male role models. Classroom observations revealed that she has not cited examples with female's role model than male role models. Do you help female pre-service teachers more often than male pre-service-teachers? Teng agrees that she helps female PST than male PST during activities because sometimes they are passive and slow in doing class activities. Her comments-I usually tell them to sit up and be active like the boys (see Likert scale part B 2.1 Q2a, Q2b Q2d, Q2e Q2f, part B 2,2 Q2 & part C, Q1, Q2, Q3, Q4, Q9, Q10, & Q12) on intentionality of bringing beliefs, allowing male pre-service teachers to head group work, equal interactions with both male and female pre-service teachers in the classroom, representation of text materials, setting of experiment in classroom, role models and educators' help towards practical activities. But she is willing not to discriminate the pre-service teachers because to her, "they have equal opportunity to learn hence questions and activities are distributed equally. This was her comments "the students have equal opportunity to learn so I try to share the activities equally to them."

About reproducing gender beliefs in science education with regard asking male pre-service teachers difficult questions and female simple questions, she strongly disagrees that she asks male pre-service teachers difficult questions and female pre-service teachers simple questions during science engagement (see Q5 & Q7). Classroom observations revealed that Tengo neither asked male pre-service teachers difficult questions nor female simple questions during class engagement. But distributed questions equally to the pre-service teachers and they responded. This is against the entrenched cultural beliefs in the society that educators sometimes tend to assist and ask male students higher order questions than female pre-service teachers during intellectual activities. Question 11, about male pre-service teachers performing better in responding to questions and leading group discussions in science classroom about classification

of animal's kingdom. She strongly agrees that male pre-service teachers perform better in Biology 211- genetics and in Zoology 323-animal ecology than female pre-service teachers. This was her comments during the interviews "when you ask questions generally in the classroom the boys or male pre-service teachers respond quickly and rightly than the females."

The following questions in Likert scale part C show the responses of educators. Q13, do you assign female pre-service teachers to lead project/field work? She strongly disagrees that she allows females pre-service teachers to lead in field work such as educational visit to industries during science engagements. Do you cite negative examples with female pre-service teachers and positive examples with male pre-service teachers? It is evident in the data that Tengo strongly disagrees with saying or passing bad remarks on girls, hence does not cite any bad examples with females PST, such as, she is sleeping as a pregnant woman. Also, she agrees though that she cites positive/good examples such as he is brilliant as a scientist with the male PST, (see Q14 &Q15**)**. In this sense, I perceive motivation and encouragement of pre-service teachers to learn. To her, the male PST do receive positive remarks such as brilliant and good as a scientist during science engagements to boost pre-service teachers' morale. Concerning educators respect and praise for male pre-service teachers. She strongly disagrees that she respects and praise male pre-service teachers more often than female pre-service teachers during class engagements (see Q16 & Q17). Classroom observations show that she neither respected nor praised male pre-service teachers than the female pre-service teachers rather she encouraged them to be hard working. On the question do educators consider male pre-service teachers intelligent and female dull in the science classroom. She strongly disagrees that educators consider male intelligent and female pre-service teachers dull in the science classroom (see Q18**).** On educators watching male pre-service teachers leading and dominating the female pre-service teachers. She strongly disagrees that male pre-service teachers lead and dominate females while she watches them but asks the females to get into the groups and participate (see Q19**).** This was her comment during the reflection moments, "What men can do women can do it better"- reflective journals.

Subversion of Gender Stereotypes in Science Classes

Tengo responding to the concept subversion in life science class said, what comes to mind about subverting gender stereotypes is to challenge discrimination of females and male students in the class by stopping pre-service teachers that stereotype and subordinate females in the

classroom (see 2.3, Q1). She practiced subversion in the class by giving the students equal treatment to ask and respond to questions and carrying out demonstration activities. About educators rebuking the dominate male pre-service teachers in the science classroom, she strongly agrees educators do rebuke and that she rebukes males who dominate the females in biology class by asking male pre-service teachers to allow females to be group leaders, ask and respond to questions (see Q20). This was her comments during the classroom observation "boys do not hijack the classroom activities alone, allow females students to participate, head and lead the activities in the classroom like you do (see Likert scale part C, Q5, Q7, Q11, Q13, Q14, Q15, Q16, Q17, Q18, Q19 & Q20) on educators' asking females to lead project/ field work, performance of male and female students, citing negative/ positive examples with female role models than male role models, and educators 'respect and praise for female and male pre-service teachers, intelligence of females and male pre-service teachers and educators' watching and sometimes rebuking/subverting the male pre-service teachers who lead/ control females during classroom engagements.**"**

Summary

Tengo though unconsciously sometimes stereotypes pre-service teachers during science engagements has some understanding and awareness of reproduction of gender stereotyping and subversion in the science classroom. She was selected for the study, interviewed and observed based on the useful information provided that assisted me to conduct the research.

7. Zima's responses based on Likert scale questionnaires rating.

Zima on responding to Likert scale questionnaire on the following questions, what comes to mind when you come across the terms sex, gender and stereotype? She said sex refers to biological organs of either male or female, gender refers to masculine of feminine roles in terms of work and stereotype is stigmatization and discrimination (see part B, Q1a & Q1b).

On cultural reproduction of gender stereotypes, she said what comes to mind is the ability of the gender to represent and perform what was taught in the society or school. That is roles reproduced and played by men and women (see part B 2.2 Q1).

The following Likert scale questions and responses depict what Zima responded to about reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On responding to the following questions on Likert scale, Q2a, do you intentionally bring assumptions or beliefs concerning male female pre-service teachers to science classrooms? She disagrees that she intentionally brings belief and views concerning male and female pre-service teachers to the biology classroom**.** This is because, right from the family she practiced equity in the house by distributing roles such as cooking and ironing clothes to boys and girls to do. So, she was aware of equity before working in the college. In my house, there is no discrimination, no masculine job and no feminine job. The boys cook and iron my clothes as well as girls do. Except that boy are skeptical of washing plates because they believe it's for females- interviews excerpts**.** I perceive that Zima used power and sexuality to reject cultural norm of girls cooking and boys eating but distributed house chores to male and female children, an awareness towards equity and a just living. On the question do you unintentionally bring beliefs concerning pre-service teachers, Zima agrees that she unintentionally brings assumptions and beliefs about male and female pre-service teachers to the classroom by allowing males to dominate class engagements (see Q2b). Question 2d, do you allow male pre-service teachers to head group work during science engagement. She disagrees that she allows male pre-service teachers to head class activities. On the questions do you and do you not interact equally with pre-serve teachers? Zima disagrees that she interacts equally with pre-service teachers during classroom interactions (see Q2e & Q2f). But stereotype by allowing male pre-service teachers to lead female during group work and asking questions especially when the equipment's are heavy to carry for demonstrations in the class. Also, when I was at home with my parents, I rejected working with my mother, sisters and other women on the farm but prefer to work with boys in transplanting crops such as millet. In this sense, Zima's use of gender and sexuality not to work on the farm with mothers and sisters shows act of resistance and power- interview excerpts, (see Likert scale part B 2.1, Q2a, Q2b, Q2d, Q2e & Q2f) on intentionality, male pre-service teachers heading group work, equal and unequal interactions with male and female pre-service teachers.

On the science education text materials that represent more men that woman. She agree**s** that text materials used in science classes convey words and images of men than females (see Likert scale part C Q1, Q2, & Q3) on representation of text materials.

On reproducing some gender beliefs in science education, the following questions reflect her responses. Do you ask male pre-service teachers' difficult questions and female simple questions? She strongly disagrees that she asks male pre-service teachers difficult questions and female simple questions during science engagements (see part C Q5 & Q7). On the question, do you ask male pre-service teachers to set experiment while female pre-service teachers watch? She strongly disagrees that she asks male pre-service teachers to set activities while female watch during classroom engagements (see Q9). When this question was asked, do you cite examples with female role models than male role models during teaching? She strongly disagrees that she cites examples with female role models than male role models (see Q10). Concerning the question do male pre-service teachers perform better than female pre-service teachers in the classroom? Zima agrees that male pre-service teachers perform better than female pre-service teachers in the Zoology 203-reproduction and growth and 399-fisheries taught at the time of the study because, male pre-service teachers proved it by answering questions during life science engagement (see Q11). But she always encourages the female pre-service teachers that they can perform as well. "This is because, when I was a student in the university, boys came to me for intellectual assistance and I taught them – interviews excerpt, (see Q11). Also, the classroom observations show that male pre-service teachers participated more in Zoology 203 and Zoology 399 by asking and responding to questions.

Do you help female pre-service teachers more often than male pre-service teachers during classroom activities? She strongly disagrees that she helps female pre-service teachers more often than male pre-service teachers in the science classroom (see Q12). Classroom observations show that she neither asked the male pre-service teachers nor female pre-service teachers to sit properly during the classroom interactions. This is because some male pre-service teachers and female pre-service teachers sat in front of her table (educator's table) and backing her instead of facing her and the board like other students in the classroom. This I perceived self-stereotypic actions of both male and females' pre-service teachers. Because it is likely to distract their attention from healthy intellectual engagement. Also, I perceived constraint of space and likely seats to accommodate all the pre-service teachers. This may inhibit students learning and intellectual skills for transformation.

On the statement educators assign female pre-service teachers to lead project work/field work more often than male pre-service teachers. She disagrees that she allows female pre-service teachers to lead project work than male pre-service teachers during biology engagements (see

Q13). On questions 14 & 15, do you cite negative examples with female pre-service teachers and negative examples with male pre-service teachers? She strongly disagrees that she cites negative example with females and positive examples with male pre-service teachers during classroom engagements, (see Likert scale Part C, Q5, Q7 Q9, Q10, Q11, Q12 & Q13 Q14 Q15) on difficult and simple questions, setting experiments, role models, educators' assistance, performance of male and female pre-service teachers and field work activities and negative/positive remarks on pre-service teachers.

Do you respect and praise male pre-service teachers more than female pre-service teachers? She disagrees that she praises and respects male pre-service teachers more than female pre-service teachers (see Q16 & Q17). Do you consider male pre-service teachers intelligent and female pre-service teachers dull during classroom interaction? She disagrees that she considers male pre-service teachers intelligent, and female dull during science engagements (Q18). **"**Friends do you know that females are intelligent and can do better what males are doing in science- collective journals. Do you watch the pre-service teachers when the females ask male pre-service teachers to lead group activities and respond more to questions? She disagrees that she watches the male pre-service teachers dominate activities, asking and responding to questions in the classroom (Q19). But classroom observations revealed that she watched the male pre-service teachers dominated the female pre-service teachers by asking and responding to more questions in the classroom, but she was silent in rebuking the male pre-service teachers.

Subversion of Gender Stereotype in Science Classes

On subversion of gender stereotypes in the classroom, Zima said what comes to mind is the way teachers can challenge the superior words such as powerful and strong giving to males and inferior terms such as weaker and passive giving to females (see 2.3, Q1). Question 20, do you subvert or rebuke pre-service teachers during science engagements? She strongly agrees that she rebukes male pre-service teachers who lead and dominate science activities during teaching and learning, (see Likert scale part C, Q16, Q17, Q18, Q19 & Q20) on educator's respect and praises, stereotyping male and female pre-service teachers based on intelligence and dullness, male pre-service teachers' asking and dominating classroom questions and subversion of educators.

However, classroom observations showed that she could not subvert actions of female pre-service teachers who brought babies and cakes to the classroom at the time of the study. Also,

I perceived that female pre-service teacher may be protesting college rules, ideology and ethics though trying to transform their babies by socializing these babies early enough to science environment that had denied them over the years. However, these pre-service teachers are unaware that they were oppressing and subordinating themselves from intellectual activities, skills, and learning. Therefore, Zima and the male pre-service teachers are also complicit in stereotyping or oppressing the female pre-service teachers because neither Zima nor the male pre-service teachers rebuked the actions of the female pre-service teachers in the life science classroom when babies were moving around.

Summary

Zima, sometimes stereotype the pre-service teachers and sometimes subvert stereotypic actions of male pre-service teachers. She has awareness of subversive strategies to reduce discriminatory practices of male and female pre-service teachers. Sometimes female pre-service teachers stereotype themselves during science engagement. Zima becomes complicit when she remains silent to female pre-service teachers' self-stereotyping and/or oppression during science engagement.

8. Boko's responses based on Likert scale questionnaires rating.

Boko responded to the following questions asked, what comes to mind about sex, gender and stereotype? He said what comes to mind about sex is male and female, gender is male and female different roles and stereotypes means gap or gender discrimination about male and females (Questionnaire Part B Q1a & Q1b).

About cultural reproduction of gender stereotypes, he said what comes to mind is pregnancy associated with women who can reproduce children and roles in the society and school (see part B 2.2, Q 1) on gender stereotypes reproduction.

The following Likert scale questions and responses depict what and how Boko responded to reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On the following Likert scale questions asked, do you intentionally bring assumptions and beliefs about male and female pre-service teachers; Boko disagrees that he intentionally brings to the chemistry class beliefs about students (see Q2a). On the question, do you unintentionally

bring beliefs and views about pre-service teachers to the class? He agrees that he occasionally brings to classroom assumptions and beliefs concerning the pre-service teachers by engaging more male pre-service teachers to respond to questions than females. This was his comment "mostly I use boys during class teaching and learning because the females sometime are slow in responding to questions (see Q2b). However, during and after teaching educators should endeavor to watch their engagement with pre-service teachers because they may be stereotyping the pre-service teachers consciously and unconsciously in the science class-collective journals**.** Do you allow male pre-service teachers to head class activities during science engagements? Boko agrees that he usually allowed boys to head group activities in the class (see Q2d). This was his interviews excerpt "because I believe male pre-service teachers are more active and quicker in responding to activities and questions." Based on the questions do you not and do you interact equally with boys and girls in the chemistry classroom? He agrees that he does not interact equally with male and pre-service teachers in the science classroom. Thus, he does discriminate when giving responsibilities such as marking of assignments and leading class work, as boys readily come to mind as better students that can handle such roles (see Likert scale part 2.1, Q2a, 2b 2c, 2e and 2d), on intentionality, male pre-service teachers heading group work, equal and unequal interactions with male and female pre-service teachers.

On reflection and representation of more men than females in science text materials, Boko agrees that science education text material convey images of men more than females (see part C Q1, Q2 & Q3), on men and women representations in science textbooks.

On gender beliefs in science education, he responded to the questions as follows: Do you ask male pre-service teachers' difficult questions and female simple questions? He disagrees that he asks male pre-service teachers difficult questions and but agrees that he asks female pre-service teachers simple questions during science engagements because he perceive that they are weaker (see part C Q5 & Q7). On the question, do you ask male pre-service teachers to set experiment while female pre-service teachers watch? He agrees that he asks male pre-service teachers to set activities while female watch during classroom engagements because female pre-service teachers sometimes are slow in participating. This was his interview excerpt "boys are more active than girls when it comes to setting and doing activities (see Q9). When this question was asked, do you cite examples with female role models than male role models during

teaching? He disagrees that he cites examples with female role models than male role models (see Q10).

Concerning the question, do male pre-service teachers perform better than female pre-service teachers in the classroom? Boko agrees that male pre-service teachers perform better than female pre-service teachers in chemistry 112-inorganic chemistry taught at the time of the study (Q11). However, classroom observations show that females were seen actively involved and participating during the classroom engagement. Do you help female pre-service teachers more often than male pre-service teachers during classroom activities? He agrees that he helps female pre-service teachers more often than male pre-service teachers in the science classroom because the "females don't carry out the jobs given to them on time and to encourage them (the girls) I do help" (see Q12).

On the statement educators assign female pre-service teachers to lead project work/field work more often than male pre-service teachers. He disagrees that he allows female pre-service teachers to lead project work than male pre-service teachers during biology engagements (see Q13). On the questions 14 and 15, do you cite negative examples with female pre-service teachers and positive examples with male pre-service teachers? He disagrees that he cites negative example with females and but agrees that he cites positive example with male pre-service teachers during classroom engagements to motivate them to do more. It is evident in the data that Boko disagrees with saying or passing unsavory remarks on girls, hence does not cite any unpleasant examples with females' pre-service teachers such as, 'she is sleeping as a pregnant woman'. He agrees though that he cites positive/good examples such as he is brilliant as a scientist with the males PST, to boost pre-service teachers' confidence to learn, (see Likert scale Part C, Q5, Q7 Q9, Q10, Q11, Q12 & Q13 Q14 Q15) on difficult and simple questions, setting experiments, role models, educators' assistance, performance of male and female pre-service teachers and field work activities and negative/ positive remarks on pre-service teachers.

Do you respect and praise male pre-service teachers more than female pre-service teachers? He disagrees that he praises and respects male pre-service teachers more than female pre-service teachers (see Q16 & Q17). Classroom observations show that he neither praised nor respected male pre-service teachers more than female pre-service teachers. Do you consider male pre-service teachers intelligent and female pre-service teachers dull during classroom

interaction? He agrees that he considers male pre-service teachers intelligent, and female dull during science engagements because the males are always active, ask questions and perform better than the females in chemistry 112- inorganic, (Q18). Evidently, classroom observations showed that the male pre-service teachers were active, responded to activities and answered questions more than the female pre-service teachers. Do you watch the pre-service teachers when the females ask male pre-service teachers to lead group activities and respond more to questions? He strongly agrees that he watches the male pre-service teachers dominate activities, asking and giving answers to questions asked in the classroom due to female pre-service teachers' dispositions to class engagement (Q19).

Subversion of Gender Stereotype in Science Classes

On subversion of gender stereotypes in the classroom, Boko said what comes to mind is "working against the age long beliefs that boys are better than girls when it comes to achievements or performances" (see part B 2.3, Q1).

Question 20, do you subvert or rebuke pre-service teachers during science engagements? He strongly agrees that he rebukes male pre-service teachers who lead and dominate science activities during teaching and learning by telling the males pre-service teachers to allow girls respond to questions and intellectual activities as well. Also, he does challenge stereotypic practices in the classroom by encouraging the "female gender not to look down on themselves but to take roles as leaders during group activities"-interviews excerpt. Thus, he appoints female pre-service teachers in the classroom as leaders during group work and male pre-service teachers are made to obey.

(See Likert scale part C, Q16, Q17, Q18, Q19 & Q20) on educator's respect and praises, stereotyping male and female pre-service teachers based on intelligence and dullness, male pre-service teachers' asking and dominating classroom questions and subversion of educators.

Summary

Boko stereotype pre-service teachers unconsciously but has some understandings of subversion during science engagements. He was selected interviewed and observed based on the rich information he provided when completing the questionnaire. However, Boko is complicit in female pre-service teachers' self-oppression. This is because sometimes he watched and kept

silent when female pre-service teachers were oppressed by the male pre-service teachers in the science classroom.

9. Nagam's responses based on Likert scale questionnaire rating.

On the following question and terms, what comes to mind when you come across terms such as sex gender and stereotype? Nagam said sex is physical union of male and females' genitals, gender is male or female and stereotype means treatment of students based on gender roles (see part B Q1a & Q1b).

On cultural reproduction of gender stereotypes, he said what comes to mind is treatment of students based on gender roles (see part B, 2.2 Q1).

The following Likert scale questions and responses shows how Nagam responded to reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On the following questions on Likert scale, Q2a, do you intentionally bring assumptions or beliefs concerning male female pre-service teachers to science classrooms. He disagrees that he intentionally brings belief and views concerning male and female pre-service teachers to the chemistry classroom. Please help me, is it possible for a science educator to intentionally discriminate students in the classroom? Other participants responded "yes" it can happen if the teacher comes with patriarchal ideology of male preference to females as it is practiced in his society/community-collective journals. On the question do you unintentionally bring beliefs concerning pre-service teachers, Nagam agrees that he unintentionally brings assumptions and beliefs about male and female pre-service teachers to the classroom by allowing male to dominate class engagements (see Q2b). Question 2d, do you allow male pre-service teachers to head group work during science engagement. Nagam disagrees that he allows male pre-service teachers to head classroom activities because he treats the pre-service teachers equally "believing that male and females pre-service teachers can perform and succeed equally in the science classroom" -interviews excerpts.

On the questions do you not and do you interact equally with pre-serve teachers? Nagam disagrees that he interacts equally with pre-service teachers during classroom interactions (see Q2e & Q2f). But stereotype by allowing male pre-service teachers to lead female during group work and asking questions (see Likert scale part B 2.1, Q2a, Q2b, Q2d, Q2e & Q2f) on

intentionality, male pre-service teachers heading group work, equal and unequal interactions with male and female pre-service teachers.

On the science education text materials that represent more men that woman. He agrees that text materials used in science classes convey words and images of men than females (see Likert scale part C Q1, Q2, & Q3) on representation of text materials. Some science videos I watched such as on Isaac Newton, space travel and chemical engineers working on site represents men as scientists mostly than females- reflective journals

On reproducing some gender beliefs in science education, the following questions reflect his responses based on Likert scale. Do you ask male pre-service teachers' difficult questions and female simple questions? He disagrees that she asks male pre-service teachers difficult questions and female simple questions during science engagements because they have equal ability to learn, (see part C Q5 & Q7). During the classroom observations Nagam does ask pre-service teachers questions but did not ask male pre-service teachers difficult questions and female simple questions. This is based on societal assumptions that educators sometimes distribute high order questions to male and low order questions to females based on perceived ability differences.

On the question, do you ask male pre-service teachers to set experiment while female pre-service teachers watch? He disagrees that he asks male pre-service teachers to set activities while female watch during classroom engagements (see Q9). When this question was asked, do you cite examples with female role models than male role models during teaching? He disagrees that she cites examples with female role models than male role models (see Q10). Also, classroom observations showed that he does not cite examples with female role models than male role models during the classroom engagement.

Concerning the question, do male pre-service teachers perform better than female pre-service teachers in the classroom? Nagam disagrees that male pre-service teachers perform better than female pre-service teachers in chemistry 123- organic chemistry (see Q11). Do you know that sometimes females can perform even better? When I did my masters to be honest, I have never seen a female student as intelligent as that girl. In our group and class, she was the best student in organic chemistry at the end of the master's program with many boys and few girls in class who could not compete with her. I can't remember the exact number now, but boys were many than girls-interviews excerpts.

Do you help female pre-service teachers more often than male pre-service teachers during classroom activities? He was neutral that he helps female pre-service teachers more often than male pre-service teachers in the science classroom (see Q12). On the statement educators assign female pre-service teachers to lead project work/field work more often than male pre-service teachers. He disagrees tha**t** he allows female pre-service teachers to lead project work than male pre-service teachers during biology engagements (see Q13). On the questions 14 and 15, do you cite negative examples with female pre-service teachers and positive examples with male pre-service teachers? He disagrees that he cites negative example with females and positive examples with male pre-service teachers during classroom engagements, (see Likert scale Part C, Q5, Q7 Q9, Q10, Q11, Q12 & Q13 Q14 Q15) on difficult and simple questions, setting experiments, role models, educators' assistance, performance of male and female pre-service teachers and field work activities and negative/ positive remarks on pre-service teachers.

Do you respect and praise male pre-service teachers more than female pre-service teachers? He disagrees that he praises and respects male pre-service teachers more than female pre-service teachers (see Q16 & Q17). However, classroom observations showed that he praised, encouraged, and boosted the female pre-service teachers when they corrected a male pre-service teacher who could not respond correctly to the question such as Bitwal what is the chemical formula for ethanol and how many electrons will occupy the second shell of Sodium atom with atomic number 11 and mass number 23? This was his comment when the female pre-service teachers corrected the male PST "very good you girls are up and doing I like that." Do you consider male pre-service teachers intelligent and female pre-service teachers dull during classroom interaction? He disagrees that he considers male pre-service teachers intelligent, and female dull during science engagements (Q18). Do you watch the pre-service teachers when the females ask male pre-service teachers to lead group activities and respond more to questions? He disagrees that he watches the male pre-service teachers dominate activities, asking and responding to questions in the classroom (Q19). But classroom observations show that sometimes he watches the male dominate the females and sometimes he rebukes the male pre-service teachers by telling them to allow female pre-service teachers participate in classroom activities.

Subversion of Gender Stereotype in Science Classroom

On subversion of gender stereotypes in the classroom Nagam said what comes to mind is fighting against or rejecting gender stereotyping in the science classroom (see 2.3, Q1). Question 20, do you subvert or rebuke pre-service teachers during science engagements? He strongly agrees that he rebukes male pre-service teachers who lead and dominate science activities during teaching and learning by educating them. That, discrimination can affect the female learning and performance. Thus, he invokes their consciousness that all pre-service teachers are potentially endowed to perform and succeed in chemistry by sharing intellectual activities equally and collaboratively in the classroom (see Likert scale part C, Q16, Q17, Q18, Q19 & Q20), on educator's respect and praises, stereotyping male and female pre-service teachers based on intelligence and dullness, male pre-service teachers' asking and dominating classroom questions and subversion of educators.

Summary

Nagam sometimes stereotype pre-service teachers and sometimes subvert their stereotypic actions during science class engagements. He was selected, interviewed, and observed based on gender stereotype and subversion information provided that assisted me to conduct the research. Though Nagam motivated the pre-service teachers, he was complicit in females' pre-service teachers' self -stereotyping due to his silence when male pre-service teachers sometimes dominated intellectual engagements in the class.

10. Bodam's responses based on Likert scale questionnaire rating

With reference to Likert scale questions about what comes to mind when you come across the term sex, gender and stereotype? Bodam said sex refers to male and female organs, gender is male and female attributes the society gives to men and women and stereotypes means discrimination based on male and females' roles (see part B Q1a & Q1b).

About cultural reproduction of gender stereotypes, Bodam said what comes to mind are roles played by men and females in the society (see part B Q1).

The following Likert scale questions and responses depict what Bodam responded about reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On the question do you intentionally bring assumptions and beliefs concerning male female pre-service teachers to science classrooms, he disagrees that he intentionally brings belief and views concerning male and female pre-service teachers to the physics classroom (see Q2a). On the question do you unintentionally bring beliefs concerning pre-service teachers, Bodam agrees that he unintentionally bring assumptions and beliefs about male and female pre-service teachers to the classroom. For instance, he said I did not know that I was discriminating the students until I observed my video engagement with the pre-service teachers in the class-collective journals (see Q2b). On the question do you allow male pre-service teachers to head group work during science engagement. He agrees that he allow male pre-service teachers to head class activities because they are active and stronger in carrying work given to them (see Q2d). This was the interviews excerpt- **"**the boys have demonstrated severally in physics class that they can do the activities, so I use them most of the time." When the following questions were asked, do you not and do you interact equally with pre-serve teachers? Bodam disagrees that he interacts equally with pre-service teachers during classroom interactions. This is because sometimes he asks the male pre-service teachers to engage in setting activities such as electrical circuits and proving Gaussian theory in Physics 402-electricity, (see Q2e & Q2f). Also, he stereotypes by allowing male pre-service teachers to lead female during group work and by asking questions (see Likert scale part B 2.1, Q2a, Q2b, Q2d, Q2e & Q2f) on intentionality, group work participation, equal and unequal interactions with male and female pre-service teachers.

On the science education text materials that represent more men that woman. He agrees that text materials used in science classes convey words and images of men than females (see Likert scale part C 2.2, Q1, Q2 & Q3) on representation of text materials.

Concerning gender beliefs in science classroom, Bodam responded as follows:

On the question do you ask male pre-service teachers' difficult questions and female simple questions? He disagrees that he asks male pre-service teachers difficult questions and female simple questions during science engagements (see part C Q5 & Q7).

On the question, do you ask male pre-service teachers to set experiment while female pre-service teachers watch? He strongly disagrees that he asks male pre-service teachers to set activities while female watch during classroom engagements (see Q9). When this question was asked, do you cite examples with female role models than male role models during teaching? He strongly disagrees that he cites examples more often with female role models than male role models (see Q10). Also, classroom observations show that he does not cite examples with female role models than male role models. Concerning the question, do male pre-service teachers perform better than female pre-service teachers in the classroom? Bodam agrees that male pre-service teachers perform better than female pre-service teachers in 402-electricity taught at the time of the study because more male pre-service teachers responded to classroom engagement more often than female pre-service teachers (see Q11).

On the statement educators assign female pre-service teachers to lead project work/field work more often than male pre -service teachers. He disagrees that he allows female pre-service teachers to lead project work than male pre-service teachers during physics engagements (see Q13). Do you cite negative examples with female pre-service teachers and negative examples with male pre-service teachers? He disagrees that he cites negative example with females and positive example with male pre-service teachers during classroom engagements, (see Likert scale Part C, Q5, Q7 Q9, Q10, Q11, Q12 & Q13, 14 &15) on difficult and simple questions, setting experiments, role models, educators' assistance, performance of male and female pre-service teachers and field work activities and negative/ positive remarks on pre-service teachers.

Do you respect and praise male pre-service teachers more than female pre-service teachers? Bodam disagrees that he praises, and respects male pre-service teachers more than female pre-service teachers (see Q 16 & Q17). Classroom observations show that he does not respect male pre-service teachers more than female pre-service teachers. However, during the interview's session, he said he gave an instruction to pre-service teachers during physics lesson that no female pre-service teacher should come to his office. This was because, a female pre-service teacher who missed test came to his office dressed in transparent clothing to seduce him. So, "I was annoyed and announced to the whole class that no female pre-service-teacher should come to my office again" (interview excerpt). Do you consider male pre-service teachers intelligent and female pre-service teachers dull during classroom interaction? He strongly disagrees that he considers male pre-service teachers intelligent, and female dull during science engagements

(see Q18). Do you watch the pre-service teachers when the females ask male pre-service teachers to lead group activities and respond more to questions (see Q 19)? He agrees that he watches the male pre-service teachers dominate activities, experiment and responding to questions in the classroom because they participate actively most of the time. “They make my teaching easier and faster to complete what I have for the day” (interview excerpt).

Subversion of Gender Stereotype in Science Classes

On subversion of gender stereotype Bodam said it is “stopping completely or reducing discrimination in the science classroom.”

Do you subvert or rebuke pre-service teachers during science engagements (see Q20)? He disagrees that he rebukes male pre-service teachers who lead and dominate science activities during teaching and learning. It is evident that he does not rebuke/subvert the male dominating the females in the classroom. This was his comments “to be honest I never thought of subversion, and it never crossed my mind to rebuke the boys when they dominate class work, I give them to do” (interviews excerpt). This shows that he was not conscious of challenging male pre-service teachers’ stereotypic dominant actions (see Likert scale part C, Q14, Q15, Q16, Q17, Q18, Q19 & Q20) on educator’s respect and praises, intelligence of male and dullness of female pre-service teachers, male pre-service teachers’ asking and dominating classroom questions and subversion. Also, classroom observations show that the female pre-service teachers who came late 30 minutes to the classroom were not rebuked or cautioned. This I perceived self-stereotyping of females by themselves and complacency of Bodam to oppress the females from learning though may be unconscious. However, Bodam said, “I must confess, the exercise created awareness on how teachers sometimes discriminated boys and girls in the class”- reflective journals**.**

Summary

Bodam stereotype pre-service teachers consciously and unconsciously. Though Bodam has understanding and awareness of subversion, during classroom engagement did not put subversive strategies into practice. He was selected, interviewed, and observed based on rich information he provided when completing the questionnaire. However, Bodam is complicit in female pre-service teachers’ self-stereotypic practices due to his silence to challenge male pre-

service teachers' dominance and female pre-service teachers' stereotypic actions in the physics classroom.

11. Dula's responses based on Likert scale questionnaire rating.

About Likert scale responses on the following questions asked what comes to mind when you come across the concept sex, gender and stereotype. Dula said sex is the identity of male and female, gender refers to male or female activities and roles and the concept stereotype is the idea people have concerning individuals in the society that could be true or false (see part B Q1a & Q1b).

On cultural reproduction of gender stereotypes, Dula said what comes to mind is giving birth to young ones and socialising them with cultural norms (see part B 2.2 Q1).

The following Likert scale questions and responses depict what Dula responded to about reproduction of stereotypic practices, beliefs and subversion in the college.

Cultural Reproduction of Gender Stereotypes

On the question, do you intentionally bring beliefs and assumptions concerning pre-service teachers during science engagement? Dula disagrees that he intentionally brings views and assumptions about male and female pre-service teachers to the science classroom (see Q2a). On the question, do you unintentionally bring to science classroom assumptions concerning pre-service teachers? Dula agrees that he unintentionally brings beliefs and views about male and female pre-service teachers to the physics classroom by encouraging the male pre-service teachers to always assist the female pre-service teachers in the class due the view in the society that women are seen as the weaker people, (see Q2b). "Sometimes when I am in the class teaching, I distribute lessons equally to pre-service teachers but sometimes I forget"- collective reflection.

On the question, do you allow male pre-service teachers to head group work during science interactions. He agrees that he allows male pre-service teachers to head class activities during physics teaching and learning (see Q2d). This was the interview excerpts "though the curriculum says we teach equally I allowed male students to head group work to fast-track my teaching. Questions 2e & 2f state, do you and do you not interact equally with pre-service teachers? He agrees that he does not interact equally with male and female pre-service teachers but discriminate when it comes to activities and intellectual questioning, he allows male pre-

service teachers to dominate sometimes (see Likert scale part B 2.1, Q2a, Q2b, Q2d, Q2e, Q2f) on the intentionality of assumptions, engagement with group work, equal and unequal participation with male and female pre-service teachers.

With reference to the following questions, do text materials represent more men images than females. He was neutral in responding to texts representation of male and females' images (see liker scale Part C, 2.2, Q1 Q2 & Q3) on representations of images of men and women. Though old textbooks materials had more images of men doing science activities, but the new texts show little of such images- reflective journals.

On reproducing some gender beliefs in science education, the following questions reflect his responses

Do you ask male pre-service teachers difficult questions and females simple questions? Dula disagrees that he asks male pre-service teachers difficult questions in the classroom and female pre-service teachers' simple questions (see part CQ5 & Q7).

Do you ask male pre-service teachers to set experiment while females pre-service teachers watch? He disagrees that he asks male pre-service teachers to set experiments while the female pre-service teachers watch during interaction in the science classroom (see Q9). Do you cite examples with female role models than male role models during teaching? He disagrees that he cites examples with female role models than male role models (see Q10). Classroom observations revealed that Dula, has not cited examples with female role models than male role models during classroom interactions. I think teachers should not cite negative example with students because it can discourage them from learning- reflective journals.

Do male pre-service teachers perform better than female pre-service teachers? He disagrees that male pre-service teachers perform better than female pre-service teachers in physics 121- general physics at the time of the study (see Q11).

Do you help female pre-service teachers more often than male pre-service teachers during classroom activities? He disagrees that he helps female pre-service teachers more often than male pre-service teachers in the science classroom but sometimes allow male pre-service teachers to offer helping hands (see Q12).

On the statement educators assign female pre-service teachers to lead project work/field work more often than male pre-service teachers. He disagrees that he allows female pre-service

teachers to lead project work than male pre-service teachers during physics engagements (see Q12). Do you cite negative examples with female pre-service teachers and negative examples with male pre-service teachers (see Q14 & Q15)? He disagrees that he cites negative examples with females and positive examples with male pre-service teachers during classroom engagements, (see Likert scale Part C, Q5, Q7 Q9, Q10, Q11, Q12 & Q13) on difficult and simple questions, setting experiments, role models, educators' assistance, performance of male and female pre-service teachers and field work activities and negative/positive remarks on pre-service teachers.

Do you respect and praise male pre-service teachers more than female pre-service teachers? Dula disagrees that he praises and respects male pre-service teachers' more than female pre-service teachers (Q16 & 17). Educators need to praise and respect students who perform excellently to motivate and encourage them -collective journals. Do you consider male pre-service teachers intelligent and female pre-service teachers dull during classroom interactions? He disagrees that he considers male pre-service teachers intelligent, and female dull during science engagements (see Q18). Do you watch the pre-service teachers when the females ask male pre-service teachers to lead group activities and respond more to questions? He agrees that he watches the male pre-service teachers dominate activities, asking and responding to questions in the classroom because they participate actively than the females (see Q19). In this sense, Dula is complicit of stereotyping the female pre-service teachers in the classroom.

Subversion of Gender Stereotypes in the Science Classroom

On subversion of gender stereotypes in the physics classroom, Dula said is avoiding or not tolerating act of discrimination in the class.

Do you subvert or rebuke pre-service teachers during science engagements? He disagrees that he rebukes male pre-service teachers who lead and dominate science activities during teaching and learning. This is because the male pre- service teachers provide quick answers to questions asked during class engagement. "I do not stop the boys, they should help the female pre-service teachers to learn because the teacher may not remember to encourage all the students in the classroom"- interviews excerpts, (see Likert scale part C, Q14, Q15, Q16, Q17, Q18, Q19 & Q20) on educator's respect and praises, intelligence of male and dullness of female pre-service teachers, male pre-service teachers' asking and dominating classroom questions and subversion

of educators. I think all educators should learn from this study of gender not to discriminate boys and girls -collective reflections.

Hey researcher, ask for financial assistance so that you give us our own part. The exercise is too! too! long no time due to lectures, invigilation of examinations and college responsibilities-reflective journals.

Summary

Dula stereotype pre-service teachers and has awareness about subversion, but do not implore subversive strategies in the physics classroom to curb stereotypic practices of male and female pre-service teachers. Dula was selected, interviewed, and observed based on the information and thick responses he provided when completing the questionnaire. He is complicit in stereotyping the female pre-service teachers due his silence sometimes to rebuke the dominance male pre-service teachers in the science classroom. Next is the summary of six educators 'gender stereotype and subversion responses by gender, percentage and remarks as presented herein.

*With regard to **"what"** aspect, these categories of data description of reproduction and subversion of gender stereotype were elicited:*

Table 5.1 Summary of Educators' Responses on Reproduction and Subversion of Gender Stereotype in the College Based on Gender, Percentage Likert scale Rating and Remarks.

Strongly Agree**= SA** Agree = **A** Neutral**= N** Disagree = **D** Strongly Disagree= **SD**

	SA	A	N	D	SD	Total response by gender for each question	Educators' responses by Likert scale rating and percentage (100 %)	Remarks based on Likert scale rating of educators' responses
1. Educators intentionally bring assumptions and beliefs concerning male and female pre-service teachers	M F	M F	M F	M F 4males 1female	M F 1female	M F 4 2	D= 5= 83% SD=1=17%	Educators do not intentionally bring assumptions and beliefs to class
2. Educator's unintentionally bring assumptions and beliefs to the science class classroom	1female	4males1female				4 2	SA=1=17% A=5=83%	Educators do bring beliefs and views to science class

3. Educators allow male pre-service teachers to head group work during science engagements		1male		3males 1female	1female	3	3	A=1=17% D=4=66% SD=1=17%	Educators do not allow male PST to head group work
4. Educators do not interact equally with pre-service teachers		1male	1male	2males 1female	1female	4	2	A=1=17% N=1=17% D=3=50% SD=1=17%	Educators do not interact equally with pre-service teachers
5. Educators interact equally with pre-service teachers		1male	1male	2males 1female	1female	4	2	A=1=17% N=1=17% D=3=50% SD=1=17%	Educators do not interact equally sometimes
6. Science text materials represent men images and words more than women images.		3males 1femles	1male		1female	4	2	A=4=66% N=1=17% SD=1=17%	Text materials do represent more men than women
7. Educators ask male pre-service teachers difficult questions in the class				4males 1female	1female	4	2	D=5=83% SD=1=17%	Educators do not ask difficult questions
8. Educators ask female pre- service teachers simple questions		2males		2males	2females	4	2	A=2=33% D=2=33% SD=2=33%	Educators do not ask simple questions
9. Educators ask male pre-service teachers to set experiments while female pre-service teachers watch		1male		1male	2males 2females	4	2	A=1=17% D=1=17% SD=4=66%	Educators do not ask male PST to set experiment while female watch
10. Educators cite examples with female role models more often than male role models		3males 1female			1male 1female	4	2	A=4=66% SD=2=33%	Educators do cite examples with female role model than male role models
11. Male pre-service teachers perform better than female pre-serve teachers in Biology, chemistry or physics		1male	1male	2 males	2females	4	2	A=1=17% D=2=33% SD=2=33% N= 1=17%	Male PST do not perform better than female PST
12 Educators help female pre-service teachers more often than male pre-service teachers	4males			1male 1female	2females	5	1	SA=4=66% D=2=33%	Educators help female pre-service teachers in the science classroom
13. Educators assign female pre-service teachers to lead project work/ field than male pre-service teachers				4males 1female	1females	4	2	D=5=83% SD=1=17%	Educators do not assign female PST to lead projects
14. Educators cite negative examples with female pre-service teachers				2males	3males 1female	5	1	D=2=33% SD=4=66%	Educators do not cite negative examples with females

15. Educators cite positive examples with male pre-service teachers		1male		3males 1female	1female	3	3	A=1=17% D=4=66% SD1=17%	Educators do not cite positive examples with male PST
16. Educators always respect male pre-service teachers more than female pre-service teachers in the science classroom				3males 1female	1male 1female	4	2	D=4=66% SD=2=33%	Educators do not respect male PST than females PST
17. Educator's praise male pre-service teachers more than female pre-service teachers in the science classroom			2males	2males 1female	1female	4	2	N=2=33% D=3=50% SD=1=17%	Educators do not praise male PST more than female PST
18. Educators consider male pre-service teachers intelligent and female pre-service teachers dull during science engagement		1male		2males 1female	1male 1female	4	2	A=1=17% D=3=50% SD=2=33%	Educators do not consider male PST intelligent, and females dull
19. Educators always watch while male pre-service teachers lead and, dominate females in asking and responding to question in the classroom	1male	1male		2males 1female	1female	4	2	SA=1=17% A=1=17% D=3=50% SD=1=17%	Educators do not watch male PST dominance in the class
20. Educators always rebuke/subvert male pre-service teachers during science engagement	1male 2females	2males		1male		4	2	SA=3=50% A=2=33% D=1=17%	Educators sometimes rebuke male PST in the class
	SA	A	N	D	SD				

Next is the frequency representation of gender, highest qualification, teaching subjects and year of teaching experience of educators.

Table 5.2 Frequency of Gender Representation of Six Educators

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	4	66.7	66.7	66.7
	Female	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Table 5.3 Educators with Masters and PhDs as Highest Qualifications

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MSc	4	66.7	66.7	66.7
	PhD	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Table 5.4 Frequency of Educators' Teaching Subjects

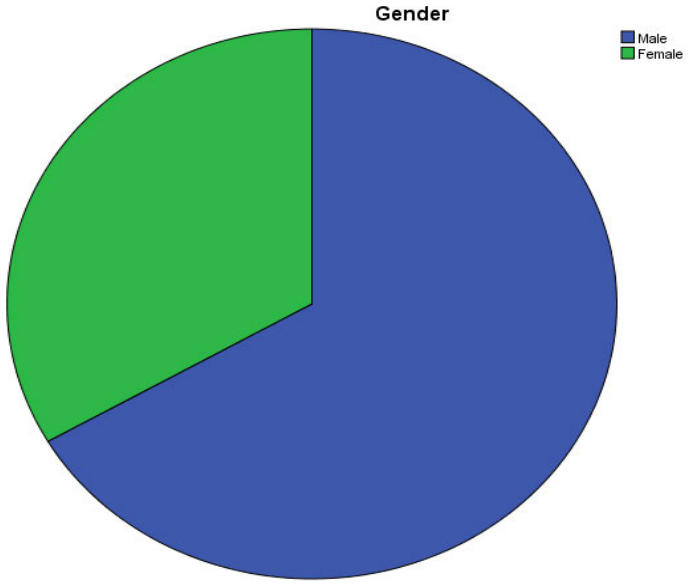
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Biology	2	33.3	33.3	33.3
	Chemistry	2	33.3	33.3	66.7
	Physics	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

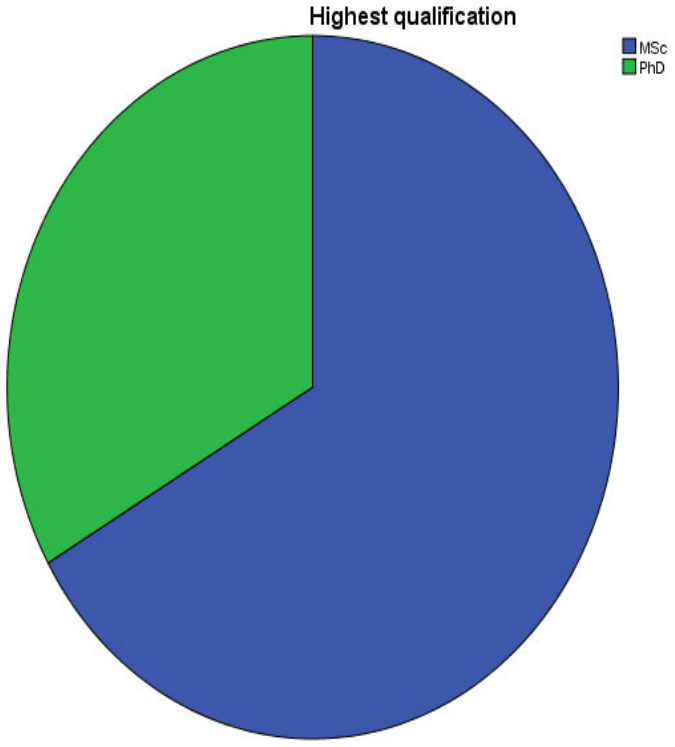
Table 5.5 Educators' Years of Teaching Experience

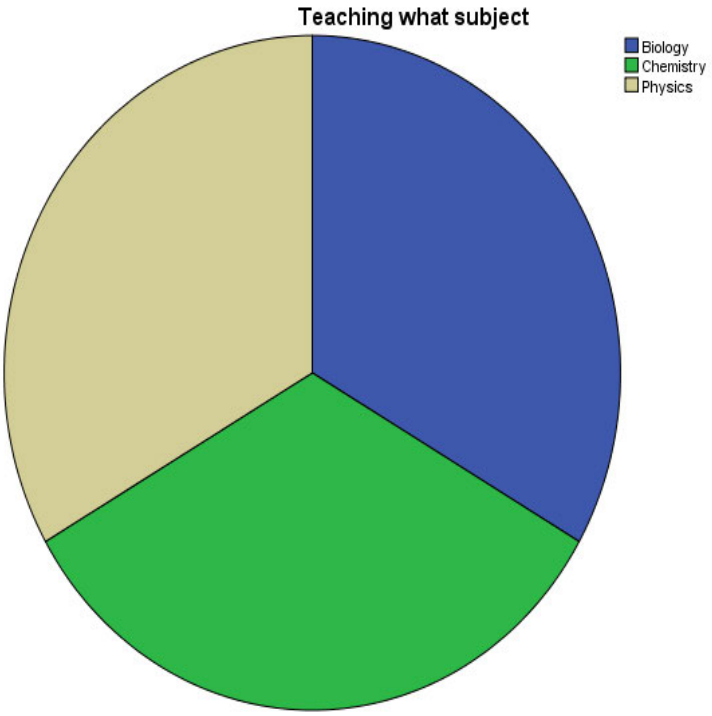
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	(6-10) yrs.	3	50.0	50.0	50.0
	(11-15) yrs.	1	16.7	16.7	66.7
	Others (16-35) yrs.	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

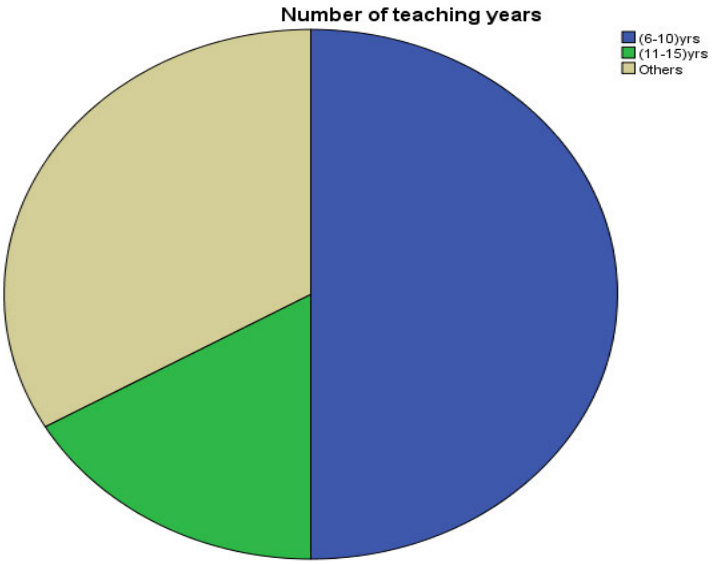
Next is the pie cha/pictorial representations of educators' gender, highest qualifications, subjects taught and years of teaching experience.

Figures 5.1 Pie Chart Showing Male and Female Gender, Highest Qualifications, Teaching Subjects and Years of Teaching Experience






Teaching what subject
Biology
Chemistry
Physics


Number of teaching years
(6-10)yrs
(11-15)yrs
Others

5.2 A CROSS ANALYSIS OF SIX EDUCATORS' BACKGROUND, SEX, GENDER, REPRODUCTION AND SUBVERSION OF GENDER STEREOTYPE-*Stage Two*

The first second section (5.2) focuses on cross analysis of questionnaire responses of six science educators with regards to their notions, views and beliefs about gender stereotypes reproduction and subversion in the physical and life sciences. Here, data from the questionnaire instrument (Appendix 2) was analyzed in three parts: A, B and C, as reflected on the questionnaire. The analysis of the questionnaire is followed by the pattern of inferences, deductions, and summary. It is preceded by a focus on the biography of educators, concepts of gender stereotype, notion of gender stereotype, reproduction and subversion of gender stereotype and science educators' beliefs about gender stereotype and reproduction in science classes.

Also, in the second section (5.5) of this chapter, I produce the analyses and themes of the qualitative data about six science educators purposively selected who were observed, interviewed and responded to the questionnaire based on beliefs, understanding of gender stereotype and reproduction in science classes. This part highlights the intersection of gender, patriarchy, and power in schools and in the college of education. The segment also foregrounds the college of education a political, moral, and democratic space for science engagements

5.2.1 Questionnaire and Background of Educators

In this section, observations, suppositions, and inferences, summary, and deductions are made from the questionnaire (see Appendix 2) on the background of educators. I used codes to denote gender, subject, and level of module for each of the six educators. The codes are as follows.

ZIMA (**FBSED1)** (Female Biology Science Educator1)

TENGO (**FBSED2)** (Female Biology Science Educator2)

BOKO (**MCSED1)** (Male Chemistry Science Educator1)

NAGAM (**MCSED2)** (Male Chemistry Science Educator2)

BODAM (**MPSED1) (**Male Physics Science Educator1)

DULA (**MPSED2)** (Male Physics Science Educator2) as shown herein in the tables 5.1

Table 5.6 Educators' Backgrounds

(F=female; M=male)

Science Educators	Teaching subject	Gender	Years of teaching experience	Qualifications	Courses taught	Number of Male/ females	Total number of students	Age /years)
ZIMA	Biology	F	21years	PhD	Zoology 399 Zoology 203	137/70 13/08	207 21	54
TENGO	Biology	F	17 years	PhD	Zoology323	80/68	148	50
BOKO	Chemistry	M	11-15 years	BSc, MSc	Chemistry123	100/60	160	49
NAGAM	Chemistry	M	33 years	BSc, MSC	Chemistry112,	43/07		65
BODAM	Physics	M	6-10 Years	BSc. Ed, MSc. Ed	Physics 402,	60/90	150	48
DULA	Physics	M	6-10Years	BSc. Ed, MSc. Ed	Physics121	56/48	104	49

*With regard to "**how"** aspect, these categories of data description of reproduction and subversion of gender stereotype beliefs were elicited:*

5.2.2 Analysis of Science Educators' Biographies

The analysis in table 5.6 reveals the following inferences.

Inference 1: Science educators' sex and age influences enrolment of pre-service teachers (see table 5.6) backgrounds of educators

Inference2: All male and female science educators teaching physical and life sciences subjects recorded more male pre-service teachers than female pre-service teachers in enrolment except for physics 402 which recorded higher enrolment and participation of 90-females than 60-male pre-service teachers

According to some researchers, the subject biology has traditionally had more females than males (Baram-Tsabari & Yarden, 2008; Jones, Howe, & Rua, 2000), though Grunspan et al. (2016) observe that in biology classes male students predominate. On the contrary, the biology

course recorded 230 male pre-service teachers, more than the 146 female students, when this study was conducted. Perhaps other Nigerian colleges of education need further investigation on this issue. The general perception that biology is mostly for females is in line with Direito, Connolly, Simon, and Trevethan's (2017) argument that females are more inclined to studying biology while males have greater interest in studying physics. Possibly, there were more male pre-service teachers in the biology class in the college of education where the research is conducted because of the opportunities available and perhaps all the science educators were females -models and had PhD as their highest qualification with motivational attributes. Therefore, the male pre-service teachers may think that their performance or scores could increase if biology is chosen. Consistent with Marjon and Nugroho (2019), teachers' higher degree-qualification could influence teaching, learning and performance of students.

Also, it is likely that there are one or two pretty female PSTs studying biology which they perceive easier to pass and their motivating performance in the subject. Science educator's good report due encouraging strategies boosted male's confidence to study biology. Or they have interest in biology more than other science subjects and may be other possible reasons. Still yet, male pre-service teachers may deliberately take the challenge of biology because it is relatable to other courses they are studying, and I think possibly diverse careers now available with biology. Of course, these are male PSTs, and may think that biology may have less laboratory work, and easier to pass conceptually than physics. Further, it is likely the enrolment and perception of male pre-service teachers was driven due to utility value and career growth, examination culture, the school's organisation, and educators' orientation where Biology was made interesting. However, the educators said females study biology because they perceive the course to be easy and there are female role models teaching the modules. That more male pre-service teachers are studying biology because the course have been dominated by females over the years. Therefore, in my view, I perceive that the male pre-service teachers would want to boost their confidence and are motivated hence, reinforce their dominance idea that they are more able than females in the life science enrolment, participation, and performance (sex segregation) as were socialized in their cultural environment and became ingrained in their minds (Aina & Akintunde, 2013; Simpkins, Price, & Garcia, 2015).

Inference 3: Science educators' years of teaching experience and qualification were linked to higher enrolment of pre-service teachers.

Inferences 4: It is possible that years of teaching experience of male science chemistry educators with master's degree may have influenced on high enrolment of students choosing science modules. This is because, the two science chemistry educators with higher years of teaching experiences, namely, 33 and 14 years had higher population of 100 male pre-service teachers and 60 female pre-service teachers in chemistry 123 class and 43 males PST and 7 females PST in chemistry 112 class (Table 5.6). It is possible that pre-service teachers ask and discuss with friends' which modules are good and not difficult, where educators are nice, and they can have better grades. This likely to be underpinned socially and psychologically due to supportive power from parents as a result of career deficit to study courses such as medicine and pharmacy in future (Simpkins et al., 2015; Teo & Wee Yeo, 2017). While one physics science educator with lower years of teaching experience 6-10 years also had higher population of 10 males, 6 females in physics course 112 class and 56 male students and 48 female students in physics course 121 class.

Inference 5: The situation of the ratio of female to male is different with one male physics science educator with teaching experience of 6-10 years teaching physics course 402 having higher population of 90 female pre-service teachers than 60 males' pre-service teachers.

Inference 6: This could be inferred that physics and the advanced course Physics 402 may not be perceived abstract by the female pre-service teachers, possibly also there may be more career opportunities later, motivational beliefs due to predictive power of encouragement from parents (Simpkins et al., 2015). Other factors such as personality, and the science educator's age 48 years (youngest) among the six science educators may have influenced the female students' higher population than boys, due to utility value attached to the courses. While other courses recorded lower population of 7 female PST in Chemistry112 and 48 females in Physics 121 (Table 5.6) may be due to the abstract or difficult nature of the courses, lack of students' interest, personality, low self-concept and sex of the science educators (Baanu, Oyelekan, & Olorundare, 2018; Mujtaba & Reiss, 2013; Teo & Wee Yeo, 2017). However, current quantitative study on high school children in Philippine shows that self- efficacy, self-concept and self- esteem as elements of self-perception to engage in science activities does not significantly affect academic performance (Tus, 2020).

5.2.3 Summary of Science Educators' Background

All the science educators had teaching experience of more than ten years (Table 5.6) and one had thirty-three years' experience. Also, the science educators have BSc. Ed and MSc. Ed in their area of speciality, with two females as PhD holders. The science educators are considered qualified and relevant for this study because they met the researcher's criterion of more than 10 years of teaching experience. In addition, their gender heightened awareness as observed from the questionnaire (Appendix 2) positioned them as appropriate participants for the study. Therefore, it was anticipated that they would supply relevant and rich data for the research work based on their knowledge and experience and as they interact daily with male and female students in physical and life sciences teaching and learning.

Some researchers argue that teachers' gender could affect student's achievement, enrolment and engagement in physical science physics course (Ates, 2005; Marjon & Nugroho, 2019). However, Chowdhury (2014) argues that teachers' sex, gender, and age do not have significant effects on the effectiveness of teaching during male and female students' engagement and resultant performance of Assam high school students in India.

5.3 ANALYSIS OF CONCEPTS SEX AND GENDER

5.3.1 Questionnaire on Teachers' Notions on Sex and Gender

The questionnaire 1a can be found in **Appendix 1-Part B**. In this section, data were analyzed and then followed by the findings and discussion.

5.3.2 Data from Question 1a

The data were analyzed to explore life sciences and the physical sciences educators' notion of sex and gender, as presented in Tables 5.7 and 5.8 One table is in terms of subjects taught and the other in terms of male/female responses.

Table 5.7 Educators' Notion of Sex and Gender in Terms of Subjects Taught

Science educators	M/F	Notion about sex	Notion about gender
1	Female **Biology Science** Educator1	Had the notion that sex refers to the biological organ of either male or female (Biological and Physiological -anatomical)	Had the notion that gender refers to masculine or feminine in terms of their work. Gender social role (GSR)

	(FBSED1) ZIMA		
2	Female **Biology Science** Educator 2 (FBSED2) TENGO	Looks at sex as male and female (Physiological)	Sees gender as roles and attributes. Gender social roles (GSR)
3	Male **Chemistry Science** Educator 1 (MCSED1) BOKO	Views sex as biological organs of male and female (Biological and physiological)	Considers gender as definite attributes either male or females. (Physiological)
4	Male **Chemistry Science** Educator 2 (MCSED2) NAGAM	Sees sex as male and female. To him these denotes physical union of male and female genitals. (Physiological)	Define gender as male and female. (Physiological)
5	Male **Physics Science** Educator 1 (MPSED1) BODAM	Sex and female	Roles assign to male and females
6	DULA	Considers sex as male and female (Physiological)	Considers gender as male and female (Physiological)

Table 5.8 Educators' Notions of Sex and Gender in Terms of Male/ Females Responses

Educators' Number	Sex / Response	Gender / Response	Key Concepts
Life science educators (ZIMA & TENGO)	See sex as being biological and physiological. Meaning reproductive aspect of being and anatomical aspect of same being.	Two female life science educators (ZIMA & TENGO) view it as gender social roles (GSR).	Reproductive and gender social roles (RGSR)
Three male physical science educators (BOKO, NAGAM & BODAM)	Looks at sex as physiological. Meaning, the anatomical aspect of male or female.	One male physical science educator views it as roles and anatomical organs of the body (Physiological).	Reproductive and gender social roles (RGSR)
		Two male physical science educators are of the view that gender is physiological.	Reproductive organs (RO)
One male physical science educator (DULA)	No response	No response	

*With regard to "**how"** aspect, these categories of data description of reproduction and subversion of gender stereotype beliefs and views were elicited:*

5.3.3 Analysis of Questionnaire

5.3.3.1 Questionnaire on Educators' Notion on Gender Stereotypes

The data from Appendix 1 (Question 1 b) was analyzed. In this section, the concept of gender stereotypes was explored, and educators were asked to give their notions concerning this concept. The data from the questionnaire is summarised in Table 5.9.

Table 5.9 Educators' Notions about Gender Stereotypes and Key Concepts

NO	Male/ Female	Module	Notion about gender stereotypes	Key Concept

1	F	FBSED1	Had the notion that stereotype means being biased towards males and females	Male/Female discrimination, inequality and patriarchy
2	F	FBSED2	Notion is the differences in society	Male and female bias
3	M	MCSED1	Considered gender stereotypes as different treatment of students based on their gender	Differential roles linked to action and activity
4	M	MCSED2	Had the notion that gender stereotypes are due to inequality in gender	Gender discrimination and inequality based on economy and leadership positions
5	M	MPSED1	Had the notion that it is unequal treatment of male and female	Discrimination based on roles
6	M	MPSED2	Had the notion that gender stereotypes are roles played by either males or females.	Gender inequity associated with performance

5.3.3.2 *Likert Scale Questionnaire Responses on Educators' Notion on Gender Stereotypes*

In Table 5.10, a Likert scale questionnaire was also used to analyse science educators' responses of gender stereotypes. Below is the coding for female and male biology, chemistry and physics science educators

(Codes: FBSED1 (Female Biology Science Educator1**) FBSED2 (**Female Biology Science Educator 2) **MCSED1** (Male Chemistry Science Educator1**) MCSED2** (Male Chemistry Science Education 2) and **MPSED1** (Male Physics Science Educator1) **MPSED2** (Male Physics Science Educator 2).

Table 5.10 Likert scale of Science Educators' Responses on Gender Stereotypes

Questions	Male	Female	Strongly Agree	Agree	Neu-tral	Disagree	Strongly Disagree

2a I intentionally bring to the science class, assumptions or beliefs concerning male and female learners/ pre-service teachers	4	2		1MPSED (1 male)		1MPSED 2MCSED 1FBSED (2 males and (1 female)	1FBSED (1female)
2b I unintentionally bring to the science class assumptions or beliefs concerning male and female learners/pre-service teachers	4	2	1FBSED (1female)	2MPSED (2males) 1FBSED (1female) 1MCSED (1male)		1MCSED (1 male)	
2c I intentionally or unintentionally do not bring to the science class assumptions or beliefs concerning male and female learners/ pre-service teachers	4	2		1MPSE (1 male)	1MPSED 1FBSED 1MCSED (2males) (1female)	1FBSED 1MCSED (1female & 1male)	
2d I usually allow boys to head group activities during teaching and learning of Biology, Chemistry and Physics	4	2		2MPSED 1MCSED (3males)		1FBSED 1MCSED (1female & 1male)	1FBSED (1female)
2e I do interact equally with boys and girls during teaching and learning of Biology, Chemistry and Physics	4	2		1 MCSED (1male)	1MPSED (1male)	1FBSED 1MCSED 1MPSED (1female & 2 males)	1FBSED 1female
2f I do not interact equally with boys and girls during Biology, Chemistry and Physics lessons	4	2		1MCSED (1mlale)	1MPSED (1male)	1FBSED 1MCSED 1MPSED	1FBSED 1 female

	(1female & 2 males)

5.3.3.3 The following deductions emerged from the Likert Scale Gender Stereotype Questionnaire

Deduction 1: Some science educators consciously come to the class with pre-assumptions or beliefs about their pre-service teachers while some stated that they had unconsciously brought to science class gender stereotype beliefs (see Appendix 2), for instance Zima agreed to "intentionality of bringing to the science class assumptions or beliefs concerning male and female pre-service teachers." Also, there was acknowledgement by some male educators in the group of participant educators that they had unconsciously allow male pre-service teachers to lead and dominate classrooms intellectual activities. They assume that male pre-service teachers will perceive themselves to be superior, agentic and more able in the classroom. More so, they may see the boys to have responsibility for guidance who bring their cultural beliefs and views into the classrooms and that leadership positions are meant for them only. These male students and educators are likely to view females as inferior and having less confidence during class activities due to female students' passivity. Their action can be said to be contextually motivated, psychologically, and culturally informed. This shows that these educators unconsciously reproduce gender stereotype in the science classrooms. This action in the science class may trigger both implicit and explicit stereotypes messages to the girls, causing a decrease in participation, motivation, and interest in their science courses. Potentially, such actions may affect performance, interest and participation of females in science teaching and learning (Ekine, 2013; Forbes & Schmader, 2010). Therefore, the pre-service teachers who are stereotyped implicitly (when the stereotype is not pronounced) or explicitly (when the stereotype is pronounced) will likely be affected due to emotional stress. For example, female students, on hearing that physics, chemistry and mathematics are difficult courses to study and excel, tend to avoid studying some modules such as Physics 121-general physics, 100 males and 60 females and Chemistry 123-organic chemistry with 66 males and 42 females (see table 5.6) as revealed by participants Boko and Dula, physics and chemistry educators in the college. The female pre-service teachers due to entrenched stereotype in society and the college environment may perceive that they may perform poorly if taken due to low self-efficacy, low

motivation, and lack of confidence. Therefore, I think, it is likely that they perceived/construe some of the concepts such as structural formula in organic chemistry, mechanics, and electromagnetism as difficult to learn hence were emotionally stifled (Reilly, Neumann, & Andrews, 2019).

5.3.3.4 Responses from Open Ended Questions Regarding the Treatment of Boys and Girls

The second section of the questionnaire 2.1-part B asked questions and responses about how educators treat boys and girls during teaching and learning. Table 5.11 provides the evidence from each educator for the questions 3a to 5b.

Table 5.11 Science Educators' Treatments of Boys and Girls

Science educators	Treatment of boys and girls	Reasons for the treatment
FBSED1	She treats boys and girls equally [Q3a and 3b] She teaches the male and female pre-service teachers by grouping them equally [Q4b). She does not show any gender stereotyping [Q4d] in that both boys and girls are rebuked [Q5b].	Nobody will feel inferior or superior [Q3c and 4a]. To avoid discrimination against any sex or any gender [Q4c]. Boys and girls are helped equally during experiments [Q 5a] No reason was given for the rebuke [Q5b].
FBSED2	She treats boys and girls equally.	Because they have equal opportunity.
MCSED1	He treats them equally believing that both males and females can perform well [Q3a]. He does not treat them academically differently. However, he tends to spare the females in terms of physical activities [Q3b]. But in terms of physical strength, the males may be [i]stronger [Q3c]. He does not teach them differently but as a class of males and females. [Q4a and 4b]. The teacher also said he helps both boys and girls equally during demonstration experiments [Q5a]. He rebukes any boy and girl provided he or she is recalcitrant Q5b].	He believes that the male and females are equally endowed academically [Q3c]. However, when it comes to physical strength to him, males may be stronger. He rebukes the male and female students provided they are recalcitrant [Q5b].

MCSED2	Yes, he treats boys and girls differently during chemistry class [Q3a]. This is done when assignments / responsibilities are given to groups [Q3b]. He also asks boys questions in the class more than girls and usually assigns leadership positions to boys. [Q3b]. The teacher mostly helps and encourage girls during demonstration experiments [Q5a]. He rebukes both sexes and roles are mostly giving to boys than girls [Q5b]. However, the teacher said he does not teach male and female pre-service teachers differently [Q4b and 4c].	He treats boys and girls differently because boys are believed to be more active and quicker in responding to questions. And they usually strike him as better leaders [Q3a and 3c]. He helps girls because sometimes the girls tend to be slow when carrying a job given them [Q5a] He rebukes both sexes when they are slow in responding to assigned roles [Q5b]. He does not teach the pre-service teachers differently because the system does provide such an opportunity for male and female to be taught differently [Q 4b and 4c].
MPSED1	He does not treat boys and girls differently but considers them equal [Q 3a, 3b and 3c]. The teacher helps both boys and girls during demonstration experiments and rebuke them [Q 5a and 5b].	He "considers them equal" [Q3a].
MPSED2	He does not treat boys and girls differently [Q 3a, 3b and 4b].	This is because both boys and girls are mentally equal. Human beings are equal [Q 3a and 3c].

5.4 ANALYSIS OF THE DATA FROM APPENDIX 1 [section 2.2 Part B, Q1]

In this section, the concept of reproduction of gender stereotype was explored. Science educators responded based on their views. Thereafter, summary and deductions of science educators' responses on reproduction gender stereotypes given.

5.4.1 Data from Question 1, Q1,

"What come to mind when you come across the term reproduction "with respect to gender stereotypes?

FBSED1 views the term as meaning the ability of the gender to perform what was taught to them.

FBSED2 said what comes to her mind on reproduction with respect to gender stereotype is giving birth to young ones.

MCSED1said it is conception associated with women that give birth to young babies.

MCSED2 said what comes to mind on the term reproduction is pregnancy associated with women.

MPSED1 said what comes to mind to children and socialising them to reproduce same roles.
MPSED2 said what comes to mind on the term reproduction is male and female reproductive system.

5.4.2 Summary of Data on Reproduction of Gender Stereotype

Analysis of appendix 2 of section 2.2 [Part B, Q 1] reveals the following.

Educators' response on reproduction of gender stereotype differs. Because their responses reveal performance of task linked to gender roles and associated reproductive organs and women pregnancy as suggested by two male educators. One female life science educator view on this is that it is ability to perform a given task considered as gender role. Two male physical science educators' views on this term are that it is associated with reproductive organs and pregnancy of women. However, one female life science educator associated it with giving birth to young ones. Two male physical science educators did not provide vital answer to this question.

5.4.3 Data from Questions 2, 3, 4 and 5a of Section 2.2 Part B

Table 5.12 below [questions 2,3, 4 and 5a] provides responses of science educators reproduction of gender stereotyping through a Likert scale questionnaire.

Table 5.12 Reproduction of Gender Stereotype Based on Likert Scale

Questions	Male	Female	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2 More men than women are represented/ reflected / transmitted in science textbooks I use for teaching				1FBSED 1MPSED 2MCSED (3males) (1female)	1MPSED (1 male)		1FBSED (1female)
3 I do not interact equally with boys and girls during teaching and learning in the class				1MCSED (1male)		1FBSED 2MPSED 1MCSED (3males) (1female)	1FBSED (1female)
4 I do interact equally with boys and girls during teaching and learning out of science class			2FBSED (2females)	2MPSED 1MCSED (3males)	1MCSED (1 male)		
5a I do not interact equally with my learners outside science class				1MCSED (1 male)		1FBSED 2MPSED 1MCSED (3males) (1 female)	1FBSED (1female)

Table 5.13 Reproduction of Gender Stereotypes Responses

Question	Male	Female	No	Yes	Not sure	Seldom
5b. Do you reflect/ transmit/			2FBSED 1MCSED (2 females) (1 male)		2MPSED (2 males)	1MCSED (1 male)

represent (reproduce) gender stereotypes?

5.4.4 Data from Question 6 Likert Scale Questionnaire

Q6 “List the things you do to reproduce gender stereotypes and discuss how you do so”

FBSED1 did not list the things she does to reproduce gender stereotypes hence could not discuss them. She hesitates and says “I don’t do so” meaning she does not reproduce gender stereotype.

FBSED2 did not list the things she does to reproduce gender stereotypes neither did she discuss them.

MCSED 1 did not list the things he does to reproduce gender stereotyping neither did he discuss anything concerning reproduction of gender stereotypes.

MCSED 2 did not list the things he does to reproduce gender stereotype and neither did he discuss reproduction of gender stereotypes.

MPSED 1 did not list the things he does to reproduce gender stereotypes, hence, could not discuss them.

MPSED 2 I did not list the things that could make him reproduce gender stereotyping therefore could not explain them.

It is likely that all the science educators were scared or not scared when completing the questionnaire but during the interviews they unconsciously mentioned some gender stereotypes practices they engage pre-service teachers within the science classroom. It is possible they were unaware of the ways in which they reproduce stereotypes hence on the questionnaire, could not list the things they do to stereotype pre-service teachers whom they have interacted and engaged with over the years.

5.4.5 Summary of Data from Appendix 1 [section 2.2-part B, Q1]

Analysis of the data from 5.5.6 reveals the following

All the physical and life science educators did not list the things they do to reproduce gender stereotype when completing the questionnaire but did when interviewed and observed in the class.

5.4.6 Questionnaire on Science Educators' Subversion of Gender Stereotype

5.4.7 Analysis of the Data from Appendix 2 [Section 2.3-part B, Q1, 2 and 3]

In this section, the construct subversion of gender stereotypes was explored, and educators were asked to bear their minds concerning the concept. Likert scale was used to produce data on the concept.

5.4.8 Data from Likert Scale Question 1

Q1 What come to mind when come across the term challenging (subverting) gender stereotype in science classrooms?

FBSED1 said it is "stereotyping of people and perceiving one to be superior or inferior to the other".

FBSED2 commented that it is "issue of differences between males and females."

"MCSED1 said it is "fighting against or rejecting gender stereotyping."

MCSED2 said "is working against the age long beliefs that boys are better than girls when it comes to achievement or performance."

MPSED1 said "is avoiding bias in the society and science classroom."

MPSED2 said "is challenging and reducing discrimination in the science class."

5.4.9 Summary of Data from section 2.3- [part B, Q 1]

On question 1, about what comes to mind on the term subversion**,** educators said subversion means challenging men age long cultural beliefs about superiority and female inferiority consciousness by encouraging the boys do not dominate females in the science classroom and female pre-service teachers not to be passive during science engagement.

5.4.10 Data from Subversion of Gender Stereotype using Likert scale Questions 2 and 3 section 2.3-part B

Q2: As a female/male science educator I usually challenge or counter gender stereotypes in the classroom?

Q: Do you counter, challenge, or combat gender stereotyping in your science classroom?

Table 5.14 Challenging and Countering Gender Stereotyping

Question	Male	Female	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2 As a female/ male science educator I usually challenge, counter gender stereotyping in the classroom			1 FBSED 1 female	1FBSED 1MCSED 1male 1female	2MPSED 1MCSED 3 males		

Table 5.15 Subversion (Challenging) of Gender Stereotyping

Question	Male	Female	No	Yes	Not sure	Seldom
3. Do you counter, challenge/combat gender stereotypes in your science classroom?			2MCSED (2 males)	2FBSED (2 females)	mp2 mp1	(2 males)

5.4.11 Summary of Data from Science Educators' Responses of Questions 2 &3 of Section 2.3 Part B

On question 2, about whether, science educators challenge or subvert gender stereotype in science classes, three male physical science educators were neutral as to whether they subvert gender stereotyping in the classroom. While one female life science educator and one male physical science educator agree that they subvert gender stereotyping in the science class. However, one female life science educator strongly agree that she challenges gender stereotype in science class.

On question 3, about whether science educators combat or challenge gender stereotype in science classes, two female physical science educators said yes, they subvert gender stereotyping in the science class. While two male physical science educators said they do not.

However, two male physical science educators were not sure whether they subvert gender stereotyping or not.

5.4.12 Data from Likert Scale Question 4

Q4. How do you counter, challenge or subvert gender stereotype in the science classrooms?

Data on how science educators challenge or subvert gender stereotyping:

FBSED1 said she counters gender stereotyping by treating both gender same or equal, grouping them together and assigning both gender as group leaders etc.

FBSED2 said she subverts gender stereotypes by giving equal opportunity.

MCSED1 said by openly reprimanding those who partake in gender stereotyping.

MCSED2 said he challenges gender stereotypes by encouraging the females' gender not to look down on themselves and to take up more challenging concepts their male counterparts are assumed to be better at.

MPSED1 did not respond to this question.

MPSED2 did not say anything on this question.

5.4.13 Summary of Data from Science Educators' Responses Question 4 Section 2.3 Part B

Two female life science educators said they subvert gender stereotyping by treating the students equal and by grouping them together and assigning boys and girls group leaders. While the two male science educators said they subvert gender stereotyping by reprimanding students who stereotype and do encourage the females to take up more challenging responsibilities males assumed to be better. Two physical science educators (MPSED1& MPSED2) did not respond to this question.

5.4.14 Data from Likert Scale Question 5a

FBSED1 listed the things she does to subvert gender stereotyping in the class. This includes, treating both genders equally, assigning both leaders of groups and grouping them together to carry out experiments.

FBSED2 listed the thing she does to subvert gender stereotype as "giving them equal treatment during teaching and learning".

MCSED1 listed things he does to subvert or challenge gender stereotyping which includes cautioning those who partake in it and educating those doing it.

MCSED2 listed things he does to challenge gender stereotypes to include treating both boys and girls equally. Appointing girls as leaders where boys made to obey. Involving girls in things hitherto were believed to be meant for boys only.

MPSED1 did not list things that he does to subvert (challenge) gender stereotyping hence could not explain.

MPSED2 says nil and did not list things that he does to subvert (challenge) gender stereotyping.

5.1.1.1 Summary of Data from Science Educators' Responses Question 5a section 2.3 Part B

5a List the things you do to counter, challenge, or combat gender stereotyping in the science class?

On listing the things, they do to subvert (challenge) gender stereotyping, two life science educators list the things they do to subvert gender stereotyping- by treating boys and girls equally by assigning both leaders of groups and grouping them together to carry out experiments. While the two-physical science' educators list things- include the cautioning and educating students about stereotyping and appointing girls as leaders to actively participate.

5.1.1.2 Data from Likert Scale Question 5b

Q5b Explain ways in which you do so?

FBSED1 also explains that in a group there are boys and girls hence, in one group she assigns the leader to be a female and another group the leader will be male. This is the strategy she uses to counter gender stereotyping in the class.

FBSED2 said that they are all given equal opportunity to ask or answer questions, carry out demonstrations.

MCSED1 said subversion (challenging) can be done through cautioning those doing stereotype who partake in it and by educating those doing it. [As in 5a above]

MCSED2 explains how he challenges gender stereotypes to include treating both boys and girls equally. Appointing girls as leaders where boys made to obey. Involving females in things hitherto believed are meant for male pre-service teachers only.

MPSED1 did not explain ways in which he challenges gender stereotypes.

MPSED2 did not explain ways in which he subverts or challenges gender stereotyping.

5.4.15 Summary of Data from Science Educators' Responses Question 5b Section 2.3 *Part* B

On explaining ways in which the science educators subvert gender stereotype, two female life science educators subvert gender stereotyping by giving both male and female pre-service teachers equal opportunity to ask and answer questions. They also challenge gender stereotyping by assigning group leaders to be female and another group male PST. While the two physical science educators subvert by cautioning and educating those students stereotyping. Similarly, four educators (FBSE1, FSED2, MCSED1 & MCSED2) subvert by appointing female pre-service teachers as leaders and involving girls to be active as males during teaching and learning process.

5.4.16 Questionnaire on Science Educators' Beliefs about Gender Stereotyping

Herein the questionnaire on gender stereotype beliefs using Likert scale and the responses analyzed, formed the following sections.

5.4.17 The Data from Appendix 2 (Questions 1 to 20) were analyzed

In this section, science educators' beliefs on gender stereotype were investigated and science educators responded based on their beliefs. Therein, the summary, findings of the science educators' responses were generated that provided answers to research questions one and two

*With regard to **"how"** aspect, these categories of description of reproduction and subversion of gender stereotype beliefs and views were elicited:*

5.4.18 Data from Questions 1 to 20 using Likert scale

The data is presented herein on the table and discussed thereafter based on findings

Table 5.16 Gender Beliefs of Science Educators in College of Education

Questions	Male	Female	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1 Many textbooks in science education I use in teaching pre-service teachers reflect more men than women	4	2		1FBSED 2MCSED 1MPSED (3 males)	1MPSED (1 male)		1FBSED (1female)

			(1 female)			
2 Authors of science education textbooks for the subject I teach mostly use 'he' more than 'she'	4	2	1FBSED 2MCSED 1MPSED (3males) (1 female)	1MPSED 1 male		1FBSED (1 female)
3 Science education textbooks/journals currently used in the department always show images of males than images of females	4	2	1FBSED 2MCED 1MPSED (3males) (1female)	1MPSED (1male)		1 FBSED (1female)
4 Male pre-service teachers perform better than female pre-service teachers in the subject I am currently teaching	4	2		1MCSED (1male)	1FBSED 1MCSED 2MPSED (1female) (3males)	1FBSED (1female)
5 As a science educator I mostly ask male pre-service teachers difficult questions than female pre-service teachers during theory lessons	4	2			1FBSED 2MCSED 1MPSED (3males) (1female)	
6 As a male/female science educator, I mostly help female pre-service teachers than male pre-service teachers during problem solving exercise in the class.	4	2	1MCSED 1MPSED (2 males)		1MPSSED 1MCSED (2males)	1FBSED (1female)
7 As a female/male science educator I always ask female pre-service teachers simple questions during practical lessons	4	2	1MCSED (1male)		2MPSED 1MCSED (3males)	2FBSED (2males)
8 I often ask male students to lead female students during practical activities in science class	4	2	1MCSED (1male)		1MCSED (1male)	2FBSED 2MPSED (2females) (2 males)

9 As a male/female science educator I often ask male pre-service teachers to set experiments in the laboratory while the female pre-service teachers watch	4	2		1MCSED (1male)	1MPSED (1male)	1MCSED (1male)	2FBSED 1MPSED (2females) (1male)
10 As a male/female science educator I often cite examples with female role models than male role models during teaching and learning	4	2			MPSED (1male)	1FBSED 2MCSED (1female) (1male)	1MPSED 1FBSED (1female) (1male)
11 Male pre-service teachers do not perform better in practical lessons than female pre-service teachers taught by me.	4	2	1FBSED (1female)	1MPSED 1MSED (2males)	1FBSED 1MCSED (2males)	MPSED (1male)	
12 As a male/female science educator, I tend to help female pre-service teachers more than male pre-service teachers during practical lessons.	4	2		1MCSED (1male)	1MPSED (1 male)	1MPSED 1MCSED (2males)	2FBSED (2females)
13 As a female/male science educator I always assign female pre-service teachers to lead project work/ field work	4	2				1FBSED 2MCSED 2MPSED (1female) (2males)	1FBSED (1male)
14 As a male / female science educator I always cite negative/ bad examples with female pre-service teachers in the class e.g., she is always sleeping as a pregnant woman	4	2				2MCSED 1MPSED 3males	2FBSED 1MPSED (2females) (1male)
15 As a female/male science educator I always cite positive/good examples with male pre-service teachers e.g., he is brilliant as a scientist	4	2		1MCSED (1male)	1MPSED (1male)	1FBSED 1MPSED 1MCSED (1female) (2males)	1FBSED (1male)

16 As a male/female Biology/Chemistry /Physics science educator, I always respect male pre-service teachers than female pre-service teachers in the class.	4	2			1MPSED	1FBSED 1MCSED	1FBSED 1MPSED 1MCSED (1female) (2males)
17 Male pre-service teachers receive better praises from me than female pre-service-teachers	4	2			1MCSED 1MPSED (2males)	1FBSED 1MPSED 1MPSED (1female) (2males)	1FBSED (1female)
18 As a female/male science educator, I consider male pre-service teachers intelligent and female pre-service teachers dull in the class	4	2		1MCSED 1male		1FBSED 1MCSED 1MPSED (1female) 2 males	1FBSED 1MPSED (1female) (1male)
19 Female pre-service teachers always ask their male pre-service teachers to lead group activities during teaching and learning while I always watch them	4	2	1MCSED 1male	1MPSED 1 male		1FBSED 1MCSED 1MPSED (1female) (2 males)	1FBSED (1female)
20 Male pre-service teachers always want to lead group activities during teaching and learning but I always rebuke them	4	2	2FBSED 1MCSE (2females 1male)	1MCSED 1MPSED (2males)		1MPSED (1 male)	

5.4.19 Findings of Responses from Science Educators' Notion on Sex and Gender

The following findings emerged after analysis of data based on questionnaire observation and summary of Tables 5.2 and 5.3.

Finding 1: Science educators' notion of sex and gender seemed to be linked to the subject they teach, age, and qualifications.

Finding 2: Science educators' have different understandings of sex and gender. Herein, two female life science educators had the notion that gender is the role given to males and females

as constituted by society. But two male physical science educators differ in their notion of gender. Thus, consider gender as physiological organs of the human body.

Findings 3: Gender is linked to performance of role differential assigned in the science class by educators

5.4.20 Findings regarding Educators' Notion of Gender Stereotypes

The following findings emerged after analysis of the data based on Questionnaire 1b and Table 5.4.

Finding 1: Drawing from both the life and physical science educators' notions, gender stereotypes (GS) are perceived discriminations of male and female based on assigned roles.

Finding 2**:** Both the life science and physical science educators' notion of gender stereotypes depend on the subject they engage students with [see table 5.4].

5.4.21 Findings regarding Educators' Responses to the Treatment of Boys and Girls

The following findings emerge from the data analysis of the questionnaire section 2.1-part B.

Finding 1: Most physical and life science educators treat boys and girls equally during lesson engagements.

Finding 2: The finding reveals that one chemistry educator (MCSED2) treats boys and girls differently.

5.4.22 Finding regarding Educators' Responses to Reproduction of Gender Stereotype Linked to Open Ended Questions

The following finding emerged after analysis of the data based on question 1 of [section 2.2 Part B].

Finding 1: Gender stereotype is perceived to be linked to reproductive organs and given birth to young ones based available data.

5.4.23 Finding regarding Educators' Responses to Reproduction of Gender Stereotype on Likert scale Tables 5.7 and 5.8

The following finding emerged after analysis of the data on questions 2, 3, 4 and 5 of section 2.2 Part B Tables 5.7 and 5.8.

Finding 1: Reveals that textbooks used for teaching science stereotype undergraduate preservice female teachers through images and written words.

5.1.1.3 Finding Regarding Educators' Responses on How the Nature of Reproduction of Gender Stereotype is Done

The following findings emerged after analysis of the data on question 6 section 2.2. part B

Finding 1: None of the science educators lists the things they do to reproduce gender stereotypes.

5.4.24 Findings Emerged after Analysis of Data from [section 2.3-part B, Q1*]*

The following finding emerged after the analysis of data on question 1 on subversion.

Finding 1: Science educators subvert gender stereotype in the physical and life science classes.

5.1.1.4 Finding on Science Educators' Subversion of Gender Stereotyping by Gender

The following finding emerged after the analysis of the data on questions 2 and 3 on Tables 5.9 and 5.9.1

Finding1: Female science educators challenge gender stereotype more than male science educators.

5.1.1.5 Finding on how Science Educators Subvert Gender Stereotypes

The following finding emerged after analysis of data on question 4 and part B section 2.3 question 5a and 5b.

Finding1: Both the physical and life science educators subvert gender stereotypes in the science classrooms by grouping, reprimanding, boosting confidence and motivating females to learn science.

5.1.1.6 Findings on Science Educators' Beliefs about Gender Stereotypin*g*

The following findings emerged after analysis of the data on questions 1 to 20 Table 5.9.2

Finding 1: The science educators report that many science education textbooks used by physical and life science educator's stereotype females by reproducing more male than female in these books.

Finding 2: Educators and male pre- service teachers are complicit in stereotyping female PST during science engagements in Biology, Chemistry and Physics (as separate sites for the study).

Though science educators respect male and female pre-service teachers (PST) sometimes keep silent in the class thus, collude with male PST to stereotypes female PST based on cultural socialization ideology in the society and in science education environment. This is because sometimes educators watch and remain silent when the male pre-service teachers dominate females during intellectual engagements. Also, when female pre-service teachers self-stereotype themselves, by coming late to class, bringing babies and commodities to the science class, the male PST and educators do not subvert or challenge their actions.

Finding 3: Science educators have limited knowledge and understanding about stereotypic practices and subversive strategies in the science class.

Though, educators consciously and unconsciously stereotype pre-service teachers, and sometimes, subvert the actions of male PST, they have limited knowledge on what they do, how and why they stereotype and subvert and/or curb stereotypic gender practices and discrimination against females PST in the science classroom (see section 5.2-summary).

Finding 4: Educators sometimes boost females' pre-service teachers' confidence to learn based cultural socialization.

This is done by helping, motivating and encouraging the female PST during intellectual engagement as in setting and doing science activities. This is because female PST are perceived by educators to be slower and weaker during science engagement.

The discussion in this section follows how the findings were generated about science educators' notions of sex and gender, gender stereotype, reproduction, subversion, and beliefs in the college setting where the study was conducted.

5.4.25 Findings regarding Educators' Notion of Sex and Gender Roles linked to the Subject they Teach (see tables 5.6, 5.7, & 5.8)

Drawing from Table 5.7 and based on different notion of sex and gender responses, it is deduced that three male physical science educators are of the notion that sex, and gender concepts refer to only female and male physiological organs. Two female life science educators

view the concept sex as being biological and physiological and reproductive aspect of a human being. The two female educators also consider gender as social role (GSR) albeit limited perspectives. However, one male science educator did not respond to what sex and gender concepts are as reproductive organs. I consider sex concept as the biological attributes of male and females and gender as social roles and activities for male and female in any social environment and education. In addition, interviews snippet revealed that "gender is associated with social construction of role for males and females"-Dula. "Gender is social construction of females and males"- Boko. "Sex is biological characteristics of male and females"- Nagam.

The notions of science educators on sex as physiological and biological reproductive of a human being and gender as social roles for male and female is consistent with WHO (2016) and John et al. (2017) who describe sex as the biological and physiological characteristics that defines humans and whereas the concept 'gender' to the socially constructed roles, behaviours and attributes that a given society considers appropriate for men and women as being masculine and feminine (Stoller, 2020). However, Butler and Spivak (2015) extends this concept to politics and consider gender as a social construct that should be resisted by political, social struggle and educational interventions. Butler (2011) differ in her notion of gender and considers it as being performative, that is, what male and females can do in a specific context such as teaching engagements. Fulton and Schwarz (2017) agrees with Butler and add their notion of gender as malleable depending on the context - as the roles can be easily changed and the gender social roles differ from cultures and can be ascribed to men and women depending on the prevailing circumstances. Researchers also argue that gender is based on social performative roles of male and female in a social-cultural space (hooks, 2010; Weiler, 2017). In this regard, hooks (2010) avers that feminism is for everyone to act and perform. Thus, loving feminism is preferable because, it takes care of individual differences regardless of sex, gender, and context. But Wingrave (2018) has a view that gender is either innate or acquired because it is biologically underpinned. He adds that policy makers, researchers and teachers need to rethink gender in education training agenda and to support changes to educational practice that could provide children with more equitable gender teaching, learning affordances and experiences for change (Wingrave, 2018). As America Association of University Women (AAUW) rightly put, "Gender can influence classroom, school and education policy, we need to think equal, build smart, innovate for change and balance for a better social world" (Buse, Evans, George, Ford, & Anderson, 2017, p. 22).

Therefore**,** science educators' responses (See Table 5.7) show that they think sex is biological and describes some physical and reproductive differences of human beings. While gender is a social or cultural construct associated with male or female roles perceived in the social world. Of course, sex and gender differences are problematic, these differences pose grave concerns for researchers when they become markers for which people are esteemed, devalued, or stereotyped. For instance, men masculine characteristics are associated with power and valued more than female feminine characteristics that are associated with weakness and inferiority. Therefore, men are given masculine role leadership head to perform while females are assigned feminine subordinate roles to act (Ryle, 2011; Schwarz, 2017).

5.4.26 Discussion of Findings regarding Educators' Notions of Gender Stereotypes

One female life science educator had the notion that gender stereotypes meant male and female biases in favouring males over females regarding intellectual, economic and social distribution of resources. Another female life science educator did not understand what these terms meant hence could not provide any definite response. One male chemistry physical science educator considers stereotypes as differentiated gender treatment or marginalization. Another male chemistry physical science educator had the notion that gender stereotype is gender discrimination. One male physics physical science educator could not provide his notion on what gender stereotype meant likely as he did not understand the term. The second male physics science educator had the notion that gender stereotypes are differentiated gender roles. Therefore, the different views given by female and male science educators are likely linked to the subject they teach undergraduate pre-service teachers in the college of education based on the available data on tables 5.7. and 5.8. In addition, interviews with educators reveal their notions about gender stereotype thus: Gender stereotype "signifies differences of giving assignment to boys and girls in the society"- Zima. "Discrimination of men and women is the root of gender stereotyping"- Boko. "To give superior roles to males than females"- field notes.

Gender stereotypes notions from different educators implies that male and female biases, differential gender role and discrimination are based largely on the sex of the individual. Their varied notions of gender could have been environmentally and psychologically established. Also, their beliefs about gender stereotype as discrimination and differentiated gender roles may be scientifically oriented as they are science educators with science identity influenced by perceptions of scientists and their work in the real world. This is in line with the voice of Kollmayer et al. (2018) who describe gender stereotypes as specific sets of beliefs about

personal attributes of individuals that concerns interests, competences, and roles, of men and women in the society. Bordalo et al. (2016) regard gender stereotypes as mental images of the real differences between males and females. I view gender stereotypes as preconceived positive or negative assumptions the society and educational institutions ascribe to males and females which motivate or affect them in the social space and education.

5.4.27 Discussion on the Likert Scale Questionnaire on Intentionality of Reproducing Gender Stereotype

From the foregoing views in section (see section 5.2 & table 5.1) summary of educators' responses, on intentionality or unintentionality of bringing to science classroom assumptions, some science educators do and most do not intentionally bring to class assumptions or beliefs concerning male and female pre-service teachers. It is also evident that science educators sometimes do not engage equally with boys and girls during theory and activities classes but stereotype girls in physical and life sciences classes. This is done when educators consciously and unconsciously allowed boys to head class activities and dominate intellectual engagements in the physical and life science lessons. This confirms that they do discriminate and stereotype the boys and girls during theory and demonstration work in the physical and life classes. Also interviews data shows that educators sometime discriminate pre-service teachers in the science classroom. For instance, "I am not aware that I treat boys and girls differently until during and after the interviews sessions"- Tengo. "This exercise has opened my eyes that I was not balancing my teaching in the class"- Nagam. In this regard, Fulton and Schwarz (2017) opine that teachers stereotype students during classroom interactions. This also concurred with Schober et al. (2016) who argue that in education and particularly in science education, discrimination still exist based on sexes. This can be inferred that the sex type which is not stereotyped might likely perform better in both physical and life sciences theory and practical work than the stereotyped group (Kuppens, Langer, & Ibrahim, 2018). This is because stereotyping affects the cognitive ability of individuals, hence decrease examination performance of individual and group members whose sex are being stereotyped (Bordalo et al., 2016; Schober et al., 2016). Differing, Strand (2000, p. 6**)** aver that "gender stereotype serves as shortcuts to processing stereotypical flow of information unit." That is, stereotypical information and ideas are triggered and influence individuals to stereotype faster. It is also evident from the analysis [table 5.10, Q2d] that both the physical and life science educators ask boys to direct classroom activities. This reveals that male pre-service teachers who are

sometimes asked to pilot class activities likely perceive themselves to be superior and agentic to girls and would like to always dominate the class (Portelli & Eizadirad, 2018). This also reveals that they subvert gender stereotyping when talking but reproduce same in action while teaching these subjects in the class (see tables 5.10 & 5.11). Succinctly, the numerical data and qualitative data show how educators reproduce different views and beliefs on the same workplace about gender stereotype and inequality (see appendix 2, tables 10, 11 and 12). That is, on completing the questionnaire, the educators argued they don't discriminate undergraduate pre-service teachers, but when interviewed they accepted stereotyping the students. For instance, during interviews Tengo said "to be honest I prefer to give activities that are heavy to boys than girls because male students are stronger physically." Classroom observations show that educators distribute physical activities that involve test tubes and microscopes to male pre-service teachers to handle for group demonstrations than female pre-service teachers. "More boys prefer to work with me during class activities so, I engage them more- Dula." "Male pre-service teachers demonstrate commitment than females during dissection activities-Tengo.

"Yes, must of the time we educators discriminate females- collective reflection."

This assertion mirrors researchers' views that in science classes, what teachers say is sometimes different from what they practice in actual sense (Hussénius, Andersson, Gullberg, & Scantlebury, 2013). It is likely that educator's class and patriarchal context may have influence on their classroom gender practices. This reveals that the two categories of science educators have firm beliefs that gender stereotype means discrimination and bias toward males and females. This norm also could be traced back from the Nigerian society they are coming from and is being reproduced in the social and educational spaces they work daily.

5.4.28 Discussion of Findings regarding the Treatment of Boys and Girls

On the treatment of undergraduate pre-service teachers in the class, two female life science educators and two male physical science educators aver that they treat the pre-service teachers equally because both males and females are academically endowed and mentally equal. They also said to avoid discrimination and they do not make the male students feel superior and female students inferior. However, one chemistry male physical science educator said this, "I treat male pre-service teachers and female pre-service teachers differently due to socialization and culture"-Boko. His reason being that boys are more active and quicker in responding to questions than girls in the class. He also assigns leadership positions and ask boys more

questions than girls. The educator said he encourages girls during demonstration experiments but sometimes rebuke both sexes. However, the educator contradicted himself because he said he treats boys and girls equally in the science class [See part 2.1, Q4b & Q4c]. Also, the chemistry science educator said in terms of physical activities that demands strength, he allows male pre-service teachers to carry heavy equipment while female students observe. He added that sometimes female pre-service teachers are slow in doing activities hence choice of male pre-service teachers for demonstrations. Boko re-echoes this during interviews when he said "in our culture and based on history, boys are seen as strong, brave warriors hence are socialized to take active roles." Therefore, science educators' ungirded actions consider boys and girls not to be equally endowed academically and mentally. This subversive act and stereotypical mind set conscientize the class on boys' superiority and inferiority of girls that impact on their science engagements. Thus, these educators subvert gender stereotyping to create awareness unconsciously and consciously to male and female pre-service teachers. Unconsciously, because the educators may not be aware that they are challenging stereotype in the class in action. Consciously, because science educators feel they want their teaching to be gender balanced in the class which I suspect could be a drive toward equality of teaching engagement in the science class. This conscious and unconscious subversion of gender stereotype could be socially, religiously, and morally inclined. Religiously and morally inclined because men and women have been taught that humans are equal from their religious perspective and should be considered and believed as such. (See section 5.8.3). Also, data from interviews revealed this, "Religion taught me that both men and women are equal"- Dula. Of course, cultural upbringing socializes educators to discriminate in education environment- Bodam.

Furthermore, one chemistry educator (MCSED2) treats boys differently because he is aware that male students are 'stronger, quick, and active to respond to questions' asked in carrying out activities given. Hence, he gives boys leadership responsibilities and ask boys more questions than girls. This is because he feels that girls are sometimes slower in responding to issues. Even though the male chemistry educator [MCSED2] said he treats boys and girls differently, he contradicted himself when he said he treats them equally from his answers given in (part 2.1-Q3a and Q3b). "I treat them equally believing that both males and females can perform, but in terms of physical activities I tend to spare the females" -Nagam. This shows that he is having mix feelings about how he treats boys and girls. However, a critical analysis of his two opinions as reflected reveals that he treats them differently part 2.1- Q3b, "I don t

treat them differently academically, however in term of physical activities, I tend to spare the females." Classroom observations also revealed dominance of male pre-service teachers who were seen asking more questions than female's pre-service teachers. This implies that he reproduces stereotypes in science subjects that he teaches. One may infer that his different perceptions on how he treats boys and girls may be anchored on societal belief and could as well be emotionally and contextually formed. However, other physical and life science educators responded that they treat boys and girls equally in the science class. The equality views are also evident in qualitative data analysis where some educators treat students equally. For instance, Boko said he balances or equalises classroom teaching practices to avoid discriminating the undergraduate pre-service teachers based on religion. Therefore, the chemistry educator MCSED2 and other educators who discriminate, have different gender perception of boys and girls, and could be culturally and psychologically influenced. While the reasons for other science educators who treat male PST and female PST equally could be religiously, emotionally, and contextually informed. In consistent, Bordalo, Coffman, Gennaioli, and Shleifer (2019) perception and beliefs about oneself and others are usually shaped by similar psychological forces which in turn influence action.

5.4.29 Discussion on Findings regarding Reproduction of Gender Stereotype

With regards reproduction of gender stereotype, three male physical and one female life science educators connote reproduction of gender stereotyping to reproduction of human's beings. It shows that they haven't understood the term reproduction as it relates gender stereotyping. Also, it could mean, they are biologically, psychologically, and contextually too conscious of reproduction as they feel it can only be seen and applied to biological concepts and are immersed in it. Thus, these set of educators, even if they are reproducing gender stereotypes consciously are aware that they are doing so. This is because they haven't really understood the concept of "reproduction" in the context used as it relates to physical science subjects and concepts in education linked to gender stereotyping. However, two science educators relate the concept to male and female gender roles (see Annexure 2). But a critically analysis reveal that they do reproduce gender stereotypes in various form such as engaging more boys in intellectual activities, leaderships positions, being passive to oppression and sometimes colluding with male students to further subjugate the female undergraduate pre-service teachers inside and outside the science classes. For instance, collective reflections revealed this: "I do not know that I discriminate mostly females during class engagement I

think it could be due to socialization in my culture"-Boko. This unconscious action could be inferred that female have less attention from the educators will suffer psychologically and emotionally depression. Hence, they will see themselves inferior, not capable and may be dislike sciences. While the male pre-service teachers or students will always see themselves superior and would always want to dominate and exhibit power of hegemony in the teaching and learning endeavour. This is because the science educators may not be aware that reproducing gender whether implicit or explicit gender stereotype in the class setting could have psychological and emotional impact on the PST. It is likely that the male and female educators tend to believe stereotype reproduction is a norm in the society. Hence, try to reinforce the hidden power of hegemony, superiority of male PST and then assume inferiority and passivity of female PST which may be transferred from the cultural and religious sites which hitherto socialized them to believe and reproduced into the science classroom. Also, data from the lesson observations reveal that educators collude and were complicit in stereotyping female pre-serve teachers because, "educators allowed male pre-service teachers to dominate intellectual activities in the classroom."

On the nature of inequality, dominance and being passive, they do regarding reproducing gender stereotype in the class. However, the science educators were not aware of what they do that depict gender stereotypes. This could mean that the science educators are not sure of the things they practice and how they exhibit these oppressive activities that denote gender stereotypes in the science classrooms. These educators sometimes may be reproducing stereotypical assumptions and beliefs consciously and unconsciously. This means that, they are likely to be psychologically and culturally ingrained of stereotype but cannot apply in action. That is, these educators do not understand the nature, how and why they reproduce gender stereotype in the class but in actual sense they do in their interactions with undergraduate pre-service teachers.

5.4.30 Discussion on Science Educators' Beliefs on Gender Stereotype

The findings from questionnaire and interviews analysis on beliefs reveal that science educators' responses show that gender stereotype is conveyed into science classroom by scholars, teachers' practices and through textbooks used for teaching science. For example, authors reproduce 'he' more often than 'she' in the textbooks. Often, the journals used in physical and life sciences show images of male than images of females performing activities and experiments (See Annexure 2). Interviews response revealed this, "yes, many science

education textbooks convey images of men as scientists conducting activities in industries or laboratories than female images so can we teach differently no"- Tengo. This resonate with Kerkhoven et al. (2016) who argue that gender bias and stereotypes can be present in education resource materials in form of language and visual content, images such as drawings and pictures and videos like film and animations which teachers reinforced in the class. Llee (2010) conducted a study in English language textbooks in Hong Kong and Australia for both visual content and language and found that men were depicted as working nearly twice as often as women. However, women were portrayed as victims or caring more often than men. Also, Islam and Asadullah (2018) conducted content analysis of English text materials in Bangladesh, Pakistan, Malaysia and Indonesia, found out that the textual and pictorial indicators were pro-male bias in the textbooks. Ekine (2013) and Barton, Sakwa, and Society (2012) concurring, argue that in science education textbooks, men images are portrayed as active generation and application of knowledge more often, while women images depict women being passive and occupy subordinate positions. Thus, women current and historical contributions to knowledge is not usually reflected or reproduced in most text materials for study in Nigeria and in Africa reducing women to second-class citizens thus, undermining global commitments to equality and inclusivity of females. But language and meaning used in texts can be both empowering and marginalising as language and words therein have power for liberation or subjugation (Simpson, Mayr, & Statham, 2018; Thornborrow, 2014).

Thus, gender stereotype reproduced in science textbooks in words anchored on belief and images affects the female folk psychologically and emotionally. The reason being that the female students reading these books will always wonder why they are not represented equally or more than males. This feeling will cause decrease in motivation, attitude to learn, performance and cognitive ability of these students thereby decrease their interest in science (Marjon & Nugroho, 2019). This is in line with Forbes and Schmader (2010) who aver that gender stereotyping inhibit cognitive ability, motivation, attitude and performance of those who suffer stereotype in stereotypical threat contexts. This lowers performance, mastery of the subject taught and interest in science. As rightly put by Forbes and Schmader, stereotype threat involves a complex integration of cognitive, affective, and physiological processes that work either alone or in concert to deplete working memory resources, thus depriving individuals of the cognitive capacity needed for successful performance and on a variety of challenging cognitive tasks (Forbes & Schmader, 2010, p. 22).

But Pavlova et al. (2014) argue that gender stereotype as a construct affects both male and female performance on a variety of cognitive tasks. Stereotyping affects both females and males, with a more pronounced impact on females when given spatial task as car manoeuvring parking space (Forbes & Schmader, 2010).Yet an explicit negative message for males elicits a striking deterioration in performance of females. For example, females on hearing that physical science modules such as in chemistry and physics are difficult, may not have interest to study physics and chemistry courses and may performance poorly if chosen (Forbes & Schmader, 2010; Mazerolle et al., 2015). In accord, Mazerolle et al. (2015) posit that stereotype threat not only reduce subjective experiences and self-efficacy, but undermine memory capacity efficiency of individuals who are exposed to stereotype environmental condition.

Also, science educator's response on gender stereotype linked to their beliefs reveal that male pre-service teachers' performance in intellectual engagement is much better than female PST in PS and LS subjects. Often, science educators neither ask boys difficult questions nor girl's simple questions during teaching and learning theory/practical lessons. Also, some science educators believe that they do not allow male students to lead and guide the female pre-service teachers. Neither do they allow them to set demonstration experiments while the female pre-service teachers watch during academic activities in science class. However, they tend to balance their teaching by setting teaching trajectory toward equality, because the teachers help both boys and girls to learn as they claim. For example, Dula commented we teachers need to treat them equally, because both male and female pre-service teachers perform equally sometime and sometime male outperform females." Zima said "playing and watching videos of teaching could show educators' discriminate due to cultural ideology, we can think better to balance instructions." However, deeply examining their responses show that they do and do not sometime stereotypes directly but collude with boys to stereotype the female. This is resonate with researchers views that teachers are complicit in marginalising the students particularly females in science classes by reproducing masculinity and patriarchy in the classrooms to sustain ideological male dominance (Brown, 1999; Tarrant & Ward, 2020). Occasionally they subvert gender stereotyping by not allowing male students set activities and control female students during lesson engagements. For instance, data from interviews and observations depict this– I know women can do it, what a man can do a women can do even better. During lesson observation, a female pre-service teacher was seen and heard asking educator critical question such as what the difference between Methane and Pentane during organic chemistry class is.

Also, science educators often do not use female role models but male role models and cite bad examples of female behaviour and good examples of male PST. These science educators, in my view, sometimes are practising gender stereotyping and subversion unconsciously.

5.4.31 Discussion on Subversion of Gender Stereotype

It is evident that the science educators sometime subvert gender stereotyping (see Annexure B, section 5.2, tables 13 & 14). This is done by grouping the students, assigning boys and girls into group leaders, and cautioning them when carrying experiments in the science class. They reprimand boys who stereotype female pre-service teachers. They also encourage girls to take challenging task. Also, data from interviews and observations reveal the following: "During class teaching, I distribute lessons equally to my students but sometimes I forget"- Dula. Lesson observations revealed that sometime educators balance their teaching by asking both girls and boys questions. This can be inferred that these educators bring into class cultural patterns that allows them to treat boys and girls equally which are emotionally and contextually established. Emotionally because in the society they may be socialized to treat boys and girls equally and are used to it. Hence, bringing same cultural norm (subversion) to the science class. This will likely reduce the power of hegemony, dominance, and superiority of boys over girls. Hence, both male and female pre-service teachers will be motivated and encouraged to study science having been critically conscientized psychologically and contextually through interactions with the science educators during teaching and learning moments. When conscientisation in the form of subversion is invoked, the issue of dominance and superiority of boys and inferiority of girls will be reduced. Therefore, when power of hegemony and dominance of boys are curbed, females will be emancipated using the lens of critical consciousness and their interest in science promoted. Critical consciousness entails that both the science educators and the students embrace classroom teaching and learning consciousness skills to emancipate themselves from the power that creates and maintain injustices and inequity and be able to liberate themselves from it. This led to one of the educators Nagam to remark as follows: "I am so glad that you females are up and performing all the activities in this class, this very encouraging!" In addition, Bodam said "the exercise is good because I am now aware that both educators and the students reproduce and could challenge gender stereotyping- interviews." Therefore, I argue that the educator's unconsciousness of stereotypic practices during class engagement has been transformed into liberation and empowerment as demonstrated by Bodam's comment on critical awareness and understanding that could be dismantled for liberation and intellectual

progress. This resonate with Diemer et al. (2016) who aver that critical consciousness aims at illuminating understanding of how individual are oppressed and could emancipate themselves from the oppressors' power for the overall development of the oppressed and the society in general (Giroux, 2018; 2009 and Freire, 1972). Therefore, the focal point of this study is to raise gender awareness, informed of collective political struggle to freedom due to entrenched gender inequality in science education classrooms. Thus, the aim to emancipate and transform the contradictory education spaces characterized with female subordination and relegation. For instance, during reflection an educator commented thus, "I understand females have been discriminated in the college over years, but we can change for freedom and transform ourselves from college bias structures"-Tengo. "We could free, change and develop ourselves if we stand up to resist oppression in the school"- Boko. "Yes, I think educators could empower and transform themselves from oppression-Bodam." "Transformation could start from community"- Dula. Therefore, I argue that the political, liberation and transformation account of critical feminist theory and critical consciousness stance becomes a possibility for empowerment, change and transformative agents in colleges of education (Jemal, 2017 & Weiler, 2017). I am of the view that if women renounce liberty because of fear, then they will continue to remain in perpetual marginalization, frustration and pain. This study seeks to comprehend the deeper meaning of women oppression, going beyond deceptive appearances of subjugation, oppression and relegation of women and girls in science education environment, and at the same time to strip the coded dominant capitalist agenda of oppression and inequality for a drive towards equality, love and peaceful, co-existence in the world.

The unconscious practice of relegation of females, gender stereotyping and subversion by science educators and male PST if properly researched, could be traced from the cultural dynamics of the society, and are reproduced into the science class in Nigeria which may be psychologically underpinned. This is because the Nigerian society perpetuate and reinforced gender stereotyping through promoting complex and challenging tasks for men and basic jobs for women due to religious beliefs and moral ground (Makama, 2013; Nwachukwu & UnekeEnyi, 2015). For instance, Boko remarked that religion and moral values in our culture made us to see and believe that women are subordinate humans, but we can transform the beliefs"- Dula. The Nigerian science educators in this study sometimes interrogate boys with more difficult questions and girls with easier questions and promote unfair teaching engagements. This scenario is captured in this statement, "I ask boys complex questions

sometime to test their intellectual ability"-Nagam. Rather, interactions with girls sometimes, tend towards anti-social, non-educative topics, and girls are less constantly called to help with demonstrations or activities, neither do educators direct questions nor praise girls as boys (Ekine, 2013). For example, Tengo during interviews commented that "girls sometimes are reluctant and passive during engagement, so boys take advantage to dominate them." This scenario dampens female interest and motivation in science and implicitly promote male interest and participation. If science educators use critical feminist theory and critical consciousness insights in the class, they will be able to create and imbibe adequate awareness that their actions in the class can elicit explicit and implicit gender stereotypes messages which affect the students. This will result in the science educators being more conscious with the way they interact with male and female pre-service teachers in the science classes. For instance, data from journals reveal that – "this exercise has created some awareness of discriminations of students during class engagement"- reflective journals. "I and my colleagues' educators could now balance our teaching well and be fair to all males and females in the class"-collective journals. A constant engagement with critical consciousness skills will create an awareness of power and inequities that controls their lives and that of their pre-service teachers for equitable teaching and learning for change and development. For instance, an educator remarked "I can now educate female students dominated by male students to liberate and transform themselves from intellectual oppression"-Zima. But educators, administrators and students could change and transform the college structure- Tengo. This in turn will probably result in liberation and transformation of equality of gender practices for both the sexes, sustaining their interest and motivation in science for better performance in social justice spaces. This approach resonate with Freire's assertion that critical consciousness involves a reflective awareness of the differences in power and privilege and the inequities that are embedded in social relationships such as education for transformation (Alfaro, 2019; Freire, 1985). Diemer et al. (2016) calls critical consciousness an antidote to social oppression. An act that Freire calls 'interpreting the world' and in this case reading science education teaching and learning processes that foster commitment to social justice (Freire, 1985; Gadotti & Torres, 2009; McDonald, 2007; Nos Aldás & Pinazo, 2013). Still yet, the development of this type of consciousness which Paulo Freire calls "conscientization" (Freire, 1973, p. 33). This is both cognitive and affective and leads to critical discourse, collaborative problem-solving, and establishment of ethical human relationships (Sigala, 2018). Critical conscious science educators are those who have the voice,

dispossessed and are in pain- they will critique the negative stereotype messages and images of themselves which were created, maintained and reproduced by the oppressors (Valenzuela, 2016; Zabala, 2018), thus emancipating themselves and other students to promote interest and participation in science. These pre-service teachers through teacher-students dialogue with questioning will make power visible and hold human entrenched power relations accountable for injustices and inequities in the social world, through teaching and learning awareness of practices of gender inequalities (Giroux, 2017; 2014; Demier et al. 2016).

On the issue of respect and moral ideals, both the PS and LS educators do not respect male PST more than female PST but reinforce respect for both genders equally. Data form interviews revealed the following: "all students are equally endowed with intellectual potential, so I respect boys and girls the same way"- Dula. Educators were seen talking to both male and female pre-service teachers politely and democratically during lesson engagement- lesson observation. This account agrees with critical theory and critical feminist reproduction theory assertions for democratisation and renegotiation of classroom engagements for intellectual, economic freedom and moral ideals (Freire, 1972; Butler, 2011 & Giroux, 2010). This may be that science educators' have some elements of ethical cultural norms that reinforce morality in science education. Thus, reproducing these beliefs and norms while teaching and learning physical and life science subjects will narrow the gender equity gap. Similarly, they do not praise male pre-service teachers' more than female pre-service teachers in the science classrooms. This reveals that the science educators embrace subversion consciously and unconsciously. Consciously because they don't motivate and promote the male students' interest more than female students in the science class. Unconsciously because they are not aware that they are subverting gender stereotyping of male PST in action by boosting the female interest and confidence and the same way demotivating the boys. Also, they do not sometime stereotype but subvert gender stereotyping by not considering 'male pre-service teachers as being intelligent and female pre-service teachers as dull'. This, I will label as 'subversion innocence'.

Analysis also reveals that female pre-service teachers do sometime stereotype themselves in the form of triggering 'self-stereotyping consciousness' and fear, by keeping silent while in pains in the classroom. Even though, they sometimes subvert gender stereotyping by remaining passive as oppositional consciousness by not allowing male pre-service teachers as a responsibility to lead them to perform class engagements against societal beliefs that men

should always dominate women. Findings also reveal that male pre-service teachers sometimes dominate and take control of class activities, but science educators do occasionally rebuke them and encourage females to participate. Data from observations reveal that -sometimes the male pre-service teachers dominated the females during class engagement and sometime the females were active in doing class activities. This seems an established belief system whereby male pre-service teachers from their culture believes that a man should always dominate, lead, and take charge of a woman. But the science educators do consciously and unconsciously subvert the male PST actions.

It is my belief that the PST bring into the science class their bias cultural and strong emotional beliefs ingrained from their society. That, men should always direct the women and are immersed in it hence reproducing and reinforcing this belief in the science class while interacting with fellow pre-service teachers. Nevertheless, the science educators may not even be aware that they are unconsciously subverting pre-service teachers' reproduction of gender stereotyping. This could mean that the rebuke actions of both the life and physical science educators are a subtle way of marginalising the male students and liberating or emancipating the female pre-service teachers. This is re-echoed in this statement "Yes, I stop boys from marginalizing and oppressing the females in the class"-Zima. This resonate with Portelli and Eizadirad (2018) who argue that subversion is subtle and is a necessary tool for survival that should be used to liberate individuals who seem marginalized, oppressed and disfranchised from immoral form of power that creates, maintains, oppresses and harm themselves. This action will promote social justice and equity for peace and harmony in line with critical feminist counter-hegemony and political activism insights for emancipation, equality and transformation (Weiler, 2017). This means that subversion may arise from an intuition, and it is a moral call, an inside voice or sense of consciousness, to pay attention to the needs of the self and others who are marginalized and oppressed, to stand up to injustice and inequity with the goal of challenging abusive forms of power and control over their lives. Therefore, it is vital that in subverting gender stereotype in education there is need to produce knowledge aim at liberating and transforming individual's consciousness from oppressive practices. That is, the reason for disrupting gender stereotype should be on production of knowledge that will expose and challenge the coded power relations and inequalities in institutions of higher learning and social world. For instance, during lesson observation a female had confidence, then corrected a male pre-service teacher when he could not answer the question posed by the educator thus

transforming the classroom intellectual activities. “I believe male and female students could challenge oppression and transform themselves-Zima. “Both educators and pre-service teachers could challenge oppression-Nagam. Thus, narrowing gender inequities and oppression in the life and physical structures. Doing so, I suspect it will emancipate the discriminated, stereotyped and possibly the undemocratic undergraduate pre-service teachers and students alike who consciously or unconsciously may be in pains and rekindle their interest and motivation to learn in the contradictory colleges of education and university spaces in the world (Ikonen et al., 2018; Laing & Maylea, 2018). The next section foregrounds emerging themes and qualitative data analysis that resonant around gender, patriarchy, power for transformative opposition.

5.5 THEMES EMERGING FROM THE QUALITATIVE DATA ANALYSIS-*Stage three*

5.5.1 Introduction

In this section, a thematic account of how gender and patriarchal orientations intersect to inform transformative resistance of science educators and PST in the science classroom. This part also highlights counter-hegemonic perspective if acquired by science educators and students could reposition science education classrooms for political and democratic struggle for emancipation and transformation. Herein, analysis of science educators’ views and beliefs about gender stereotype and reproduction was done resonating around seven main themes. All the data, findings, and discussion from earlier sections were sifted through for the emerging themes to ensure trustworthiness of the study. Because trustworthiness informs credibility, trust, and merit of the study to guarantee knowledge production. Also, I ensured data validity by affirming that the construct gender stereotype reproduction and subversion was investigated with the right methodological procedures and ethical considerations. Meaning the data generated, and knowledge produced, attested to what it ought to reveal and has merits for public consumption. Therefore, gender production and reproduction themes herein depict what branded complex and contradictory science education classrooms in Nigeria college of education where the study is conducted.

*With regard to **“how”** aspect these categories of data description of reproduction and subversion of gender stereotype beliefs and views were elicited:*

Gender Reproduction and Production Themes

Analysis herein shows how science educators reproduced and subverted gender stereotyping in science classes

5.1.1.7 Intersection of Gender, Patriarchy and Cultural Resistance in Schools

Gender and patriarchal ideology determine what goes on in education by evoking resistance or opposition to teaching and learning engagements in schools. This is possible, because girls and boys, men and women with different gender, culture and patriarchal subjectivities will have different experiences in form of opposition to schools' interactions. Both their resistance and their 'reading' of the ideological messages of schools will also differ in specific school settings. Therefore, in the college, pre-service teachers (PST) are perceived differently by male and female science educators, depending on the expectations of these teachers' own experiences, and their views of what gender and patriarchal values and habits are considered appropriate to them (Gaskell, 1985; McRobbie, 1978; Weiler, 2017). The discriminatory scenario is evident during interviews session, when Dula said: "I treat girls differently so I give them few intellectual activities than boys because of history and cultural ideology." Nagam remarked "Of course boys are stronger and can withstand pressure so I give them more activities than girls during class activities."

In this study, I am interested in given weight to both female and male science educators' culture, gender and patriarchal subjectivities and how these in turn interact with PST, coming from different cultures, gender, patriarchal ideology, and sexual orientation which is necessary for negotiation in the science classes. This is because, the dynamics and complexities inherent in science classroom are more likely be understood due to intersections of PST' and educators' sexual emotions, gender, patriarchal, multiple culture and subcultures embedded in schools as in the college. Therefore, the nuances and dynamics of power relations in science classes may be exposed. For example, male pre-service teachers own sexism may likely reproduce the role of girls during schooling as oppressed and subordinate. While this relationship sometimes reflects capitalist's reality, of marginalization and subordination, it may not be the ideology or state policies of capitalism that directly pressurise these females but rather, the immediate and oppressive sexism of males. Thus, feminists argue that the "moral failure to condemn or even to see the sexism of male culture and subculture in the class rooms leads in turn to a failure to understand the full dynamics of working-class culture and life" of boys and girls (Weiler, 2017, p. 283). This scenario was observed in the class during lesson engagement with educators and

PST thus, educator sometimes do not resistance stereotypic actions neither do they subvert dominant boys in the science class. “Sometimes I watch the boys dominating the girls”- Bodam. “Yes, sometimes the females’ passivity attracts males’ dominance”-Boko.

In this sense, I argue that the moral limitation for science educators to condemn or even see male’s pre-service teachers’ sexual reactions and patriarchy as dominance seeping into the science classes which sometimes distort females learning is a failure to understand and negotiate the full dynamics of female PSTs’ culture and life during schooling in the college. For example, science educators who do not negotiate classroom gender dynamics properly may have partial understanding on how female pre-service teachers subtly or consciously pose resistance to schooling. Therefore, they are more likely to reject the social-justice values of official state institution or school, and the dominant official ideological message in the curriculum. With the little knowledge that teachers have on gender issues, they may not perceive that the historical and cultural resistance exhibited by females and males likely be a deliberate attempt to challenge dominant views. This challenge can take various forms such as using their sexual behaviours in the form of opposition to hidden messages and authority of the school. It seems that the younger men teachers and of course science educators, with little gender consciousness, may view these actions as antisocial, defiant and aggressive tendencies to disrupt the teaching and learning process (Thomas, 1980; Weiler, 2017). Thus, educators may lack understanding that what these female pre-service teachers are doing is to use sexual emotions and behaviour as acts of resistance to the accepted norms in the class. The PST take and believe what their culture imbibe in them as important norms and hence demonstrate it as assertion of their individuality as a source and form of power to gain some control over their own lives (Deem, 2011; Purvis & Hales, 1983; Thomas, 1980). Quite interesting, Fuller’s interview observation with girls of colour from Afro-Caribbean, Indo-Pakistani and white British girls in comprehensive schools in London with regard to gender and class positioning reveals that they wish to gain control to protect themselves. This means that these girls I perceive do not wish to be controlled by others within and out of school but have the desire to control themselves at present and in the future, by exercising self-control to achieve self-determination to regain their humanity (Brock, 2017; Deem, 2012). The oppressive elements and control mechanism are what could be considered ‘triple jeopardy.’ It could also, mean that these girls were faced with triple oppression of sexuality, gender, and patriarchal elements hence, triggered their anger and power to assert personal control over their own existence

(Fuller, 1980; Purvis & Hales, 1983; Valerie & Parmar, 1981). Some of these girls are cautious in entering sexual relationships with boys and teachers because they may be labelled and stereotyped as being of loose morals which usually attract sanctions in the culture they belong. These oppressive elements displayed by the girls are constituted as aggressiveness, confidence, resistance, stubbornness, and caution, and are reflections of power play acquired during socialization process to oppose dominant gender ideological messages during schooling and social interactions (Brock, 2017; McRobbie, 1980; Thomas, 1980). But I suspect that resistance could be a vital instrument in schools and colleges of education space which if applied in education and any other social space to regain human existence can drive moral, academic emancipation, and transformation for social economic development.

This study therefore reveals ways in which science educators, male and female PSTs' lives reflect and are shaped by the forces of cultural production and reproduction. For instance, "the production and reproduction of gender stereotypes is socio-cultural due to ideological power and socialization process"- Dula. More so, reproduction is done by educators and students in ways in which they experience the social world, enact, and invoke their femininity and masculinity to appropriate political and democratic ideals to negotiate dominant and oppressive forces within it for economic gains and intellectuality in education sphere. As McRobbie puts it,

> one way in which girls combat the gender and class-based and oppressive features of the school is to assert their 'femaleness', to introduce into the classroom their physical maturity by showing their sexual bodies in such a way as to force teachers to take notice. A class instinct then finds expression at the level of jettisoning the official ideology for girls in the school (neatness, diligence, appliance, femininity, passivity etc.) and replacing it with a more feminine even sexual one (McRobbie, 1978, p. 104).

Because boys and girls, men and women belong to different gender, patriarchal ideology, culture and subcultures, the schooling of male and female PST through different pathways is a complex space for teaching and learning.

Kessler et al., sheds lighter on this perspective:

> Yet the central fact, perhaps the most important point our interviews have demonstrated, is that the complex of gender inequality and patriarchal ideology is not smooth functioning machine. It is a mass of tensions, contradictions and complexities that always have the potentials for change (Kessler et al., 1985, p. 47).

Therefore, by exploring at gender, sexual elements and patriarchal orientations of boys and girls and male and female teachers in schools, it is vital to also analyse the intersection of power in family and schooling contexts. This includes the need to understand the intersection of the family, the workplace, the state and school in terms of sexual ideology and structural constraints on girls and women resistance in schooling, colleges of education and work progress.

5.1.1.8 Resistance and Accommodation as Process of Schooling

Resistance and accommodation are important elements and an expressed hope in the schooling of girls and boys. *Resistance* is a political, public and collective cultural pattern of opposition by schoolgirls and women, male and females as a mode of agency to negotiate social relations characterized with oppressive beliefs and practices. *Accommodation* is individual strategy employed by girls to negotiate oppressive hegemonic tendencies of teachers, boys and school structures in order to appropriate better condition for living and human existence (Giroux, 1983a; Weiler, 2017). For example, manipulation of school examinations and certifications may position girls to oppose oppressive aspects of their lives to get control for the present and future, by asserting their humanity to meet their needs. Such individual manipulation and negotiation to disrupt oppressive elements of schooling with perception to succeed within the school system of examination and certification is considered “accommodation” (Weiler, 2017, p. 287). Though, resistance and accommodation are important elements in negotiating schooling and social relationships, the limitations of shallow analytical debates are of concern to researchers; that, these concepts can only be slotted to study girls and women lives, without much significant impact in understanding the complex oppressive conditions of women and men in different contexts. Also, there is no clarity between these constructs of resistance and accommodation as it did not adequately explain whether feminine behaviour or reluctance to school authority and learning could be considered accommodation or resistance. Thus, in a complex and overlapping relationships of domination and oppression in social space, specifically schooling, it has limited analytical value due to its failure to focus on complexities of social construction of gender, sexuality, patriarchal and most importantly, power as the

intersection point of schooling, family, and work. Therefore, when resistance and accommodation are not used in a complex social world, only description of attitudes or actions of individuals in schools will be interpreted outside of a social world. In this sense, resistance and accommodation become only "convenient categories into which observed behaviour or beliefs can be slotted, which is frustrating and feel like empty and abstract ideas that can be applied to any social actions" (Weiler, 2017, p. 288). Lather argued that *resistance* is usually "informal, disorganised and apolitical" hence cautions that, it is problematic, when there is lack of nuance understanding of girls, class, gender ideology and schooling (Lather, 1984b, p. 44).

Contrary, Anyon comments that personal resistance to sexism, gender and patriarchy and the negotiation of existing concepts of femininity could lead to acceptance of status quo. Yet, both resistance and accommodation as forms of daily activity may provide most females with strategies to negotiate individually perceived social conflict or "oppression of fragmented and isolated cultural life" (Anyon, 1984, p. 45). Nonetheless, I perceive those girls and woman, resist dominant and oppressive patriarchal values and relationships in different ways from men. But the practical question especially for women and girls is, how can human ability create meaning and resist an imposed cultural ideology be converted to praxis and transformation (McRobbie, 1991; McRobbie & Garber, 2002; Paule, 2016). I perceive female pre-service teachers' resistance during interviews with Zima who said "female PST sometimes resist boy's dominance by correcting and dominating the class activities." I have never seen an intelligent girl such as Fika, she corrects the male students and sometimes myself"- Nagam. "I think females as agents could resist oppression in schools and society"-Tengo. "Females have power to transform themselves and the world"- Boko. However, a disturbing trend regarding gender transformative activities and choices of girls and women in schools emerges because researchers who attempted developing women's relationships in school context found out that schools are contradictory sites for girls and women, despite the perpetration of sexist texts and practices providing the possibility of resistance to male hegemony on the part of both the students and teachers (Gaskell, 1984; Kessler et al., 1985; Weiler, 2017).

Therefore feminists attention was drawn on women and girl's, men and boy's family and schooling complexities on the need to analyse power relations intersection in each specific site (Ashenden et al., 2020; Kessler et al., 1985). For example, some girls may benefit from connection of science, masculinity and power underpinned historically and culturally as females studying Science and Technology may see themselves as 'different' and powerful than

other women and as one of the boys. We thus need to understand the family, workplace, and the school in terms of sexual ideology, gender and structural constraints on women and girls' lives (Becky, 2010; Dennise, 2010; Zander, Höhne, Harms, Pfost, & Hornsey, 2020). Often the struggle for elite girls will be different from those of working-class female teachers and even middle-class, thus, to neglect class, gender, sexuality, and patriarchal differentials is to distort both the realities of their experiences and the possibilities for resistance in each context. For example, women who are oppressed by sexism as well as class, their form of opposition will differ from men's socio-cultural experiences. In addition, the way men and women will understand schooling will quite be different from that of boys and girls of the same gender, sexual positioning, class and patriarchal ideology (Becky, 2010; Dennise, 2010; Zander et al., 2020). In this sense, Feminist theorists assert that resistance has different meaning for boys and girls, men and women from diverse cultural stances. Thus, *resistance* can only be understood in relation to male and female gender class, sexual positioning and patriarchal orientations. Both women and men, boys and girls can resist oppression and domination by negotiating social forces to appropriate possibilities to meet their own needs. Though resistance has some shortcomings, it provides us with authentic possibilities to understand the schooling of men and women for a new gender order. I now turn to resistance or opposition by females and males to illuminate contradictory schooling of students and science educators in the college of education in Nigeria and how they could negotiate and renegotiate gender dynamics using transformative resistance as a vital component of their human existence. What was it in this research?

In this study, girl's and female pre-service teachers' passivity, refusal and sometimes sluggishness to head and lead during intellectual activities, carry heavy objects and hesitation to ask questions in the science class may likely be either acts of resistance and or ignorance and possibly not emotionally and physically well. This behaviour could possibly be underpinned by historical and cultural factors and influenced by their sexual bodies, gender and patriarchal ideology and not powerlessness and unwillingness to study. It is possible that female educator s and PST in the college space consciously or unconsciously perceived that the only way they can come out of domination and oppressive features is to resist some practices in the school science classes by asserting their femaleness to locate their humanity. This may likely be one of the easiest ways they can change and transform their living conditions in the Life science and Physical science classes. It is also likely that these female PST want to be treated as women in the class and society hence the culture of resistance exercised. While such girls displayed

resistance in the class by being submissive and reluctant and not participating in the lesson's activities, leading group work and asking questions as forms of power, they fail to recognise the limits of their resistance. Thus, they placed themselves in a structural position that deprive them from political, democratic, moral and social spaces conducive for radical reconstruction, change and emancipation. These female PST consciously and unconsciously do not know that they are also rejecting intellectual ability, political and democratic consciousness and power of critical thinking for social transformation and emancipation (Giroux, 1983a, 2010b; Quigley, 1990; Sargis, 2008).This type of resistance could be dominating rather than liberating logic (Sargis, 2008, p. 3). Therefore, female pre-service teachers' inability to appropriate gender critical thinking for emancipation and transformation but use their femaleness and physical maturity to pose resistance in form of passivity and submissiveness is often deeply embedded in their culture. Therefore, the act of domination also, by the male PST could be mode of resistance imbibed from the cultural ideology and society as well. Because they were made to believe that dominance is part of the cultural normative ingrained which should be practiced, hence constant resistance to always dominate and subordinate the females in the science class. Thus, reproducing cultural dominant features. Nonetheless, these male pre-service teachers, consciously and unconsciously may not know that what they are practicing is injustice, subjugation, and marginalization. In this sense, both the girls and the boys wouldn't want to counter what the culture taught them, but rather reproduce and reinforced the norms during teaching and learning processes to gain control over their own lives. Thus, scholars' comments that resistance is a manifestation of struggle and a political solidarity to challenge and confirm then confront capitalist hegemony for freedom. But not all oppositional behaviour in form of resistance has radical significance, neither does it have definite response to oppression. Because oppositional behaviour may not be a reaction to powerlessness but might be an expression of triggered power, that reproduces the power language of oppression and domination. Hence, transformative resistance may be the simple appropriation of and display of power in the social world and in the school to come out of oppressive injury. Echoing limitation of schools, Giroux has this to say:

> Schools will not change society, but we can create in them pockets of resistance that provides pedagogical models for new forms of learning and social relations form which can be used in other spheres more directly involved in the struggle for a new morality and view of social justice (Giroux 1983, p. 37).

However, the question is, can resistance situated in schools lead to change and transformation? Resistance theorists, though very useful in providing little insights into the schooling of boys and girls, did not focus much on the analysis of complexities and contradictory historical and culturally oppressive practices entrenched in education. Rather, their research reproduced and reinforced resistance and inequality in schools and undoubtedly it had limited theoretical and analytical significance (Johansson & Lalander, 2012; Thomas, 1980; Weiler, 2017). Though resistance is an important construct in perceiving the lives of girls and women, men and boys due to its inherent potentials to create human as agents of change and transformation, can schools be appropriate public site for resistance and the appropriation of critical counter-hegemony for girls or female students experiencing multiple subjugation? I explore this issue next. From the forgoing discourse, I presume that transformative resistance could be a vital element which should be used in colleges of education in Nigeria and the social world. The oppositional consciousness is likely to anchor moral, political emancipation and freedom for all in an environment characterized with multiple injustices.

5.1.1.9 Females' Multiple Oppressions in the College of Education

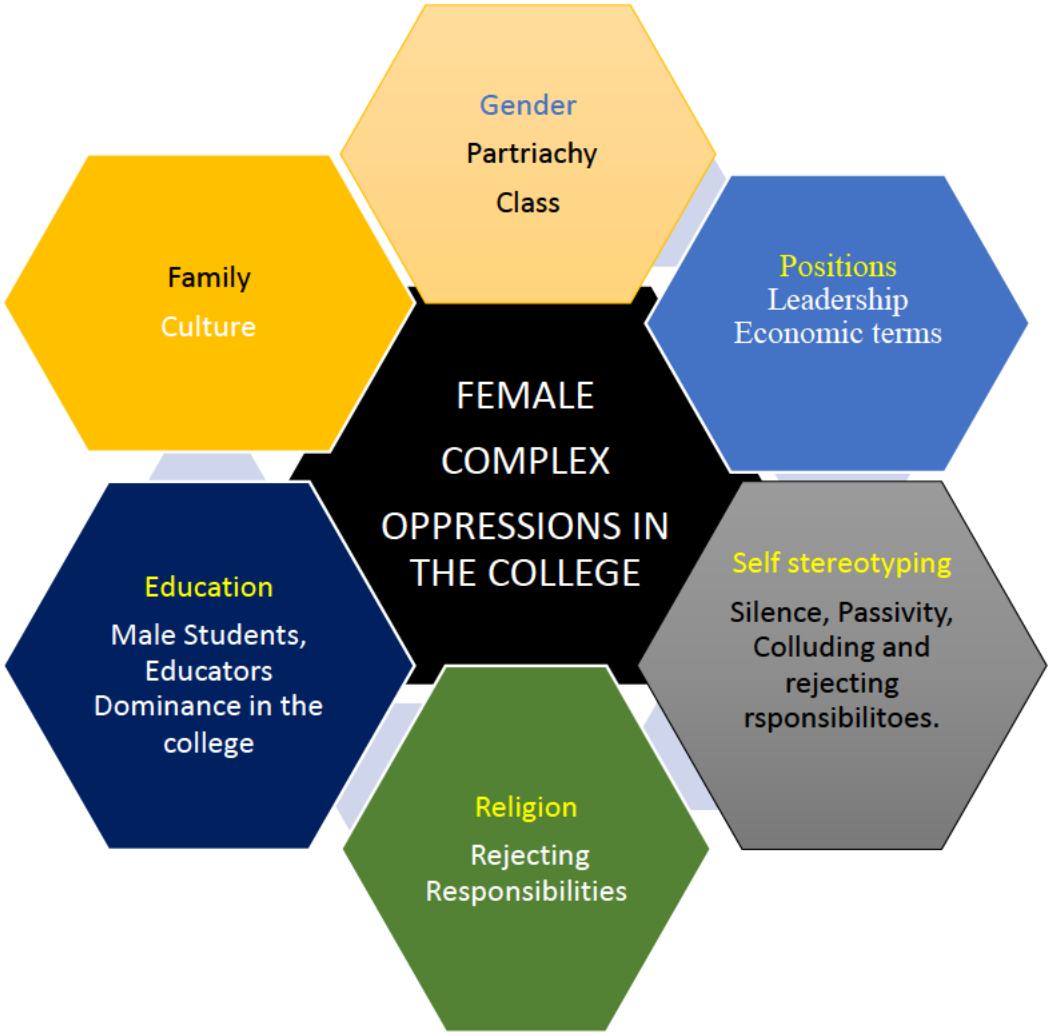
Multiple oppression due to gender, patriarchy, religion, family, college structural setting and class orientations were characteristics of the subordination that women faced in science education. Men due to masculinity and cultural influence subjugate females in religious, and institutional structural arrangement consciously or unconsciously linked to communality and passivity women and girls (Hentschel, Heilman, & Peus, 2019). Nevertheless, women themselves cause harm to themselves in the form of colluding and/ or shifting responsibilities to men based on capability and confidence to accomplish such tasks on time. This is what participant Boko said during interviews: "Even if women are given committee responsibilities in the church, and college they prefer to relinquish the work to men who are perceived more capable." "I treat female pre-service teachers in the classroom with reservation because they are weaker individuals in the society, politics, and as reflected in my religion"- Nagam. "Females are oppressed because of their gender and patriarchal ideology in education"-Dula. "Women experience contradictory science class rooms due to educators' sexual orientations, patriarchy, religious and political stances"-Nagam. "Self-stereotyping is part of numerous oppressions females face in education"-Tengo.

Further interrogation of the two female educators Zima and Tengo based on the above comments from the male educator shows that thy perceive men to be capable, hardworking and resilient.

This act of self-stereotyping I believe is disguised marginalization and reluctance which have short- and long-term effects on interest, participation, and performance of females in science education intellectual endeavour. Women also suffer from participating in managerial positions in the college due to their gender positioning. In this sense, they are usually deprived or deliberately side-lined from economically oriented cadre such as Provost, Bursar, director of works and sometimes registry offices. May be due to financial benefits attached to these exalted positions and/ or perceived female's intellectual and leadership deficiency due to gender, political, patriarchal and class cultural normative. Also, I sense that women appropriating gender awareness could still enter a space of further jeopardy, if they collude with females and males to be oppressive and dishonest while in service to humanity. This is because it is likely that men oppressive disguises may be strengthened to reclaim and propagate their social-cultural subordination dynamics in education and the society. Therefore, 1 perceive that all women in the college and other geographical settings of world, should remain committed, honest and invoke their political critical attitude to dismantle different forces that threaten their humanity for long- term emancipation and transformation. This is possible to regain their existence in the complex and contradictory education ecosphere characterized with multicultural elements of sexuality, class, gender, and patriarchy that mask or obscure liberation (Atwater, 1996; Higgins, 2021). The responses of educators from interviews and journals reflect these diverse oppressions "both female educators and PST are stereotype at home, religion and school due to their gender"- Tengo. "Politically and economically, females are silenced as a result of patriarchal ideology and gender roles"- reflective journal.

These multiple oppressive mechanism/dynamics are summarised in this model thus:

Figure 5.2 Model of Multiple Oppressions Faced by Females in the Society



With regard to ***"how"*** *aspect, these categories of data description of reproduction and subversion of gender stereotype beliefs and views were elicited:*

5.1.1.10 Gender Interface with Performance of Societal Roles and in Science Education College

"Gender is performative and repeated acts" (Butler, 2011, p. 3)**.**

The ability to continuously perform a given task in the society is associated with identity construction of male and female gender in education space and the social world. This is real when roles are repeatedly assigned to men/ boys due to perceived competence and masculinity linked to power and identity formation. On the contrary, women / girls are assigned tasks based on construction of passiveness, others, less powerful and submissiveness as identification. Therefore, these actions restricted by historical, economic, religious and socio-cultural gender norms likely affect identity, individual agency and self-efficacy of females in science education environment (Butler, 2011; Joy, Belk, & Bhardwaj, 2015).

In the college of education, particularly in the science education space, the constructs masculinity and femininity were visible and reinforced where male educators mostly were given higher intellectual roles such as preparation of students' examination results, departmental heads likely due to patriarchy and gender beliefs and competence, while females were subordinated to occupy less privileged positions and responsibilities to prepare lecture time table schedule and welfare committees assignments. Yes, females sometime accept low positions believing that the higher positions are too tasking"-Boko. "The acceptance of less privilege office is due to culture, religion and socialization ideology that females are weak and should be subordinate to male"-Tengo. This scenario was characteristic of PS and LS classes where performance was associated with gender of male and female students due to entrenched socio-cultural, historical and socialization process. For instance, Bodam during interviews said "to be honest I give more attention to male pre-service teachers than female PST because sometime the "boys" response to questions quicker." This depict how and why the male pre-service teachers were given higher intellectual activities such as response to questions and demonstration space to perform than the female students in the science class. In this case male undergraduate pre-service teachers will have interest, low anxiety with high self -efficacy, and be motivated to learn science than the female students who may have higher anxiety with low self-efficacy stifling their performance and engagement in science (Kalender, Marshman, Schunn, Nokes-Malach, & Singh, 2020). This evidently shown by the participant Bodam thus:

> The boys can act and finish classroom engagements faster than girls and sometimes the females are reluctant and passive.

Scholars argue that females experience high anxiety than male student in physics class, which in turn affect the participation and performance of women/girls in studying physical science. This is because anxiety affect student's self-efficacy, an element of motivation that drives critical role, student engagement, retention, and career status in science education. In this classroom space, I perceive that science educators should be aware of student's anxiety hence engage females with low- stakes assessment models such as mastery-learning embedded with quizzing system with no consequences and devoid of sanctions due to failure to reduce anxiety and increase self -efficacy. This is possible because high stakes grading system for instance examinations/test that attract consequences for students promote anxiety and low participation in physics (Li, Whitcomb, & Singh, 2020; Nissen, 2019; Sotola & Crede, 2021).

In chapter 5, I analyzed the questionnaire in appendix 2 into three parts A, B and C based on observation, inferences, summary, and deductions. Then the emerging themes were generated from the questionnaire, interviews and lesson observations data and discussed. The themes resonated around power of gender, patriarchy, and resistance for moral, intellectual, and political transformation in the college of education. Further, the chapter accounted for multiple oppressions that women faced in the college and likely in the society that could be dismantled if critical awareness is grounded. Herein, gender is linked with performance role in science education as likely perceived in the society.

Next section is classroom observations' data and snippets of six science educators' engagements with pre-service teachers in the college of education where the study was conducted. This section also foregrounds production and reproduction themes generated and discussed.

5.6 CLASSROOM OBSERVATIONS DATA, PRODUCTION AND REPRODUCTION THEMES

This section foregrounds data and snippets from classroom observation of six educators engaging with pre-service teachers. Then production and reproduction themes generated and discussed which resonated around patriarchy, stereotypical practices, change and transformative consciousness of educators and pre-service teachers. Then discussion of findings and educators' reflections about lesson observation engagements.

5.6.1 Data from Classroom Observations

Lesson observation is a vital method used in research to capture verbal and non-verbal clues of participants as stated earlier in the methodological chapter. Of course, it has some limitations in the sense that the participants might pretend not show some behaviours if aware that they are being observe during engagement (Cohen, Manion, Morrison, 2018). In this study, I observed what nature and how gender reproduction and subversion beliefs and views were done in the science classes.

The observation video of the lessons was viewed and listened, and notes were made. Snippets of the data from the observation conversations are given and discussed as follows:

*With regard to "**wha**t" aspect, these categories of data description of reproduction and subversion of gender stereotype beliefs and views were elicited:*

Teacher 1, Lesson 1

The life science educator started the engagement with greetings. She introduced the researcher and told the pre-service teachers to be confident and democratic. During the lesson presentation, one female PST brought into class a baby girl and another cakes. The educator was moving round the class supervising the PST without scolding females who had the child and cake. The other female and male pre-service teachers were also silent when the baby was playing and moving in the class as they turn to look at the baby.

In this sense, the male and other female pre-service teachers including one of the educators did not sanction some of the female PST who brought food into the class and ate it, clearly flouting safety and etiquette regulations in the science laboratory. It seems that these female pre-service teachers use sexuality and power to get their own ways. However, it was also an eye-opener when all the students did not object when some of their female PST brought their babies into the class and they were moving around in the classrooms. In this sense, I perceive production of cultural stereotypical practices that has been entrenched in the society as a result of socialization differential that position female pre-service teachers with confidence and commitment to move with children even in the science classroom. The act of gender production is oppressive, thus could side-line the females from critical science engagements that has the potential of empowerment, emancipation and transformation in education. Also, during lesson observation, I perceive that the female PST were critically conscious of intellectual and

economic oppression and were resilient hence wish to transform themselves from marginalization and their children by bringing them to classroom to experience schooling process and structures which was denied over the years.

Teacher 2, Lesson 5

During the classroom observation in chemistry lesson engagements, it was evident that both the male and female pre-service teachers were diligently answering questions posed by the educator in the classroom. However, some of the brave female PST had confidence, hence corrected a male PST that did not understand the concept taught by the educator. I perceive democratic, political and counter-hegemony actions amongst female pre-service teachers in the classroom linked to change and transformation.

Teacher 3 Lesson 4

During the lesson engagements, the female PST were bold and responded to questions and activities in the physical science classes (chemistry). This happened when they approached classroom engagements with vigour and commitment to learn, competing equally with the male PST. For instance, a female PST quickly said electron will always be shared not protons, when the male was struggling to answer the question. At the end of the lesson, educator and pre-service teachers were both happy with the lesson and were seen laughing.

Teacher 4 Lesson 6

During the life science class engagement, both the females and male PST were seated together listening as educator engages with them. Then in the classroom while the lesson was presented, a male PST moved closer to a female PST and was talking and holding her. I perceive the male preservice teacher probably intended to engage in unlawful act with the females and the female PST in reactionary resistance and with power defiled school rules and ideology. Furthermore, a male PST likely made advances for a relationship, disrupted lessons by engaging in romantic overtures with the female PST during the classroom engagements but these displays were subverted by a female educator as mentoring tactics. In this classroom during observation, I perceive discrimination by the educator. This is because the educator only rebuked the girl by asking the female pre-service teacher to change her seat while the boy was neither challenged nor sanctioned in the classroom. For instance, Tengo said to female PST “leave that seat and come forward.

Teacher 5 Lesson 2

The youngest of all the educators observed. He introduced the researcher and started the lesson. He engaged the PST with questions and more male than female pre-service teachers responded. I perceive he partially engaged the females. As he asked one of the male students to come and solve an equation related to electricity while the females watch despite raising their hands to respond. The class engagement was dominated by male pre-service teachers because they sometime times volunteer answers. For instance, Bodam remarked thus, Simik please come and solve the problem. Please sir I can try-Fitlink another male pre-service teacher.

Teacher 6 Lesson 3

This was observed when the educators, males and female pre-service teachers collaboratively and democratically were engaged in science intellectual, and emancipatory activities which promoted change and transformation. Because the classroom engagement reveals that the pre-service teachers were seen interacting with each other, competing and correcting themselves during intellectual engagement. For instance, during the classroom observations, I perceive the female PST corrected the science educator by changing and transforming the educator's statement on the board, when he unconsciously committed an error. This was the female PTS's response, "Sorry sir, I think the remaining electrons are two and they are to occupy the outermost shell". Then the educator remarked "Good I love that; I was not really sure." I perceive a dual transformative, political and critical consciousness within the classroom setting, because both the teacher and the pre-service teachers help each other in the class.

Therefore, during classroom observations, I perceive aggressive use of sexuality by female pre-service teachers as an act of subversion of male educator's misrepresentation of facts during classroom intellectual engagement that could likely oppress the female pre-service teachers.

In this study, I found that female educators (Tengo and Zima) who rejected to work with mothers at farm used power then negotiated and renegotiated science classrooms to resist male pre-service teachers and college ideology of dominance and discrimination for transformation of females.

5.6.2 Production and Reproduction Themes Generated from Classroom Observations of Lesson Engagements

This section is about the analysis stemming from the data generated during observation of educator's classroom engagement with pre-service teachers.

I only observed the educators verbal and nonverbal cues during the lesson presentation as they engaged with pre-service teachers. The observation was necessary to look at trends and pattern of reproduction and subversion beliefs and practices. It was also vital to elicit what and how the explicit and implicit nature of beliefs and practices were reproduced and subverted by educators. The themes herein were generated based on the lesson data and how I observed the discriminatory, dominant, resistive, passive and gender stereotypical practices that occurred during the classroom interactions. This informed the generation of production and reproduction themes discussed as follows:

*With regard to "**how"** aspect, these categories of data description of reproduction and subversion of gender stereotype beliefs and views were elicited:*

5.6.2.1 Female Educators and Pre-service teachers Self -Stereotyped and Oppressed Girls in the Class

Although life science educators were democratic, the female pre-service teachers during the life science classroom engagements oppressed themselves intellectually, when they brought food and babies into the classroom, allowing them to play, and distract attention from learning in the class. This action not only impact on females' learning but moral positioning. This likely could distract attention from the intellectual engagement in the class when the educator was explaining some concepts. I perceive also that the educator was complicit since she could neither ask the girls to control the babies nor take the cake and babies away from the class. This could possibly impact negatively on other students' concentration and motivation to study life science, since neither the educator nor the male and female pre-service teachers subverted the action exhibited for change and transformation in the classroom (Chavarria, 2017). Also, stereotypical practices by life science educators were evident when I observed them. For instance, the life science educators during the lesson observation voiced out to say: "Hey you tall guy, I mean Telly, go to store room and bring another microscope for demonstration making four now"- Zima. "If I want things to finish quickly, I use male pre-service teachers because they have confidence and are fast in responding to questions and activities in the class"-Tengo.

This I perceived are reproduction of discriminatory practices conveyed into the life science class due to cultural norm and roles differentials ascribe to males and females in the society.

5.*6.2.2 Active Engagement of Male and Female Pre-service teachers Promoted Equality*

During the classroom engagement in physical science class, I observed that both the male and female pre-service teachers were active and conscious of their intellectual engagement. This was visible when both sexes participated equally without any dominant or passive role in the class. The science educator affirming this scenario said:

> "The girls are as active and participating well in intellectual engagements as boys. For instance, the class leader is a female she reminds me whenever is five minutes to lesson time"- Nagam.

Also, as I observed the physical science class-chemistry neither the male pre-service teachers nor the educators discriminated the female pre-service teachers. This is probably because the educator and the pre-service teachers dialogically and democratically engaged in intellectual activities peacefully. This I perceive could promote interest, motivation and peaceful co-existence during classroom engagements which embraces equality of opportunities (Bianchini, 2017). Furthermore, interview data reveals that there was equality and transformation consciousness during engagement both in life and physical science classes. Because the educators boosted the girl's confidence and motivated them more by subverting male preservice teacher's dominant activities in the classrooms. Also, it was evident during the interview that female educator subverted the actions of their fellow educators who wanted to take advantage of the female PST in the school. This was evidently described by a science educator:

> Whenever I discover that my colleague's male science educators want to enter into relationships with female pre-service teachers, I talk to them to stop it. Then, I encourage female PSTs to report such moves to the school authority or their association leaders -Tengo

"I don't discriminate females and males in the class, but I teach and treat them equally because they are intellectually endowed the same"- Dula

*With regard to **"how"** aspect, these categories of data description of reproduction and subversion of gender stereotype beliefs and views were elicited:*

5.6.2.3 Educators use Gender and Power for Change and Transformation in the College

Power, gender and sexuality were employed by female and some male educators to resist college and male educators that oppress females**.** In this sense, the female educators and few male colleagues used their sexual cultural orientations to oppose institutional ideology that threaten the existence of females PST. This happened when some female educators discourage male educators and encouraged female pre-service teachers to sit up and focus on their studies for intellectual and career development. This is because with all the disciplinary measures in the college, some male educators with power and patriarchal orientations see female pre-service teachers as sex objects in the college but were resisted by few male and female educators. For example, this was what Tengo a female educator voiced out when I observed her engagement with pre-service teachers.

> Please girls focus on your studies you are not married but some of these educators are married with children they destroy you and your future career- Report cases of sexual advances to me directly or to your class representatives or school managements-Tengo

Also, interview held with physics educator reveal that there was a different scenario that occurred in the physical science class- physics, where a preservice teacher who missed a test wanted the male educator to give her a makeup assignment using power and sexual negotiations to seduce the educator. The educator instead of changing and transforming the female PST way of thinking and actions was angry hence oppressed the other female PST in the class not come to his office for anything. This action I perceived further oppressed female pre-service teachers and could probably serve as a warning to class members to behave well as ethical orientations. This was the comment made by the educator:

> This action is not only stereotypical in nature but invokes threat which could result to low confidence, motivation to learn and increase psychological disorientations on pre-service teachers**.**

Therefore, it is evident that schooling process and the science education space discriminate and oppressed students from intellectual development and democratic science engagement which Giroux consciously asserts as “intellectual error” (Giroux 1984, p. 5). Likely, both administrators and educators perceive education as a political and moral environment for the

transformation of identity, moulding of character and career development devoid of subversion or resistance**.** Yet it seems educators and school structure remain complicit in the process of stereotypical engagement with pre-service teachers during science interactions.

5.6.2.4 Discussion of Findings Based on Data Generated During Classroom Observations

Finding from classroom observations show that the female educators and pre-service teachers side-lined themselves during life science intellectual engagements. This occurred when the pre-service teachers used gender and power to commodify and subjectify the life science classroom while the educators, other female PST and male pre-service teachers remain silent and were likely complicit in the self- oppression of female PST (Ball, 2012b; Coffman, 2014; MacDonald-Vemic & Portelli, 2020). Based on triangulation process to ensure credibility, this scenario was also observed during the interview session and data analysis. Where educators remain silent when female PST were passive to intellectual activities due to dominance of male PST (see Section 6.5.2 for collaboration of qualitative data and assertions). Furthermore, classroom observations reveal that the female PST likely protested and posed resistance inform of counter-hegemony to school ideological apparatuses and denial of education over the years, by defiling college rules and regulations when especially a female child was brought into the classroom during normal teaching hours. Also, the females were critically and politically conscious of the prevailing subordination in education thus their struggle for liberation.

Active engagements between the male and female pre-service teachers in the physical science class, was also evident during the classroom observation sessions. Because the pre-service teachers were participating equally by responding to questions and activities as the educator interacted with them. This shows how the educator created a democratic, political, collaborative and equality space for learning. Though active learning that does not relate to student social community issues is limiting in perspective, because it is likely to ignore preservice teacher's immediate challenges in the ecosphere (Bybee, 2013). However, in this politically and democratic oriented physics and chemistry classrooms in the college, I perceived a learning environment which promoted inclusive learning and embraces multicultural views of pre-service teachers for peaceful co-existence. This could be seen as a drive towards political, intellectual emancipation and transformation. This resonates with Paulo Freire and Giroux who call this class a political and democratic space for science engagements that has the potential

to enhance accelerated learning since power was distributed in the classroom (Freire, 2013; Giroux, 2020).

5.6.2.5 Educators' Reflection Moments

After the classroom observations, the educators were asked to reflect on gender stereotyping reproduction and subversion in the classroom when observed. The collective and reflective journal moments were necessary to allow educators reflect on the position they took when responding to the questionnaire, their stereotypic and subversive practices in the classrooms and how they perceive engagement with all the instruments used for data collection. The following themes emerged:

Fear of making mistakes

The educators expressed worries about how they were going to be watched by others, make mistakes as the video was played for them to watch their engagements with pre-service teachers. Regarding this sensitive matter, I assured them and gained their confidence that it will only be watched between the researcher and the participants and will be destroyed.

Confidence of educators

Some educators expressed confidence in my presence and in the exercise of gender studies. For them it motivated, changed and transformed them from reproducing stereotypical gender practices in the class. Thus, they advocated that if videos of all lessons will be played for educators to watch their strengths and weaknesses, it will go a long way to improve teaching engagements in the college and elsewhere. For instance, this was a comment from an educator:

> I did not know that I had made such good presentation and few mistakes until I watched the video, thank you for the research work exposition from South Africa.

Professional development

The educators were happy with the classroom observations and reflective feedback of lessons due to its potential that it had increased their understanding and knowledge about discriminatory gender practices in the physical and life science classes. They also asserted that the observation- reflective discussion was like the teaching practice exercise they engage student with over the years to prepare and developed their science identity and enhance teaching

experience. Thus, this process has developed their science identity a drive toward professional development, gender equality and transformation.

Empowerment, experience, and transformation consciousness

The educator expressed joy that the questionnaire, interviews, classroom observations, reflective journals and collective journals exercises had empowered them experientially with emancipatory insights, thus changed and transformed their mindset about the entrenched oppression and subordination of females in the college and society.

Next is the discussion on the theoretical underpinning of this study linked to assertions made.

CHAPTER 6
DISCUSSION ON THEORETICAL PERSPECTIVES, PRODUCTION AND REPRODUCTION ASSERTIONS GENERATED- Section B-

Stage three

UNDERSTANDING HOW AND WHY EDUCATORS REPRODUCED AND SUBVERTED GENDER STEREOTYPES AND SUBVERSION BELIEFS AND PARCTICES

INTRODUCTION

In the preceding chapter, I analyzed data produced from questionnaires, interviews, and lesson observations, collective and reflective journals of science educators. Also, the preceding chapter reflected themes on gender stereotyping and subversion beliefs and views in science classes linked to educators and pre-service teachers' use of gender, sexual identity, and patriarchal elements to appropriate personal power. Also, how they used the personal power to gain control of their lives in an oppressive and domineering institution. More so, I provided an account of a college space that is contradictory and the need to renew gender critical capacity for negotiation and re-negotiation for human existence. In addition, the chapter focused on the political and democratic consciousness of science educators and their intellectual positioning for transformation.

In this chapter, I present a discussion and overview on how schools with partial autonomy are implicated in reproducing neoliberalism economic contradictions, coded gender inequalities and then possibilities for transformative consciousness, power, resistance, social justice and freedom. The discussion is drawn from social reproduction theory, liberal feminist perspectives which added impetus to critical feminist reproduction theory linked to gender, patriarchy and economic actions, then a discussion on liberal feminism linked to the prevailing Nigerian gender discourse. The chapter foregrounds findings from data and then themes obtained from questionnaire, interviews, lesson observations, collective and reflective journals in chapter 5 to produce seven assertions namely: 1. Personal power and the professional identity of educators conflate to dictate what goes on during schooling, 2. Science educators, male-students and female educators collude to stereotype female students even further in the classroom. 3. Science educators display agency and communality and have potential to enhance and accelerate transformation. 4. Science educators use power of gender and sexuality to negotiate science

classroom discourses and control. 5. Colleges of education are a complex and contradictory terrain for teaching and learning of feminism practices. 6. Schools contain moral and ethical ideals in developing gender equity 7. Science educators re-negotiate complex sexism and classroom dynamics. The chapter concludes with highlight of hidden curriculum that influences the school organisational growth, development and economic reproduction linked with inequality. Therefore, the assertions generated are discussed herein which provided insights to the research questions two and three.

6.1 SOCIAL REPRODUCTION THEORY

Over the years**,** social reproduction theorists with cultural production insights, tried to understand how schools are implicated in the process of social reproduction of inequality (Apple, 2017; Kelly & Nihlen, 1996; Starr et al., 2020). Social reproduction perspective is concerned with how school perpetuate the social relationships and the way schools reinforce the existing dominant and class relations of the social world. One core element of social reproduction theory is the "intergenerational reproduction of social class," where working class students become working-class adults; middle-class students become middle-class adults, etc. (McLaren, 2017, p. 72). Drawing on correspondence theory underpinned by social reproduction paradigm, there is a relative correspondence between schooling, class, family, and social inequalities. Thus, Bowles and Gintis (1976) highlight how children of parents with upper socio-economic status most times achieve upper socio-economic status while children of lower socio-economic parents often acquire a correspondingly low socio-economic positioning.

However, an important issue arises out of the correspondence and social reproduction theorists as they could not give adequate account because some children could cross over from the class status of their parents. Drawing on Bowles and Gintis's analysis of socio- economic class, McLaren avers that,

> Correspondence theorists could not explain why some children cross over from the status of their parents. Thus, social reproduction, as it turns out, is more than simply a case of economic and class position: it involves the complex interplay of social, cultural, and linguistic factors (McLaren, 2017, p. 73).

Thus, the proponents of this paradigm ignored the concepts of resistance, individual consciousness, and contradictions of the cultural reproduction process that wielded power to

both men and women, boys and girls in the social space. Social reproduction theory. While valuable in highlighting salient issues on gender stereotyping, overemphasises domination and oppression, rather than humanity, individual and group consciousness linked to opposition. Thus, the scholars make it appear seamless and natural that girls are turned into women in a mechanical process during schooling for economic benefits (Arnot, 1982; Bowles & Gintis, 2011; Weiler, 2017).

In this regard, it seems that resistance theorists, drawing from Willis and Willis (2017), show that, working-class students who engage in classroom resistance implicate themselves further in their own domination, because these students consciously having power and confidence appropriate strong values to reject official institutional policy to retain or go below working-class status that could further dominate them in the future. For example, we had a 'hair race' issue recently in South African high school that attracted questions in the school and public space. But who decides on the norm for hairstyle in schools? Such conflict led to challenges to the partial autonomy of schools that also function to improve the social position of all students. Yet, this is not sufficient transformation as the subordinated groups are still stifled within the schooling system. Thus, schools still operate and sustain the oppressive reasoning of capitalist's dominant class, by reinforcing discriminatory social practices linked to class, race, and gender stereotypes that further oppression which liberal feminists' question to liberate themselves for justice and peace in the social space (Mariano & de Souza, 2020; McLaren, 2017; Willis & Willis, 1981). In my own view therefore, social reproduction theorists' argument has helped in illuminating inequality and the economic oppressive dynamics in schools, colleges of education in Nigeria and social space. This is because the perspective has invoked our consciences to belief with intergenerational model of class and economic reproduction yet ignoring possibility for oppositional consciousness a limitation of the theory. Where children from the working-class are socialized to become working class families and middle-class children are socialized to become middle class citizens who do not seem to resist the deceptive appearances of capitalist ingrained ideology. Of course, the scholars ignore rethinking the possibility of educators, and pre-service teachers in the college of education as having power and transformative resistance to regain their humanity in education and work career as a space for liberation (McLaren, 2017).

6.2 LIBERAL FEMINIST PERSPECTIVES

This perspective seeks to envision justice and emotional freedom for women and men in a gendered society. The dynamics of gender domination and complexity of schools and the economy drew the attention of liberal feminists, who highlighted the discriminatory practices in texts and the schooling process. Thus, this perspective set out its notion of women liberty and emancipation in the social world (Deem, 2011; Ringrose, 2013; Weiler, 2017). However, it must be noted that the breadth of scholarship on discrimination, gender stereotypes and the oppression of women in schooling has emerged largely from liberal feminist analysis of the wider school endeavour, linked to the economy. Even though such work has contributed to insights into the schooling of women, girls, and teachers, it is limited in its focus mainly on identifying sexual stereotyping and sexual biases in curricular textbook materials and school practices. Thus, in their attempt to redress dominant and oppressive elements, it has focused little on reforming texts, school practices and state policies of education that likely re-enforce the status quo (Deem, 2012; Hook, 2019; hooks, 2010).

Of course, the liberal feminist contribution to women and their oppression has been vital. Yet, it ignores the "complexity of consciousness" and the existence of patriarchy, ideology, and human culture during the schooling process and in society (Weiler, 2017, p. 274). Rather, it emphasises the biases and distortions of specific texts and the sexism that underlie such practices as a course and career guidance for girls and boys and even science teachers (Kehily, 2002; Wong & Schwarz, 2017). This perspective has provided a narrow focus on text and institutional structural constraints that limit teachers' and students' potential. Thus, it cannot account adequately for the depth of sexism in power relationships and the connection of gender, sexuality, and class elements such as those affecting working-class boy and girls. This paradigm fails to position school and schooling process in the context of a wider but contradictory social and economic analysis. Therefore, it ignores analysing the class constraints and complexities embodying the process of schooling linked to social economic world. Therefore, I perceive liberal feminists' discourse has concentrated or hastily focused on the more superficial oppressive classroom practices, curriculum sexism materials and subordinated images of female in science education in Nigeria and possibly other parts of the world, omitting dynamics of gender and the relationship of power, transformative consciousness and the transfer of economy in education and the world. In this study, I seek to penetrate deeper to gain insight to

expose deceptive appearances of marginalization of women in institutions and the social environment for liberation.

Moreover, liberal feminists' failure to analyse class, economy and patriarchy ignores the oppression of middle-class and working-class women and that of working-class boys, hence does not penetrate deeper to unravel power relations and existence of humanity in education (Deem, 2011, 2012; Stromquist, 1990). Thus, it does not align with Marxism's consciousness that in every social system there is production and reproduction of both men and women class and economic inequalities. This point is supported by Arnot who elaborates that:

> The literature does not search deep into the class basis or the inequalities of opportunity which boys suffer…The implication then appears to be that girls should match the class differentials of educational achievement and access to occupation which boys experience. Equality of opportunity for both men and women. Or, one could say, equal oppression (Arnot, 1982, p. 68).

The arguments of gender disparity led us to another complex situation in the Nigerian state in which this study is conducted.

6.2.1 The Nigerian Gendered Discourse in Relation to Liberal Feminism

In Nigerian society, gender stereotype, representation and discrimination are skewed against women and are culturally and morally underpinned. This is because the Nigerian culture perceives and ascribes power and treat men as superior to women. This is evident in the "son preference syndrome" characterized in Nigerian culture since independence (Jessani, 2015, p. 22). Thus, the male concept of superiority has permeated the Nigerian society and infiltrated the education sector in form of gender stereotypes that impact on females' interest in science, thus letting women leak out of the science pipelines (Babalola, 2018; Ekine, 2013; Mustapha, 2012).

More worrisome is the case in Nigeria and some African countries where numerous studies seem to address the prevalent gender stereotype but limit their focus to the lack of girls' participation, enrolment, access, and performance in educational opportunity (Ezeani & Ezeibe, 2013; Federer et al., 2016; Halevi, 2019). Such abundant discourse mostly centres on skewed relationships of gender stereotypes in favour of boys without researching deep to unpack the origins of the discriminatory practices and sex stereotypes that form the basis of inequality.

Those who attempt to reveal reasons for the discrimination only discover patriarchal components underpinned by cultural and contextual factors but do not inform us how gender intersects with power relations and the neoliberal capitalist agenda within the school space and social economic class. The lack of interrogation of class and power relations leads to a blurring and nuances of what happens in the Nigerian schooling process and the economic social world. This because, women and girls' oppression are only described in terms of their gender achievement, inequality and marginalization but not viewed in terms of class, sexual behaviours and power orientation. Of course, women and girls in Nigeria and elsewhere are not perceived by men as contributors to the social economic space, sometimes are forced to remain at home as passive, submissive and nurturers in social world (Ifegbesan, 2010; Makama, 2013). Implicit is the idea that sexism and patriarchy exist within the realm of thought, and men and boys should always dominate women through their stereotypical practices of leading and dominating. More so, the dominance of men and boys, bullying, the passivity, non-aggressiveness and submissiveness of girls and women in the science classrooms and the school structures reflects what goes on in the larger society and Nigeria (Pellegrini & Bartini, 2001; Rosen & Nofziger, 2019). In this sense, the physical and life science classes in the college of education, as cases for this study, can be considered as a microcosm of what is happening in the larger society, based on available data collected during the research work. Thus, the analysis of data (see Chapter 5) reveals that there are gender stereotypes and reproduction of cultural subversive acts in science classes in Nigeria. This study can inform the perennial reformation of the Nigerian curricula that has over the years attempted to reposition the education sector and achieve gender equity and equality, a process that has remained elusive for many decades. Assuredly, is the idea that changes of texts and practices, organizing workshops and theoretical debates will lead to changes in social relationships and that boys and girls will be treated as equals within the schooling process and the Nigeria capitalist's society. The question is, has subversion of stereotypical practice for equity or equality change, emancipation and transformation in the college where the study was conducted been achieved, given all the rhetoric since independence in 1960? Undoubtedly, this rhetoric in the Nigerian social space conforms to the liberal feminist paradigm, which ignores the constraints of the material world and different form of power dynamics that have worked together and have been reinforced for years. Thus, men and women, boys and girls were probably conscientized into believing the

single truth of capitalist gender oppression and domination pre-independence and after independence in Nigeria (Alade, 2012; Bunmi & Taiwo, 2017).

Post-independence, the dominant capitalists, religious leaders and elites in Nigeria have failed to understand that women with their sexual emotions, power and class orientations can negotiate the politics and democratic spaces of the Nigerian state to gain control of their lives. First, women must be conscious to conceptualize that, they have inherent power, autonomy and moral potential to regain their individuality for change and transformation. Women could regain this consciousness by advocacy, organizing workshops and conferences on gender stereotype reproduction and subversion through collective political struggles in education and in the society. A critical feminist reproduction lens could reposition them in this regard. Because the theory, if applied, seeks to evoke the consciousness of all humanity, women and girls, teachers, and students, females with power and collective political struggle, can navigate structural constraints in institutions and in the material world. Furthermore, by pursuing resistance and appropriating counter-hegemony skills for emancipation and transformation, gender discriminatory practices can be highlighted and dealt with (Mouffe, 2014). Ringrose throws more light on this aspect of gender stereotype, power, and resistance.

> The "female body holds the sexual power to overcome men rationality, yet, the women body remain site of controversy and discipline from men and the other women" (Ringrose, 2013, p. 22).

Ringrose's perspective, in my view, asserts that the scholar focused much on female sexual body ignoring the mind, social environment that can be used by women to negotiate social contradictions for advocacy and empowerment.

Undoubtedly, drawing on Ringrose's argument above, on distortion of men rationality there is a model syndrome call "marks for sex and sex for marks" craving, perverting the Nigerian state colleges and universities and perhaps the broader social world (Fadipe & Bakenne, 2020, p. 22). Literally, it means that girls and women, boys and men can use their gender and sexual bodies to seduce administrators and teachers for scores, certification, promotions, leadership positions and economic gains, instead of mastery performance and critical skills for self-determination, job placement and economic transformation (Aderinto, 2014; Giroux, 2014). Mensah crudely puts this seduction approach as: "When you open your legs you eat" (Mensah, 2019, p. 11). This statement put into questioning the feminist liberal views of freedom in the

complex social world. For instance, I found that a female pre -service teacher who missed her test went to an educator with transparent clothing which later attracted sanction from the science educator.

Also, during the classroom observations, the female pre-service teachers protested classroom intellectual engagements hence, thought that school environment could be space for commodification and distractions without subversive acts by educators and male pre-service teachers. These actions may further their oppression and subordination during science engagements and future career development. In this study, I found that male pre-service teachers entrenched in cultural stereotypic practice sometime dominate the female pre-service teachers in the classroom while educators remain silent with no sanctions.

Therefore, my own view is that the liberal feminist engages in superficial investigations of women oppression and highlights discriminatory and gender stereotype in text materials, to the glaring neglect of boy's inequality. This is not only frustrating but contradictory to their feminist struggle. The liberal approach is further implicated due to its failure to consider the complex material world and complex schooling process influenced by sexuality, gender, class, and patriarchy of teachers, boys, and girls (Marco-Bujosa, McNeill, & Friedman, 2020). Thus, the omission of a nuanced social and economic analysis within the feminist liberalist perspective and linked to cultural production and reproduction limits its sense of knowledge in explaining the historical sources of gender stereotypes, power relations and control that affect what goes on during the schooling endeavour in Nigeria, Africa and other ecospheres. Certainly, this perspective also ignores the complexity of individual consciousness and the reality of ideology and intersection of gender and culture with school, family and work that breed oppression and domination. While liberal feminist conscious critiques of sex role-stereotypes in texts and gender classroom practices in school have been helpful, they are of limited analytical significance in investigating the complexity of social construction of gender inequality link to power relations in the family background, school, and work progress. For example, I found that both the educators and pre-service teachers as agents of transformation, had power to resist discriminatory actions both at home and in the college. This is evident when at home the educators challenged working with parents but worked with male children and while in the college rebuked or subverted stereotypic practices of pre-service teachers. In this case, researchers, science educators and students must be conscientized on feminist critical, political, and democratic skills for developing new possibilities for gender transformation order

in Nigeria and the broader social world (Freire, 1973; Giroux, 2010a; McLaren, 2015, 2017; Para-Mallam, 2018).

6.3 Critical Feminist Reproduction Theory

Differing from liberal feminist paradigm, critical feminist theorists assert that the schooling process is deeply connected to gender, class structure and economic system of capitalism (Deem, 2012; Faas, 2016; Giroux, 2014). Though, critical feminist perspectives draw inspiration from critical theory in its attempt to focus on women liberation through collective political struggle, they critiqued critical education theory for limiting its focus only on critical thinking for transformation, disregarding liberation and the power of feminism that could likely be positioned in disrupting the status quo for emancipation and peaceful co-existence in the economic world. Social reproduction theorists believe that there is a strong relationship between women's schooling and women's work. That is, girls are usually educated in the school to continue with women's inferior positions in the society within the economic space (Deem, 2011). Of course, critical feminists with economic consciousness, insist that capitalism and patriarchy are related and mutually reinforcing at both ends to produce and reproduce economic inequality. Meaning both men and women are interconnected in terms of economic relationships of gender and class division. However, feminist critical theorists have been criticised for being idealistic and political. This is because feminist critical theory is connected through central elements of women oppression, power, patriarchy and empowerment and places too much emphasis on political struggle for emancipation for economic resources (Jansson & Eduards, 2016; Liinason, 2011). Though critical feminist reproduction theorists share some limitations of social feminist theorists who attempted fusing Marxism and feminism, they deeply align with Marxist theory and thus apply the perspective of cultural production and reproduction of oppression and domination to women's lives in the society linked to economic arrangement.

Unlike critical feminist reproduction theory, Marx and Engels focused on modes of production and reproduction relations in class, but not gender elements (Deem, 2011; Fuller, 1980). Tying Marx, Engels, and Marxist theories together, women oppression is subsumed within their class positions and was analyzed through examining the demands of cultural capital which signifies ways of talking, acting, modes of style, and moving, socializing, forms of knowledge, values, and language practices. Therefore, socialist feminist theorists argue that traditional Marxist

analysis ignores the nature of women's oppression and experiences (Hartsock, 1983; Weiler, 2017). As Kuhn and Wolpe comment,

> Much Marxist analysis in subsuming women to the general categories of the problematic class relations, labour process, the state, and the so-on fails to confront the specificity of women's oppression (Kuhn & Wolpe, 1978, p. 88).

Drawing from socialism and feminism views, there exists an "unhappy marriage" due to the inherent complexity and contradictions in attempts to explain the position of women in the society (Hartmann, 1981, p. 190). Therefore, there is a need for critical socialist feminists to enact a synthesis of different positions of analysis to produce knowledge that relate with the power embedded in the gender and economic system (Barrett, 2014; Eisenstein, 1979). As Hartmann puts it,

> Both Marxist analysis, particularly its historical and materialist method, and feminist analysis, especially the identification of patriarchy as a social and historical structure must be drawn upon, if we are to understand the development of western capitalist societies and the predicament of women within them (Hartmann, 1981, p. 191).

Therefore, while the Marxist approach focused on schools as an ideological state apparatus in term of cultural production and reproduction, feminist reproduction theorists share a common reality on how power is related to historical material analysis, class and gender linked to schools. Feminist reproduction approach looks at women oppression in paid work force and domestic work, as being reproduced through what goes on in the education sector. Assuredly, the statistical analyses of women's inferior positions in the economic space are consistently tied to sexist texts and discriminatory gender practices in schools. Feminist reproduction theorists argue that what are being reproduced are not simply men and women but working class or bourgeois men and women who have relationships to one another and to production that are the result of their class as well as their gender (Arnot, 1982; Deem, 2011). As Arnot shows, this approach reveals "the diversity of class experience and the nature of class hegemony in education" (Arnot, 1982, p. 690).

Though critical feminist reproduction theorists emphasise women oppression and patriarchy, they remain committed to the idea of production which is connected to the material life of

individuals. Thus, they see the relationship between gender and patriarchy as an ideology and women's role in production as basis of any analysis of women and school engagements. That is, both paid and unpaid work becomes central to the analysis of women oppression and schooling in entrenched patriarchal society. Moreover, they focus on the way schools work ideologically to prepare girls who seem to lack autonomy but to accept their roles as low paid or unpaid workers in the capitalist regime (Deem, 2011; Patall, Vasquez, Steingut, Trimble, & Pituch, 2017; Patall & Zambrano, 2019).

Therefore, drawing from Althuserian perspectives on relationship of gender and resistance during school endeavour, education spaces are considered to have relative autonomy and seen as sites of ideology and cultural gender reproduction. However, Althusser is more concerned with the category of class not gender. More so, the failure to focus on human agency or resistance limits the perspective to insightful analytical significance of gender linked to reproduction in schools with "relative autonomy" (Weiler, 2017, p. 276).

Inspired by the Althuserian paradigm, which ignored gender and resistance, AnnMarie Wolpe, an early socialist theorist highlights the role of gender in schooling and critique of official government policy statement on education and sexism in schools for its lack of economic and social analysis. She avers that social stratification theorists do not search deep at women's social oppression and professional statuses in the society, instead linking these discriminations to innate psychological differences in terms of lack of aggression, excessive anxiety and intrinsic rewards such as nurturing relationships. She commented that such gender stereotyping discourse ignores the powerful forces of the capitalist economy, which influences and demeans or discredits unpaid domestic work of women, who are sometimes considered or falsely coded as reserve army of labour in the social world. Based on this realisation she asserts that:

> The acceptance of the role of women as wives and mothers doing unpaid work in the home and the failure to recognise either that women do work in paid jobs or that the paid work that they do is in low-paying and dead-ends jobs (Wolpe, 1978, p. 5).

Thus, ignoring the reality of women's mental and physical work as paid workers and by encouraging girls to see their own paid and unpaid work as insignificant, the school deliberately perpetuated and collude with larger society to reproduce existing inequality. Thus, her argument highlights the domination and subordination of women and the hegemonic

ideological insights of men in the economy and school structures. But Wolpe limit her consciousness by not focusing on human agency, resistance and how policy and practices are enacted and put into practice in schools.

To reject the coded "reserved army of social work" (Bruegel, 1979, p. 12) as perpetuated in school and the social space, women consciously and unconsciously may have posed resistance by appropriating the gender dynamics of negotiating schooling wage labour. This help dissolves the hegemonic tendencies of the dominant class, who proffer understanding of the single reality of oppression and domination as the only truth available to be consumed, wanting society to accept this as the norm and the only authentic way of knowing and winning the consent of the subordinate groups to further marginalise themselves. For instance, thought about gender, race, sexual orientations and economic arrangement is usually sustained through the success of the hegemonic social order. Therefore, resistance to hegemony is evident in the science classrooms or social space as non-conformance, passivity, knowledge of individual consciousness and meaning (Falkenberg, Curnow, Hart, Wilkinson, & Orlowski, 2019; Kaufmann, 2000).

Of course, resistance in turn leads to counter-hegemony pedagogies. Thus, counter-hegemony is a deliberate attempt to adopt strategies to critically challenge ways in which the dominate class infiltrate the schools and the society with their oppressive elements that impact on the subordinate and the minority. In this sense, teachers, students, and the society must be evoking their consciousness to envision alternative futures, possibilities and new but different social truths for emancipation. This emancipatory reality, I think, can only be achieved if students and science educators engage in discussion with enlightenment and transformation of consciousness to reveal a higher truth of socio-economic liberation. Therefore scholars argue that an approach to teaching and learning that foregrounds higher reasoning from challenging the status quo and shifting power to students will be transformational (Freire, 1973; Mezirow, 1991). This could allow both teachers and students to have power, advocate and model democratic and political curriculum practices for gender transformation (Celis & Lovenduski, 2018; Ezeani & Ezeibe, 2013; Kehily, 2002). Therefore, I sense that critical feminist reproduction theory has prepared a dialoguing path, as a seal of epistemological relationships for emancipatory, moral and political struggles for science teachers, students and scholars and the complex gendered world for epistemic transformation and/or liberation. In this democratic space, science educators will no longer transfer knowledge to be consumed by students,

particularly undergraduate pre-service teachers, that will further domesticate or oppress them, but will position them to search for critical knowledge that is empowering and liberating. This is because the mandate of education is not for domestication but for freedom and independence for knowledge search where the educator and educatee establish collaborative relationships. This is where no longer "I think but rather, we think with regard knowledge production continue to exist" (Freire, 1972a, p. 5). Next is the assertions of production and reproduction generated from the college of education in Nigeria.

In this section, I discuss the assertions that provided insight to research question, ***two and three***

Assertions of Production and Reproduction in the Nigerian College

These assertions were obtained by producing the data through questionnaires, semi-structured interviews, and lesson observations, collective and reflective journals from the field. This was done by analysing the data in tables and thematically in conformity with critical theory, critical consciousness and critical feminist reproduction lens of the study. Then, linking it with related literature that accounts for gender stereotypes and subversion beliefs. The data also inform how a college site can perpetuate inequality but is also a political, democratic, and transformative space for negotiation and re-negotiation for self-consciousness and individual humanity. Having produced these assertions in themes, I paused for some time and went back to revalidate them to establish the credibility, by looking at the questionnaire, collective and reflective journals, then interview data sources as they converge, to produce the major themes and thick description of what is going on in the college where the study was conducted. An interviewee was asked to comment on some major assertions to find out whether the responses aligned with what is currently happening in the college. These major assertions were also given to a professor who validated them to ascertain whether the questionnaire data, interview, lesson observation, collective and reflective data from journals match or cohere with the major findings, to answer research questions one, two and three

This section 6.3.1- 6.3.8 provides answers to these research questions one, two and three

*With regard to **"how"** aspect, these categories of reproduction and subversion of gender stereotype beliefs and views were elicited:*

6.3.1 Assertion 1: Personal Power and the Professional Identity of Educators Conflate to Dictate What Goes on During Schooling

The nature of gender stereotyping and subversion in physical and life science classes from this study have been revealed to be the cultural production and reproduction of personal power and professional identity in the form of resistance to ideological apparatuses. Resistance to schools and schooling is also influenced by gender, sexuality, class, and patriarchal elements, which conflate together to determine what goes on during school engagement (Deem, 2011; Franzway & Moulding, 2018; Giroux, 1983a; Wolpe, 1978). Both science educators, boys and girls respond to classroom interactions differently in form of resistance. I found that, both the male and female science educators stereotype the pre-service teachers (see section 5.4), interviews (section 5.1.27), collective and reflective journals (section 5.1.28). The male science educators use their patriarchal power of dominance to stereotype the female pre-service teachers by unequal distribution of intellectual activities in favour of males, by reprimanding females more than male PST committing the same offence**.** Therefore, when male pre-service teachers misbehave in the class it is normal, but when female PST exhibit the same act, it is considered antisocial and sanctions are evoked (Beaman, Wheldall, & Kemp, 2006; Caldarella et al., 2020; Merrett & Wheldall, 1992). This impacts on girls' emotionality by forcing girls to look subservient and limiting female careers in science and encouraging male students' dominance and interest. Also, the findings reveal that science educators sometimes stereotype female PST by calling on male PST to engage in more strenuous activities and giving more attention to male pre-service teachers, which conforms to the societal gender consciousness that men are physically stronger than women. This skewed treatment in the class concurs with researchers who lament that science teachers discriminate and oppress female students in the classroom, thus students become disinterested to learn (Akinsowon & Osisanwo, 2014; Ekine, 2016; Mbembe, 2016). The discriminatory practices and beliefs are in concert with the argument of feminist critical reproduction theorists who raised concerns that the social space, education and the schooling process are characterized with contradictions and complexities of oppression, domination, sexual actions, and gender oppositions against females (Deem, 2012; Weiler, 2017). On the contrary, a critical theorist (Freire, 1972) argued that within these contradictions' possibilities exist for change, freedom and transformation through reconfiguring critical consciousness model awareness (Diemer, Rapa, & McWhirter, 2016). This stereotypic scenario was captured during questionnaire, interviews, lesson observations and collective journals thus,

“Sometime I discriminate and sometime I challenge the stereotypic beliefs and practices inside and outside the science class”-Tengo. “Male pre-service teachers dominate the female pre-service teachers during intellectual engagement”-Bodam. Male pre-service teachers subordinate the female pre-service teachers because of their power, gender and patriarchal ideology”- Boko.

Findings also reveal that there is intersection of personal power with professional work (see sections 5.2 &5.3). Also, I found out through educators’ views from questionnaire, interviews, collective and reflective journals reveal that science educators prefer to work with boys than girls. This is, because they perceive that the boys are physically stronger, respond to intellectual engagement quicker and then demonstrated confident to work and learn than the female pre-service teachers. Sometimes, women in the college use tactful responses and are perceived to be seen as submissive, sluggish and lazy, so they can gain control of their lives by refusing to politically and democratically participate in class activities and questioning. This act of undemocratic and apolitical use of personal power stifles engagement in the science class and is underpinned by Nigerian cultural and social norms and values. Culturally, girls were ingrained to use these acts of negotiation to evoke their femaleness and social maturity to gain control of their lives among the dominant and bossy boys.

The study show that male pre-service teachers’ act of dominance and female pre-service teachers’ submissiveness are further reinforced by the college and the science educators, because pre-service teachers are socialized into different intellectual engagement in form of stereotypical patterns of resistance in the school setting. Also, the college where the study was conducted, teach male pre-service teachers to appropriate and continue with autonomy more than female pre-service teachers in the life and physical science classes. In this case boys are brought into leadership, managerial and autonomous power, while girls are taught to be subservient and obedient students/workers as they will continue later in their subordinated work career in the social world. Assuredly, schoolboys and male PST will be motivated into pursuing higher levels of education while girls/ females become disinterested and may not achieve cognitive skills like their male students to negotiate the political and democratic gender spaces for critical insights (Bowles & Gintis, 1976; Deem, 2011; Stromquist, 1990).

Also, I found that science educators, ingrained in power and professional ideals, are resisting the tenets of the curricular and gender debates of affording equal opportunity to all pre-service

teacher at the tertiary level of education. This conforms to the cultural gendered norms of sexism in the broader Nigerian society, which does not envisage a dedicated or explicit political, moral, civic and subversive struggle for gender equality (Alade, 2012; Dibua, 2016; Kemi & Jenyo, 2016). Of course, the Nigerian culture perceives and treat men as superior to women, this is well manifested in the "son preference syndrome" that is prevalent in the Nigerian cultural space (Kemi & Jenyo, 2016, p. 231).

More so, on male pre-service teachers' entrenched preference and superiority consciousness, I found out that, when male pre-service teachers dominate and lead classroom intellectual activities, they are exhibiting power in the form of resistance to gain control of their lives. The male pre-service teachers consciously use power in form of maleness to further subordinate the female pre-service teachers in the class. Of course, female pre-service teachers' act of perceived submissiveness, lack of aggression and quietness is also their way of resisting the dominating act of the boys and the teacher in the class, so as to gain control of their humanity. This act of transformative resistance by the female pre-service teachers resonates with researchers who argue that resistance in school and social space is not act of disobedience nor powerlessness but power for change and transformation, in order to gain individual's humanity (Shor & Freire, 1987; Weiler, 2017). However, researchers' conceived resistance differently then argue that opposition is a disorganised model of resistance to schooling that may lead to disobedience, be destructive, oppressive, then devoid of intellectual freedom and transformation (Barkley 2009; Weiler 2017).

To gain and sustain the individual consciousness of transformation, the origin of gender oppression, domination and subversive acts which revolve around historical and cultural orientations and patriarchy must be challenged. Gender stereotypes are perpetuated and reinforced, thus infiltrating into the social world and science education in form of oppression and domination of both men and women (Adisa, Mordi, Simpson, & Iwowo, 2020; Barrett, 2014; Deem, 2012; Moane, 2010). Therefore, feminist scholars calls this subjugated phenomenon 'similar oppression' because both girls and boys experience oppression in economic class or gender terms during schooling (Arnot, 1984; Barret, 1980). Children from their family backgrounds are socialized to believe that men are superior to women and should always sustain the status quo, being falsely socialized into the idea that they were born to dominate and oppress girls and have better intellectual ability than women in the material world, and in mathematics and the sciences. As adult students and teachers they find it difficult

to challenge and go contrary to the gender-biased family upbringing in Nigeria, because they would always want to be obedient individuals at home, school and workplace, conforming to the societal false consciousness that subordinates females. For example, when pre-service teachers with power pose resistance by using gender and sexual behaviours in the classrooms, science educators and school authorities consciously perceive these acts as stubbornness, defiant and non-conformance to school rules. But do not know that for pre-service teachers and sometimes educators, conscious and unconscious actions are tactical and intellectual abilities to negotiate the schooling process and the social world for economic and personal freedom that were denied to them over the years. Of course, men and women, boys, and girls as agent of change, are not completely ignorant, but have individual gender consciousness to negotiate school dynamics and the social world (Faas, 2016; Freire, 1973; Luter et al., 2017; Parsons & Priola, 2013).

In this regard, I concur with McLaren who argue that:

> The passion for ignorance that has infected our culture demands complex explanation, but part of it can be attributed, as Lacan suggests, to a refusal to acknowledge that our subjectivities have been constructed out of the information and the social practices that surround us. Ignorance as a part of the very structure of knowledge, can teach us something. But we lack the critical construct with which to recover from that knowledge which we choose not to know (McLaren, 2017, p. 74).

In this sense, I argue that ignorance will continue to keep silent individuals such as the subjugated females and the disadvantaged groups as Lesbian, Gay, Bisexual and Transgender Queer, Intersex and Asexual (LGBTQIA) in perpetual oppression and domination for refusing to challenge knowledge system that marginalizes and excludes them from the society and educational engagement.

6.3.2 Assertion 2: Science Educators and Male PST Collude to Stereotype Female Pre-service Teachers in the Classroom

The science educators and pre-service teachers are not exonerated from the act of cultural reproduction of gender stereotyping and subversion in the science classes. It is evident in the study that the male pre-service teachers sometimes collude among themselves and with science educators to stereotype the female pre-service teachers (see section 5.2-5.6.2.5), interviews,

lesson observations and reflections. They show these acts of stereotyping by dominating, leading questioning and taking leadership positions while science educators watch and do not sanction the conscious and unconscious acts of the male pre-service teachers. These boys preconceive that they have better intellectual ability than the females. More so, female pre-service teachers and science educators sometimes are complicit in stereotypic practices amongst themselves. This is done when female PST and female educators perceive that their positions are inferior in the school hierarchical structure and organization within their classroom, as coded by the dominant class. During managerial meetings and classroom engagements, they allow men and boys to contribute or dominate meetings. Why do you allow males to dominate the discussions? The answer is 'the males can do it better." Yet, pretentiously, they argue that what a man can do, a woman can do even better. This uncritical stereotypical action is what I perceived as unconscious self-stereotyping by female science educators and female undergraduate pre-service teachers in education and workplaces. In support, Coffman (2014) framed this lived space as self-defaming practice due to cultural beliefs and ideology. This derogatory perception is driven by low self-esteem, lack of confidence and ignorance of personal power and transformative resistance (Cadinu & Galdi, 2012; Carlana, 2017, 2019). However, the stereotypic and colluding spaces were also reported during interviews, lesson observations and journal sessions thus,

The "male pre-service teachers dominate the female pre-service teachers and sometimes take charge of intellectual activities while I watch"-Tengo. "You know what, the females sometime remain passive during intellectual engagements and allow male pre-service teachers to control class discussions"-Boko. "Someone like me I perceive male pre-service teachers to be intellectually capable than the female PST, so I engage more males than females PST in the class work and even during teaching practice exercise"- Bodam. The male pre-service teachers are socialized to discriminate the females in the school"- Tengo.

In agreement with the above excerpts, critical theorist, critical consciousness and critical feminist reproduction frameworks question and demand urgent explanations as to why production, reproduction and reinforcement of oppression in education is still persisting (Freire, 1972; Jemal, 2017; Weiler, 2017).

Interestingly, I submit that critical theory and critical consciousness have the potential to invoke and create awareness of institutional oppression and then challenge subordinations for

intellectual liberation and economic development. This liberation model is also captured in critical feminist reproduction theorists' argument that resistance, organised political activism and counter-hegemony tactics could be possibilities toward change and transformation of science classrooms. But researchers argue that transformative resistance is an organised strategy for transformation, because males and females could construct and interpret resistance in divers' ways to challenge stereotypic beliefs and practices to ensure epistemic freedom linked to counter-hegemony, subversive strategies and transformative opposition for liberation and democratic engagement in the science classrooms (Weiler, 2017; Giroux, 2017; Portelli, 2018). A participant captured this liberation model during reflective journals, when participant said "I think educators can challenge and free pre-service teachers from discrimination through peaceful means, encouraging and educating the pre-service teachers on the effects of differences but not rejecting school ideas."- Zima. I submit that these strategies could mitigate the multiple oppression females faced in the college.

Also, I found out that science educators who resist non-patriarchal rules at home and school may suffer double oppression that further dominates them. For instance, educators who rejected gender equity awareness and counselling from parents at home and critical intellectual practices during school engagements will continue in oppression due to ingrained historical and cultural stereotypic ideology. Although, I perceive that adopting the equality insights from family and school could emancipate them during schooling and work career. Inspired by a scholar's comment, no one can liberate himself or herself alone, neither will one wait for other individuals to emancipate him or her. Liberation occurs when we appropriate critical skills and engage in work collaboratively, politically to change and transform ourselves for the common good in the complex school space and the social world (Freire, 2018; Giroux, 2010a; McLaren, 2017; Sargis, 2008; Sicher, 1955). In agreement, researchers argue that liberatory education underpins democratic engagement, creativity and transformation for sustainable development (Freire, 1972; Sargis, 2009; Mbembe, 2016).

*With regard to **"how"** aspect, these categories of reproduction and subversion of gender stereotype beliefs and views were elicited:*

6.3.3 Assertion 3: Science Educators use Power of Gender and Sexuality to Negotiate Classroom Discourses

While science educators reproduce cultural, historical, and autonomous powers, they consciously changed the personal to political power to gain control of their lives. This is because of the historical, economic, political and democratic powers that were not visible over the years. For instance, they have little knowledge about their personal power to negotiate positions and gender engagement in the college and the social world. Undoubtedly, science educators using the power and sexuality negotiate science classrooms and the social space to gain control in a contradictory and complex oppressive school environment. This lived space is corroborated by Schwartz (2017) who argued that the personal remains the political for navigating complex social environment such as education. Drawing from Schwartz's argument, I perceive that the personal could also be democratic, innovative, emancipatory and collaborative when invoked to disrupt oppression. I found out that science educators with political and democratic ideals can negotiate school dynamics despite complex structural constraints and multicultural elements embedded within science education sites. As Tengo in this study (see section 5.2) said, if gender equity awareness can be created for educators and pre-service teachers in the college then, they will be properly positioned to re-negotiate complex oppressive school elements and the cultural, social-political world for change and transformation. Further, interviews, reflective and collective journals data reveal the following: We educators and pre-service teachers can come together and form active groups to challenge discrimination in the college-Boko. "Female associations such as in STAN and WICE should be conscious of negative impacts of inequality and then stand up to stop the disease call subordination"-Zima. "Whenever I am in the class teaching, sometimes I distribute lessons equally to pre-service teachers but sometimes I forget"-Dula. "Like in my class, I and the females' pre-service teachers sometimes challenge the male's students using personal power-Nagam. I also found that female science educators and female pre-service teachers suffered from triple oppression and domination from the family, school, and the society. It is evident in this study that the family, community and the college of education convince the female science educators and the female pre-service teachers to produce and reproduce the consciousness of male preference a by fragmenting pre-service teachers into varied social groups based on capabilities, attitudes, and behaviours as well as performance that are rewarded accordingly (Maulucci & Fann, 2016; Oakes, 1982; Wolpe, 1978). In agreement, Bourdieu (1990) lamented

that merit reward systems and gender categorization do not come from natural gifts of individuals but negotiation between higher, lower class accord and educational system. In addition, Bourdieu argues that this pattern of rewards, segment educators and pre-service teachers into different roles for immediate gratification neglecting morals, innovative skills, critical and political insights for freedom and transformation. Also, the performance and immediate reward system devoid of questioning, align with scholars' argument that social injustice thrives in oppressive environment where there is limited capacity for critical analysis, action to challenge domination for emancipation (Freire, 1973; Kessler et al., 1985; McLaren, 2017). As Arnot puts it, both the capitalist regime and men in the social space deliberately refuse women access to political and democratic power for liberation (Arnot, 1982). This is because power is knowledge and can lead to conscious action for emancipation and transformation. Thus, McLaren comments, "ignorance is not a passive state but rather an active excluding from consciousness" (McLaren, 2017, p. 75).

Here McLaren (2017) emphasizes that, when we remain in ignorance, we may probably lack critical knowledge for freedom and transformation. Therefore, ignoring gender equality awareness could lead to further oppression and domination of the subjugated individuals, particularly females in the society generally and in education specifically. In this sense, females and males who have been twisted and are in pain should appropriate critical feminist skills and political gender pedagogies using their class, sexual stance, and gender dynamics to navigate complex social world, for transformation and social justice for peace and progress.

6.3.4 Assertion 4: Science Educators Display Agency and Communality and have Potential to Enhance and Accelerate Transformation

The data reveals that science educators can change and transform their colleagues and pre-service teachers for good. That is, science educators have inherent personal power to transform both pre-service teachers and colleagues on gender inequality and stereotyping. They show these when they sometimes resist male pre-service teachers from dominating intellectual activities in the science classroom (see sections 5.2 & 5.8). Also interviews reveal the following data: "We educators and the students can change discrimination in the class rooms-Nagam. "Educators have the power to drive change and transformation"-Bodam. "I am transformed by this study"-reflective journal. "I think educators and students are agents of change"-collective journal." "We can transform the science classes for equity"- Nagam. Educators and the pre-service teachers could invoke their resistive potentials to challenge stereotypic practices in

education"-Tengo. Science educators extended the transformation praxis and act of morality to other science educator colleagues as well. With their colleagues, sometimes they caution them not to engage in sexual activities with pre-service teachers, the main reason being that it could affect the cognitive and emotional wellbeing and intellectual performance of the pre-service teachers and would constitute the uncontrolled abuse of differential power relationships. Hence, the civic, moral and ethical integrity of the teaching fraternity will be questioned, including themselves as upright educators. In agreement, scholars argue that stereotypical practices affect the cognitive ability of individual females who experience it, mainly because it cuts off the flow of cognitive information for intellectual reasoning (Alan, Ertac, & Mumcu, 2018; Grunspan et al., 2016). This means that stereotypes undermine intellectual performance by reducing memory capacity. I also found that science educators as agents ingrained with power cautioned their colleagues not to stereotype their pre-service teachers during classroom engagement and outside the classroom. Based on the Nigerian policy guide and theoretical debates on gender equality, these pre-service teachers have cognitive abilities and equal rights and should be treated equally. I found that a male science educator (Bodam) and a female science educator (Zima) may have displayed agency and assertiveness to voice out equality in form of transformation and moral freedom (see sections 5.2 & 5.8.). Also, interviews with educators captured the following: "Well, sometimes I change and transform male and female students in the class"-Zima. "Some female pre-service teachers were happy when I advised and changed their perception about relationship with staff members"-Tengo. "Even the boys dominate the female pre-service teachers but I challenged and transformed their beliefs and perception"-Nagam. This resonates with the work of critical scholars who argue that transformation, equality and liberty can only come when men and women collaborate and engage in transformative discussions. Thus, they have no passion for ignorance on gender equality issues but develop appropriate critical skills to contend with injustice and domination in the complex schooling environment and the social world (Alexis, 2016; Apple, 1982, 2017; Shor, 2012). In agreement, Freire (1972) argued for critical skills frame work to liberate oppressed educators and pre-service teachers through invoking their critical consciousness as agents and transformers as proposed by (Diemer, 2016). This concern further aligned with the critical feminist reproduction understanding that, when we put women as communal and agentic beings at the centre of analysis, it will foster change and transformation. Lather sheds light on this point:

> Adopting gender as a basic analytical tool will enable critical theory to see what is right under its nose: the possibilities for fundamental social changes that open up when we put women at the centre of our transformation (Lather, 1984, p.52).

*With regard to **"why"** aspect, these categories of reproduction and subversion of gender stereotype beliefs and views were elicited*:

6.3.5 Assertion 5: Colleges of Education are Complex and Contradictory Terrains for Teaching and Learning of Feminism Practices

Colleges of education and schools have been characterized with contradictions and complexities due to intersection of gender, sexuality, patriarchy and historical ideology that dominate science educators and pre-service teacher's mind-set to discriminate, reproduce and thus stifle gender equity, morality and transformative learning (Mclaughlin & Black-Hawkins, 2004; McRobbie, 1978; Zuze & Beku, 2019). This concurs with Apple's assertion that:

> Schools are engine sites of democracy, an embodiment of cultural, historical dangers, institutions who's curricular, teaching and learning practices threatens the moral universe of students who legitimately attend them (Apple, 2017, p. 77).

Within the college and school environments, there are crises that make political, critical skills moral and democratic principles difficult, due to the imposition of commercial pressures for profit-making and certification, because academic disciplines, curricular practices, assessment scores and research are politicized and valued in terms of market outcome and material gains and certification for work placement rather than critical innovative skills (Giroux, 2017b; Raymond, 2019). In the physical and life science classes, complexities and contradiction exist due to the sexual, gender, class, and patriarchal elements that are underpinned historically, culturally, economically and politically. In the web of these contradictions, science educators sometime reproduce stereotypic beliefs and practices, then navigate and re-negotiate the gender dynamics to gain control of their lives. In this sense, I found out that science educators in the college where the study was conducted negotiate and re-negotiate the dynamics of male dominance and submissiveness of female pre-service teachers, challenging the hegemonic tendencies of the college authority. For instance, Dula during interviews said "teachers can navigate discriminatory college structure to help pre-service teachers to learn." Educators were observed challenging male pre-service teacher's dominance during engagement-lesson observations. In addition, Tengo commented that "I have been teaching just like that without

checking and balancing my interaction with boys and girls in the class." The "reflection session is ok because it made me to think of how teachers and students can reproduce and subvert gender stereotyping for transformation of complex science classes"-Dula. "Patriarchy, history and religious tenets combine to influence educators' engagement"-Boko. "Science class rooms are complex due to gender, patriarchy, political and cultural ideologies"- Nagam.

Though many factors such as patriarchy, gender, professional experience, beliefs drive discriminatory practices during class engagement, educators can challenge these indicators to free pre- service teachers attain gender equity and feminism consciousness-collective journals. In agreement Freire (1972) argues that oppression in a contradictory space could be subverted if the oppressed such as the educators and pre-service teachers and the oppressors as authorities/ managers appropriate emancipatory consciousness. Also, Diemer (2016) concurring with liberatory model, conceived critical consciousness as a frame work that has the potential to invoke the consciences of the oppressed educators and pre-service teachers for change, development and transformation. In addition, Jemal (2017) argues that critical consciousness has the potential to equip science educators for professional development and science identity linked to equity and freedom.

I also found out that both male and female science educators who perceived domination and oppression in the institution used their personal power and professional identity to pursue struggles to negotiate the college political setting to gain control of their lives. This is revealed by Tengo and Zima, who are currently a departmental head and the deputy provost in the college (see sections 4.7.8.2 & 6.3.8). Their political, democratic and moral struggle was initially individual but changed to become collective and political action, as advocated by critical feminist theorists (Butler, 2011; Sánchez-Pardo, 2017; Welch, 2019). Though these partial struggles afforded some of them to rise to heads of departments and deanship position, some of them also strived toward being the provost (rector) of the college in the future. I discovered that when science educators are entangled in a web of college complexities, they should invoke their autonomous power, then navigate and re-negotiate using autonomous personal and collective political power to gain control of their lives and that of their students and colleagues for gender equity and transformation. Friends, "so we all bring, culture, identity, economic ideology of preference and norms of strong man and weak woman to science classroom"-Nagam. "Hopefully educators and our students will experience change and

transformation in the class- Boko. “So, women can use sexuality and power to resist or get things in society and the college”- Dula.

Therefore, science educators as agents of change could redefine their personal struggle as a political force and re-negotiate the politics of complex schooling by subverting the ideological and gender norms that are produced and reinforced in colleges of education curriculum and school structures to gain control and give meaning to their existence. This view resonates with Sargis’s theorizing that:

> Learning could only take place in an “environment free from ambiguous values, beliefs, morals, of the dominant social paradigm that oppress and dominate” (Sargis, 2008, p. 66).

More so, in this ambiguous sphere, there are possibilities for growth and transformation that science educators can utilize in tertiary education in Nigeria to come out of false consciousness coded by the practices of elites and dominant capitalist class for emancipation and transformation. More so, they could organize a collective struggle through media houses and non-violent means such as peaceful collective struggle to express their concerns, non-violent so as not to suffer from further oppression or neglect from the government, college authority, society, and the family. The politically envisaged space was captured during interviews and reflections with educators thus: “Females can form groups and subvert stereotypic practice in the college and their community”-Zima. “Males and females in the college could come together as political force to challenge oppression of females”-Boko. “Female educators in the college could unite with the pre-service teachers to democratically and politically form activism frame works for emancipation and transformation due to oppression”-Nagam.

It is worth noting that the university, colleges of education, schools and social ecological spheres have been criticized for perpetuating gender stereotypes and domination (Figueiredo & Siqueira, 2020; Fleming, 2020). While schools lack feminist critical skills and pedagogies that will provoke the autonomous and political consciousness of science educators and students during teaching and learning, there are opportunities and possibilities for gender transformation. As espoused by eminent scholars in feminism and political freedom, there exist critical gender possibilities within the complex and contradictory school structure that can be infused into education for transformation in the new gender order (hooks, 2010; Lather, 1984a; Shor, 2012).

As Shor signifies, “critical teaching should be aimed at change and empowering skills” (Shor, 2012, p 2).

6.3.6 Assertion 6: Schooling Processes Contain Moral and Ethical Ideals in Developing Gender Equity

Morality and ethics connote a civilized way of negotiating the school space and the social world (Steinberg, 2020). Therefore, fusing religious, political, moral, and ethical ideas could equip science educators and pre-service teachers with skills to rethink gender classroom spaces. For instance, in South Africa the term “ubuntu” is considered as an ethical orientation toward a just society; in Nigeria ‘Iwa’ means good character, while Zimbabweans conceptualize the word “lokileng” as good behaviour linked to religion that help people live harmoniously. Thus, African morality values and principles derive from religion, implying that African morality is, thus a religious morality that helps transform the continent for equity and a justice society (Idowu, 1962; Molefe, 2019; Sarpong, 1972). A chaotic environment breeds violence that could impact negatively on the teaching and learning of science (Dennise, 2010; Sanger, 2008; Wallace & Walker, 2020; Ye & Law, 2019). However, if science educators, pre-service teachers and other students embrace humility, endurance and commitment and a sense of honesty during teaching and learning, then the role of moral and ethical values in education can be further enhanced and form an integral part of daily teaching and learning of good moral such as ‘nnoboa’ in Ghana (Opoku 1978; Sarpong, 1972).

As Wallace puts it,

> Moral views are different from political views, moral beliefs from religious beliefs, and moral judgement from aesthetic values (Wallace & Walker, 2020, p. 2).

More so, ethics and morality, political and democratic elements if enacted and appropriated will equip science educators with critical feminist awareness to negotiate and re-negotiate gender classroom dynamics in contradictory science school spaces. This aligns with critical feminist theorizing of politicizing and democratizing the classroom by evoking the critical feminist counter-hegemony work which encompasses students’ oppression, opposition and critique of existing society and science education for equality insights (Freire, 2018; Weiler, 2017).

As Lather puts it:

> The task of counter-hegemonic groups is the development of counter- institution, ideologies and cultures that provides an ethical alternative to the dominate hegemony, a lived experience of how the world can be different (Lather, 1984a, p. 55).

I found that in the physical and life classes at the college in Nigeria where the study was conducted, science educators with ingrained moral and ethical ideals, resisted and created awareness of sexual exploitation and oppressive activities on their fellow colleagues and PST in the class, even though they lack an explicit consciousness of ethics and transformation. For instance, Bodam during collective journal engagement said "I advised the female pre-service teachers to be careful with male educators who made discriminatory relationship advances." "I asked the female PST playing with the male PST in the class to leave her seat and sit close to me for observation and monitory"-interviews. In one of the lessons, I informed all the pre-service teachers to be decent and civic in all engagements-reflective journals. In this sense, educators subconsciously transmit citizenship and moral ideals to both male and female pre-service teachers in the class which I perceived, could enhance peaceful co-existence and harmony inside and outside the science classrooms. Their subconscious endeavour could further facilitate the teaching process and motivate pre-service teachers to learn and adopt a new and active transformation gender order embedded with good behaviour. In agreement, researchers argue that moral, religious and civic values have the capacity to drive peace and freedom if properly appropriated in a stereotypic and violent environment (Sarpon, 1972; Ye & Law, 2019). On the contrary, Wallace & Wallace (2020) argue that moral beliefs and judgement differ from religious and political beliefs and views, but I argue that both elements could work together to enhance transformation, peace and harmony in a complex environment such as science education.

6.3.7 Assertion 7: Science Educators Re-negotiate Complex Sexism and Classroom Dynamics

The questionnaire, classroom observations, reflective journals, collective journals and interview data reveal that gender, sexuality, and patriarchy influence what goes on in the teacher college of education. Therefore, science educators in the complex and contradictory college space negotiate and re-negotiate to gain control and appropriate better condition for

themselves and their PST. This goal can be achieved better if science educators reflect on the powers of cultural production and reproduction and then re-negotiate the classroom gender dynamics that inform the dominant school practices and curriculum. For instance, I found out that science educators who embraced feminist practices in the science class boost the girls' confidence, by informing them to be aware of the subtle limiting gender habits perpetuated in the class. The encouraging words motivated the PST to learn about how gender practices could influence their behaviour, critical skills and thought processes. Also, interviews and collective journals data revealed the following: "Hi females concentrate during class engagement and do not allow male educators and pre-service teachers limit your abilities, you can perform and achieve even better"-Zima. "Class, let me tell you something, during my postgraduate studies, a young girl of about 25-26 years in the class out performed all the boys for three good years. I am intelligent, but this girl was wonderful and knowledgeable in organic chemistry. Right from primary through postgraduate studies and as an educator, I have not met an intelligent girl in my life like Fandi"-lesson observation-Nagam.

However, while the science educators subvert male pre-service teachers' sexist actions who consciously dominate the female pre-service teachers, the boys are demotivated to learn, yet female PST' interest was enhanced. This apparently contradictory and encouraging practices possibly occur elsewhere in society too. In agreement, Ekine (2013) argued that girls' interest could be enhanced through participation and diverse learning opportunities in a complex gendered environment. On the contrary, some critical theorists argued that the oppressed females and the marginalized groups can be liberated from contradictions through critical, democratic and collaborative knowledge systems that is empowering. The empowerment and freedom can be possible through critical consciousness model and critical theory which focus is to create awareness for change, freedom and transformation (Diemer, 2017; Freire, 1972; Giroux, 2020). This transformation model is re-echoed by critical feminist reproduction theorists whose interest is on counter-hegemony tactics, political activism and advocacy for freedom in schools, community, home and family clusters (Butler & Spivak, 2015; Deem, 2012 Weiler, 2017).

Quite interesting is the fact that women/ girls who were faced with triple oppressive forces in the family, science educators and male PST in the college, negotiated the classroom constraints by appropriating confidence, independence, then controlling themselves and refusing to be influenced by others at home and school. For instance, Zima during interview engagement said

“I refused working with my father, mother and sisters but farm with boys at home.” This attitude resonates with Valerie and Parmar (1981) study on girls of colour who made it clear that they do not want to be controlled by others but wish to control their own lives for the future and for self-determination later in life (Fuller, 1980, p. 127). Similarly, in my study, the science educators negotiated and re-negotiated cultural production and reproduction using human agency and resistive power as central components in their lives to bring change and transformation. I would critique Wolpe in this regard, in that she accounts more for the reproduction of gender at an abstract level of economy and structural analysis rather than at the level of human agency and resistive power. This focus limited her sense of how human beings could be social agents of change and transformation with the potential to influence the hidden curriculum that stifles student curiosity and critical thinking (Clark, 2016; McLaren, 2020). Therefore, educator’s potency as agents of resistance and change is re-echoed during reflective journal thus: “educators as agents have the power to change discriminatory and stereotypic beliefs and actions in the classroom”-Nagam This was also captured during collective reflections as revealed by educators thus, “I don’t know that I was discriminating females until I observed my video engagement with the students in the class.”- Bodam. Another science educator Boko said, “during and after teaching, educators should endeavour to video watch their engagements with pre-service teachers to change and transform stereotypic practices, because they may stereotype consciously and unconsciously.”

*With regard to **“why”** aspect, these categories of reproduction and subversion of gender stereotype beliefs and views were elicited:*

6.3.8 Assertion 8: History, Culture, Political Power, and Hidden Curriculum Influence Sexism in the Classroom

It is argued that all social relationships such as cultural, historical, political, economic, religious and educational engagements are power relationships that deliberately dichotomises gender roles in the society (Weedon, 1987; Hoffmann & Stake 1998; Mouffe, 2014; White & Hailwood, 2020). Therefore, the hidden curriculum enacted in education has powerful cultural, and political gendered messages that could influence science educators’ and pre-service teachers’ classroom engagements.

In this sense, the hidden curriculum promotes negative messages that are produced and inscribed into the students’ unconscious behaviour and that produce unintended outcomes

during teaching and schooling interactions. This is because schools influence students both through standardized learning situations, information and enforcement of rules. The school also determines the conduct, classroom management and the informal pedagogical procedures acquired and used by teachers with specific groups of students. This presupposes that the hidden curriculum includes teaching and learning styles that are emphasized in the classroom, the messages that get transmitted to boys and girls in the class and physical environment, governance, teachers' expectations and grading procedures enacted within the school space (McLaren, 2017; Mirza, 2004). Therefore, the instrumentality of the hidden curriculum historically, culturally and politically constructs knowledge and behaviours for pre-service teachers and science educators outside the normal course materials and formally planned lessons. It is a part of the managerial and bureaucratic 'press' of the school and the combined forces by which educators' and pre-service teachers are induced to comply with dominant ideologies and social practices related to authority, behaviour, and morality. For example, does the college authority expel school offenders or just verbally reprimand them? Is the ethos of the administrative office inviting or disinviting? Is there any cordial relationship and respect between management, educators, and pre-service teachers? (Barthes, 2018; McLaren, 2017; White, 1983). For instance, Bodam, during interviews said "sometimes the curriculum is not clear on equality content, so we teach pre-service teachers based on what we understand about equality." "Yes, though equality is inscribed in the national policy on education / Nigerian constitution, no adequate implementation and critical supervision due historical, cultural, religious, economic and political ideologies that are deep rooted in the minds of Nigerians, policy makers and government officials"-Boko. "Both the planned curriculum and the hidden curriculum are historical, sociocultural, economical and politically positioned." So, I think, with this awareness, it will be easier to reform and transform the hidden curriculum model embedded with entrenched discriminatory gender beliefs and practices in education"-Tengo.

Therefore, the hidden curriculum sometimes displaces the planned educational ideals and goals of the classroom teacher or the school towards gender equity. An example of the hidden curriculum practice occurs when teachers sometimes, consciously or subconsciously, give more intellectual attention, praise, and academic help to boys than girls. For instance, the questionnaire, interviews, lesson observations and reflective journal snippets reveal the following: "Due to history and socialization process, I interact more with male pre-service teachers than female's pre-service teachers"-Zima. "Most of the time, I support the male pre-

service teachers than female PST due to cultural and political beliefs I had in my environment over the years"- Dula. "Sometimes, more male pre-service teachers get my attention because they are active and more committed to intellectual activities than female PST-reflective journal"-Bodam. "Sometimes, I use male pre-service teachers to complete my lesson on time-questionnaire"-Boko. "Male pre-service teachers volunteer answers; hence science educators sometimes give more attention to them than females' pre-service teachers during engagement" -lesson observations.

This is also evident when administrators and teachers were shown a classroom film of garrulous and gossipy students; the teachers consciously chose females to be more talking, even though the boys in the film out talked the girls at a ratio of three to one (Clark, 2016; Erden, 2009). My study also shows that science educators have skewed perceptions of gender and are biased and behaved differently depending on whether male or female pre-service teachers responded during classroom engagement. Undoubtedly when males called out comments and asked questions without raising their hands, educators accepted their answers with joy and the male pre-service teachers are motivated, but female PST, however, are reprimanded for the same behaviour and consequently their interest in learning is affected as they become emotionally depressed and excluded from critical intellectuality. The subordinated female PST' space is also elicited during interviews and reflections thus, "I engage male pre-service teacher's more than female pre-service teachers because they are physically stronger, based on historical, socio-cultural and gender ideology"-Nagam. "In fact, I use male pre-service teachers more because they complete class activities faster than female pre-service teachers, this I have experienced right from youth age, school and in the community work"-Tengo. "Due to history, religion and patriarchal beliefs in politics, higher positions such as president, governor, head of parliament, chairmen of boards, and bursary heads are prioritized for males, while females are encouraged to occupy lower positions such as secretary, deputy provost, deputy vice chancellor, deans, heads of departments, head of catering services and sometimes health departments, these have influenced my beliefs system and views to favour male pre-service teachers in the class"- Nagam.

In this sense, the hidden message is that the males should be academically aggressive, assert power and dominate learning, while females should remain composed, passive, and submissive and powerless (Blumberg, 2008; Lo, 2015; McLaren, 2017; Okeke, 2012; Yanowitz & Weathers, 2004). The stereotypic scenario captures researchers' argument that more teachers

are likely to give male students detailed instructions on how to do things for themselves, while the same teachers are more likely to do the task for females instead, because they perceive females PST as weaker individuals. More worrisome is the idea that male learners are taught independence and the female's dependency (Labuschagne, 1995; McLaren, 2017; Menon, 2020; Sadker & Sadker, 1985).

Therefore, I found out that classroom sexism ideology is a function of the hidden curriculum which results in conscious and unconscious granting of elusive power, privileges, and freedom to males PST over females, and boys over girls, which has been preserved and re-enforced in the social-cultural space and science education teacher college over the years. With this awareness, I began to perceive the hidden curriculum with suspicion in entrenching the domination of females and thus focusing on the affluent children, for example rich kids/PST, neglecting the minority and the oppressed in the college of education in Nigeria. This is in agreement with critical feminist reproduction insights which created awareness about educational ideology and the schooling process that not only produce and reproduce economic gender roles, but reinforce, sustain and unapologetically induce educators and particularly females PST to accept stereotypic practices devoid of critical questioning (Deem, 2012; Butler & Spivak, 2015; hooks, 2010; Weiler, 2017).

Arguably, most science educators insist that they are not sexist, though sometimes are induced to conform to the current educational and social contexts. There are sometime forces of the hidden curriculum that continue to operate against them which could be traced to the history, culture, economic, politics and prescriptive nature of the overt school curriculum (Fitzclarence & Giroux, 1984; McLaren, 2017). An Australian educator, Doug White, calls the hidden curriculum the multinational curriculum. He insists that:

> The multinational curriculum is the curriculum of disembodied universals, of the mind as an information-processing machine, of concepts and skills without moral and social judgement but with enormous manipulative power. The curriculum proposed the elevation of abstract skills over content, of universal cognitive principles over the actual conditions of life (White, 1983, p. 77).

Inspired by White's assertion, scholars argue that no curriculum policy or programme is ideologically or politically innocent and the construct curriculum is inextricably related to class, culture, history, gender, sexuality, and power relations (Arnfred, 2011; Fitzclarence & Giroux,

1984; Smith & Zantiotis, 1989; Weiler, 2017; White, 1983). Certainly, teacher education does not preclude these elements of hegemony linked to gender class and sexual powers. However, not all values, attitudes, or patterns of behaviours, for example, antisocial behaviour in form of resistance and the use of sexuality for certification, which are by-products of the hidden curriculum in educational contexts, are primarily bad. The issue here is to critically identify the political, structural, historical, economical and instructional gender assumptions upon which the hidden curriculum rests and to deliberately attempt to change institutional arrangement of the classroom as to offset the most undemocratic, dominant, oppressive, and political consequences for transformation (Freire, 2018; McLaren, 2017).

I concur with researchers who argue that no curriculum is politically and democratically free from biases, because the hidden curriculum has the power to induce the behaviours of both teachers and students towards the capitalist agenda (Hooks, 1996; McLaren, 2020; White, 1983). Thus, while sexism, class, politics, history, economics and patriarchy are characteristic of the hidden curriculum, both science educators and pre-service teachers must rethink the gendered classroom practices and the social world that allocate more power to males than to females and deconstruct the curriculum and gender practices that are reproduced and sustained in colleges of education and universities then articulate higher reality for transformation (Blumberg, 2008; Freire, 1972b; McLaren, 2017). In agreement with the opinions of researchers on reproductive nature of the hidden curriculum, Shor (2012), reconceptualising the school curriculum, laments that the policy guide is deficient because it transmits rules and knowledge from teacher to students, thus stifling students' curiosity, emotional and political powers for critical thinking. This because the curriculum designers ignore questioning the school practices and the society in which it is produced and reproduced. More disturbing is when students tend to be autonomously critical and ask questions or pose resistance to intellectual activities during schooling, then the students are considered defiant and labelled rude by teachers and school authorities, who further their domination as uncritical beings rather than emancipating and transforming them. Echoing Paul Freire's idea on domination, Shor comments that,

> Education that tries to be neutral supports the domination of ideology in the society. And no curriculum can be neutral. All forms of education are political, because they can enable or inhibit the questioning habits of students thus,

> developing or disabling their critical relation to knowledge, schooling and society (Shor, 2012, p. 22).

Therefore, I perceive that female are aware of rejecting the ideological message of the school and the social world that try to threaten their human existence by negotiating and re-negotiating the knowledge linked to their intellectual, emotional and material needs, despite the ideological message of the school curriculum, which cautions them that their proper place is at home to do domestic work. In recognition of this, feminist thinkers argue that

> While the women may not necessarily incorporate all "school knowledge" it should not be taken by any means to deny what school knowledge in fact is or its attempted transmission in the classroom. Rather, it is to point out that within the classroom sets of knowledge renegotiation and /or active filtering occurs that may counter what the schools consider legitimate. How this renegotiation occurs we do not know, yet there is ample evidence to suggest its existence (Kelly and Nihlen, 1982, p.175).

In this study, subversion and transformation occurred when educators challenged the dominance of male pre-service teachers using transformative resistance thus:

"Females, you can do even better than the boys, if you pay attention and are committed - lesson observations"-Tengo. "Girls and women each one of you have the capacity and ability to excel academically. "Look at me and my position as deputy provost, then former deputy provost and acting provost they were female educators in the college"-Zima. "Do not allow male pre-service teachers and educators to dominate you in the class, you can challenge their historical, economic, religious and political discriminatory gender beliefs to liberate yourselves and perform better"- Boko. Of course, "the females can form political groups, associations and then organise workshop to create awareness to challenge historical and sociocultural stereotypic practices and beliefs of educators and male pre-service teachers in the class, college and then extend same equality framework to their community"-Nagam. "I challenged the males to allow females participate in the class. I told the males not to bring cultural, patriarchal and religious discriminatory ideology to the class but engage equally with females- reflective journals"-Dula. Although disorganised resistance has been questioned by critical feminist theorists, counter-hegemony, subversive and political actions, including transformative resistance have the

potential to enhance change, emancipation and freedom (Giroux, 2020; Portelli & Eizadirad, 2018; Weiler, 2017).

The acts of resistance as cultural production and the construct of counter-hegemony as discussed in the eight assertions above are heuristic devices used to present the research work for understanding of what goes on during schooling and educative process.

CHAPTER 7
IMPLICATIONS EMERGING FROM FINDINGS, ASSERTIONS AND DISCUSSION

INTRODUCTION

In the previous chapter, I discussed social reproduction theory, liberal feminist theory in contrast to critical feminist reproduction theory, illuminating the deceptively oppressive economic elements in education and the social world that subordinate women. Then an account of major assertions was done. The account provided answers to the three research questions. Then it illuminated the contradictory college space, as well as the potential for change by science educators and pre-service teachers in education.

In this chapter, a critical analysis of the study data and findings reveals that feminist teaching with counter- hegemonic insights could provide the possibilities for both science educators and PST to be aware and take actions on the entrenched oppressive mechanisms in the college of education. This will assist them to negotiate and renegotiate stereotypical science education classrooms that would enable them to pursue economic, political and collective intellectual transformation for social development. This is because, in the contradictory science education space, educators and PST have power, and where there is power there is oppositional consciousness for liberation for economic growth and peace in a social justice environment. Therefore, the six assertions herein, highlight and serve as mitigation strategies for stereotypic beliefs, views, practices and then the three research questions mentioned earlier.

7.1 COUNTER-HEGEMONIC AND OPPOSITIONAL CONSCIOUSNESS IN THE SPACE FOR FEMINIST-TEACHING

Counter–hegemony is critical and politicised work in form of organised and conscious collective oppositional actions (Weiler, 2017, p. 290). This entails the re-creation and awakening of a self-conscious analysis of complex situations by organizing and developing collective practices that can oppose the hegemony of the social order. This account agrees with critical consciousness and critical feminist reproduction theorists that highlight critical awareness and collective political activism for intellectual and political liberation. This will build a conceptual base for understanding and new possibilities for change and transformation of the society. Feminists appropriated this concept to construct feminist counter-hegemonic

teaching to negotiate classroom gender dynamics to balance the curriculum and rethink social oppression (Lather, 1984a; Spanier, Bloom, & Boroviak, 1984). This construct ties method and theory aimed at critiquing oppositional practices in the schooling of boys and girls (Sandoval, 2013; Schniedewind, 1981). Though schools as well as colleges of education are entangled with constraints and complexities, I perceive that feminist counter-hegemony as oppositional consciousness has the transformative, democratic and political potential to reposition science education. Drawing on Freire's idea of contradictory school space, Weiler has this to say:

> Critical teaching in a dominant institution means that teachers are constantly living a contradiction. But, possibilities for critical work exist within that very contradiction (Weiler, 2017, p. 291).

Therefore, teachers must not only understand the structural constraints and complexities under which they work, but also the potential inherent in teaching for transformative, personal and political work. Therefore, a feminist critical perspective can be a source for counter-hegemony while PST resist hidden and distorted modes of cultural production and reproduction. The creation of counter-hegemony as a repertoire of their critical teaching can provide fertile grounds for analysing how modes of cultural production and reproduction are displayed by subordinate groups. This can be analyzed to reveal the limits and potential for critical thinking and new possibilities for change and transformation of students and subcultural groups' resistance (Giroux, 1983a; McRobbie & Garber, 2002; Weiler, 2017). School sites can be the right environment for feminist teachers to raise issues of sexuality, gender and patriarchal oppression in order to renegotiate gender knowledge in the classroom. Schools or colleges of education can serve as progressive forces by introducing ideas of women movements to girls and remind them of the inherent structural limitations and oppression they encounter in the school and social world. This is because, schools and social spaces reproduce women and girls' oppression in paid work force and unpaid domestic work. Because of the inferior position of females in the economy, the underperformance of girls is tied to sexist texts and discriminatory practices perpetrated and reinforced in schools (Deem, 2011; Giroux, 1983a; Mahlomaholo, 2011). For instance, the school intentionally and sometimes out of ignorance or omission marginalize, discriminate against and stereotype girls. Teachers are highly complicit as they occasionally create self-doubt and sustain it amongst female students. Sometimes through non-verbal cues, antisocial and negative signals emitted by educators, the female pre-service

teachers marginalized are demotivated and thus have low self-efficacy to learn (Atomatofa, 2019; Mahlomaholo, 2011).

Aligning with the consciousness of discursive knowledge in motivating and promoting females and marginalized students' interest in science classes, I draw on the idea that curriculum should be democratized by reorganizing the knowledge to favour the disadvantaged and marginalized. This means that power and intellectual engagements in science education should be distributed by science educators equally amongst female and male students in the classrooms. This may likely provide possibilities for collective, democratic, political and peaceful discussions. For instance, in Sweden, equality is put in place in education, political and business spheres because men and women, boys and girls are perceived to have equal values and rights in Swedish society (Nyström, Jackson, & Salminen Karlsson, 2019). This has mobilised support for the politicization, civility and equality of schoolteachers, educators and students with regards to gender and structures of powers inherent in education and economic sphere (Apple, 1982, 2017; Kessler et al., 1985). This equality epistemology likely will create affordances for both the teachers and students to see *oppositional consciousness* as a vital component of teaching and learning, hence build transformative resistance in a gendered environment for equality. This re-awakening of consciousness will make students and teachers realize the forces acting upon their lives that threaten their individual and collective existence. Therefore, feminist conscious teachers can in turn be positioned to contribute to constructing this "alternative vision" of social reality and moral justice connected to critical feminist struggles by interrogating historical, economic, political and cultural ideologies of oppression (Weiler, 2017, p. 291). Scholars' critique on male critical educational theorists who overlooked feminism as a powerful force can challenge the status quo through women's studies courses and critiques of sexist texts and practices that could give a boost to feminist counter-hegemonic teaching in education (Hartsock, 1983; Lather, 1984b; Weiler, 2017).

As Lather expresses it:

> Adopting gender as a basic analytical tool will enable critical theory to see what is right under its nose: the possibilities for fundamental social changes that open up when we put women at the centre of our transformation (Lather, 1984a, p. 52).

Echoing Gramsci's view that revolutionary theory must be grounded in political struggle for change and transformation, Lather argues that feminist theory and women's movement are coherently grounded in the struggle to make the personal political for transformation. Therefore, critical feminism could provide the lens for the personal and public to create revolutionary politics in school and social world in accelerating gender transformations (Lather, 1984b). But contrary to Gramscian concepts of counter-hegemony and resistance, feminists argue that resistance is usually perceived as unofficial, disorganised and apolitical while counter-hegemony is a critical theoretical understanding as well as an organised active political opposition (Lather, 1984b; Mayo, 2017; Weiler, 2017). More so, Weiler, drawing from Connell, argues that:

> The doctrine that tell teachers the schools are captive to capitalism and exhorts them to get on with the revolution outside, could not be more mistaken; it is teachers' work as teachers that is central to the remarking of the social patterns investing education (Weiler, 2017, p. 297).

Therefore, in my view, the starting point of counter- hegemony is the world of science educators and pre-service teachers, and for them to challenge gender oppression historically, socio-politically and democratically in order to appropriate alternative values system in the existing dominant society. There is a need to position ourselves as conscious critical feminist teachers to understand the complex interwoven relationships of power, gender, patriarchy and sexuality in schools and colleges of education. More so, to act brazenly at whatever sites we find ourselves to embrace and encourage opposition to oppression in science education and the building of counter-hegemonic practices through critical understanding. This means the creation of counter-hegemonic classroom spaces with power sharing as a critical and democratic zone for dialoguing and collective engagements for economic, political and social transformation. Therefore, critical scholars, political and democratic feminist teachers, male educators, parents and students from their multiplicity of lived histories, social-economic contexts and diverse voices can rethink their world in line with the liberation mandate of critical theorists (Bell, Meriläinen, Taylor, & Tienari, 2020; Giroux, 1983a; Javaid, 2020).

7.2 SEXUALITY DETERMINE GENDER RELATIONS RESULTING TO GENDER ATTITUDE IN COLLEGE

Sexuality in form of actions have been found to influence what goes on in the college of education and during schooling process. Gender relations defined by the society for men and women are not biologically constructed but they are too naturalized and fixed within social relations that reinforces dominant formations of gender and sexuality in education (Abdulloev, Gang, & Yun, 2014). Hence from our arrival into the world, hegemonic and universal notions of gender and sexuality constrain and oppress frequently, thus, silencing alternative ways of being human. This render 'moral' and common-sense the subordination of women and the enactment of compulsory heterosexuality in the society and academic endeavour (Giroux, 1983a; Stromquist, 1990; Sultana, 2010; Ye & Law, 2019).

Researchers argue that sexuality inform of sentiments and behaviours shown by adolescence during schooling could be pervasive. This leads to further oppression and domination of themselves, when they reject coded official ideological messages inscribed in the curriculum that oppress them or threatens their existence during schooling (Fine, 1988; Lees, 1986; Mkwanazi & De Wet, 2014). However, sexual actions and gender could be displayed to gain control of their lives in an oppressed and subjugating society. For example, girls can use sexuality and power to manipulate and to pass examinations and get certification in order to gain control of their lives in the future and to appropriate self-determination in an oppressive social world. For instance, excerpts from educators demonstrate their sexual powers to navigate classroom dynamics: "science educators could change personal power into political to challenge oppression in the classroom"- Zima. "Educators' sexual stances could influence classroom gender engagement"- Boko. When we collaborate, discrimination can be challenged in the science classroom"- Nagam.

In this study female PST' conscious assertion of physical maturity and refusal to participate in class lessons activities and questioning could be a form of transformative resistance to counter what happens in the political, historical and cultural contexts they lived. Therefore, the act of reluctance by the females to participate in intellectual engagements by triggering aggressive use of sexuality becomes a form of power to gain control of their personal lives and identity as science pre-service teachers. I perceive this act as females' resistance consciousness to male dominance when personal power is changed into political struggle for intellectual and economic

emancipation and freedom, which has been the driving force of critical consciousness and critical feminist theorists (Deem, 2011; Wangi, 2020). These acts could be female's resistance to male dominance. Similarly, female science educators used their sexual emotions, actions and gender stances to exercise power while at home with their spouses and/or parents. In this study, two female educators' refusal to be treated in the traditional role of girls as farmworkers with their mother reflects their assertion of power. These two female science educators displayed resistance in form of power to gain control over their private life. Not surprising, the same educators brought their assertive behaviours embedded in their subconscious mind to the class to subvert males' attempts to dominate females in the class. Female science educators also try to boost girls' attitudes and confidence towards learning as they encouraged the female PSTs to learn when demotivated. The science educators displayed contradictory behaviours of working with boys in the farm they strengthen boys' confidence and dominance in the class further. This is because at home the female science educators displayed power to reject mothers' offer to work with them in the farm. While in the college, they used the same power sometime to stereotype, motivate and boost female PST' confidence and challenge boys' dominance in the life and physical science classes. This act of encouragement and challenging pattern, I perceived could be historically, religiously and politically motivated due to entrenched subordination of females.

7.3 PERSONAL POWER AND PRIVATE INTERSECT WITH PROFESSIONAL WORK TO DICTATE CLASSROOM PRACTICES

It has been argued that power if used properly is a mode of resistance to dissolve oppression and recreate good conditions of living (Apple & Apple, 1995; Giroux, 2014), yet knowledge is never neutral and is a power tool for freedom. The deliberate production and circulation of knowledge is part of the social distribution of power (Apple, 2017). Knowledge of how discursive power can be used to construct a common-sense reality of oppression and be integrated into cultural, professional, and political life is central in the social relationships of power connected with gender, sexuality, and patriarchy relations.

It is evident that there were intersections of power and gender within science educators' home background and their professional work. This is visible when they exercised personal power at home with their parents by not working on the farm with them even when there was a strong patriarchal belief in the early sixties, where the practice was that girls and women were

traditional farmworkers to hoe the fields and at the same time prepare food. It is evident that some female science educators once married exercised this power when they socialized their male children to be gender sensitive. They encouraged the boys to cook, wash and iron their clothes as well as girls do. Therefore, in their teaching job, they used this same gender stance and personal power to subvert boys when they subjugate and stereotype girls during class lessons. These science educators took the personal struggle of gender activism to both male, female PST and colleagues in informing them of a deliberate gender transformation mission in the class. It is also evident that the girls used a stance of 'submissiveness' and inactiveness of not participating when ridiculed, to gain control of their lives, individually and collectively. This act of defiance and use of personal power to resist participation in the class could be fuelled by the current global awareness of gender discrimination by youths.

However, boys' acts of oppression and dominance in the science classes is considered as a norm in society. The boys' use of exploitative personal power over girls continues oppression and marginalization. They consider the women's intellectual and social inferiority as an entrenched norm in the society. I argue that this ingrained dominant power is premised on socio cultural, historical and economic socialization process which could be disrupted for freedom, when the personal power becomes the political momentum.

Summarizing, the power relations exhibited by the science educators can be traced to their home background, informed by historical, cultural and socio-economic contexts. This assertion concurs with researchers who argue that the forces of domination and oppression could be made visible if cultural and historical contexts are researched by conscious critical educators to illuminate elements of oppression and marginalization in the form of personal or political power that silence females and the minority groups in schools and the society for transformation (Armstrong, 2020; Blackmore, 2011).

7.4 POWER OF EDUCATORS AND PRE-SERVICE TEACHERS CAN DRIVE POLITICAL AND MORAL TRANSFORMATION IN COLLEGE OF EDUCATION SPACE

Science educators who developed gender and power consciousness extended this personal power to the life science and physical science classrooms by making it a site for deliberate political struggle for change, emancipation, and transformation. This they did by trying to challenge the male PST when they sometimes dominate and lead the female PST during class

lessons and activities. They also challenge educators who attempt to stereotype the pre-service teachers inside and outside the science classes. Of course, democracy, transformation and freedom can only be achieved if females are not complicit in the social oppressive world but take an active individual and political group stance against it. Indeed, Jemal critical consciousness paradigm stance suggests that the most powerful tools that perpetuate and reinforce gender oppression, injustice and domination in the complex and contradictory institutions and social space are "silence, division and ignorance" (Jemal, 2017, p. 44). In this sense, both science educators and PSTs with entrenched sexual emotions, power and gender orientations need to re-negotiate the complex gender school environment for social justice, freedom, and moral growth.

Even though schools and colleges of education structures and processes are contradictory and complex, such environments nevertheless can enhance science educators' change and transformation (Giroux, 2010a; Ogoma & Alaiyemola, 2015; Weiler, 2017). Morality is the ability to behave in a civilised way in the social world (Steinberg, 2020). This is because, moral views are quite different from political views and religious beliefs. Of course, anti-social, unequal and chaotic environments promote civil disorder and demotivate the teaching and learning process (Steinberg, 2020; Wallace & Walker, 2020). Therefore, science educators, and pre-service teachers should always behave in civilised manner in the science class and the social world. This is evident when science educators displayed moral values by encouraging female pre-service teachers and males to respect each other then, channel their power to studies for intellectual progress and social mobility. Therefore, it is vital that both PST and science educators should exhibit some sense of honesty, endurance, commitment, and respect to teaching and learning spaces in a socially accepted way (Dennise, 2010; Narinasamy & Mamat, 2018; Sanger, 2008); ways in which critical teaching, peace and development, social justice, including ethics and feminism should be the focus. This approach could trigger the human potential for growth and developments, social harmony, and equality. In the life science and physical science classes, the six science educators with entrenched ethical ideals consciously and unconsciously transmit these qualities to both male and female pre-service teachers when they cautioned them not to engage gender discrimination and antisocial practices inside and outside the class that could impede their learning opportunities. For instance, we could use school environment to challenge oppression or further the discrimination of students"-Nagam.

"Education space, is the right place to create awareness of stereotypic practices"- Boko.

“The political nature of science education makes it easier to raise consciousness of educators about gender equity”- Tengo. “Gender equity can be achieved by political and democratic consciousness”- Nagam.

Though schools will hardly change society we can interrogate the dynamics of gender in colleges of education and the social spaces for change, social justice and transformation (Giroux, 2010b; la Velle, 2020; Mama, 2005). Therefore, science educators used democratic and political means by ensuring equal opportunity when PSTs stereotype each other in the class. These PSTs may be opposing school ideology by refusing to engage themselves in meaningful teaching and learning engagements. They consciously and unconsciously stereotype and resist in the class and social world by asserting their maleness and femaleness. Science educators, and pre-service teachers are potentially agents of social change that could, through reflection and action, problematize and challenge oppressive experiences in schools, colleges of education and their direct social world. In this case their sense of agency will be recognized in relation to their cultural, economic and historical contexts (Karousiou, Hajisoteriou, & Angelides, 2019; Pantić & Florian, 2015). Therefore, in feministic colleges of education, science educators and pre-service teachers who are novices on gender issues will be re-awakened and well informed as social agents who could then use their power to question oppressive tendencies of colleges of education, schools, the curriculum, and the immediate social space they find themselves in.

I believe that teachers, science educators and pre-service teachers who take up feminist pedagogy and reflect on their historical moments, will be equipped with power to negotiate transformation regarding gender, sexual and patriarchal forces and the contradictions in science classes and to address the anti-social, unequal, and chaotic environment that breeds civil unrest, imperilling morality and impeding the teaching and learning of gender consciousness.

Consciousness constitutes truths and values, but truth is a form of knowledge embodied with power (Armstrong, 2020; Giroux, 2010a; Luter et al., 2017; Sargis, 2008). It is important to emphasize that building systemic consciousness about gender stereotypes and oppression at larger scale in institutions and the social world is crucial for both critical feminist science educators and pre-service teachers. Therefore, I conceptualize that we must take on critical gender knowledge to disrupt the pre-defined oppressive values in schools, colleges of education and the society. This can be accomplished by rejecting the routinized and mystified sources of

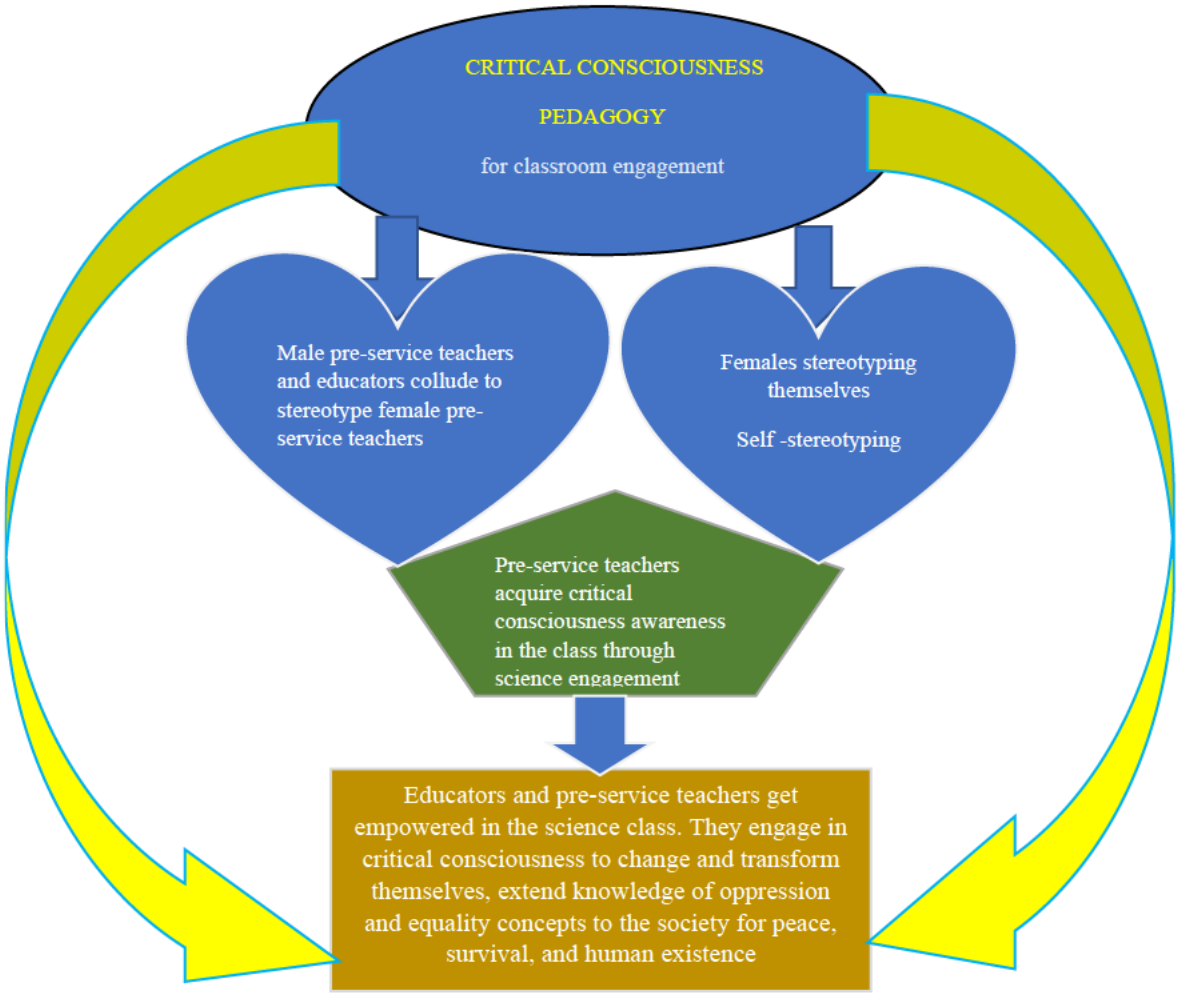
the oppressive gendered culture and institutions in which everyday life is structured and undergirded. This could change the dominant structure and ideas in institution and society. Alternatively, people may slide back into marginalized and dominating knowledge conditioned by the elites, teachers, clergy, researchers and pedagogues that is immersed in gender contradictions. If we take the systemic inequality and domination for granted, critical consciousness, political and democratic critical thinking and likely moral judgement will be forgotten, then the momentum to teach and learn feminism for growth, love and transformation will be lost. Science educators and teachers are then deprived of the gender model of power for change, emancipation, and transformation. Power and autonomy can be primary drivers of motivation and interest during teaching and learning gender engagements, therefore individuals with power may acquire autonomy to re-negotiate both individual and collective life in schooling and society. An autonomous and politically knowledgeable person cannot be easily manipulated to make clouded gender decisions that will continue to oppress and dominate him or her and others in the gendered social world (Jerit & Zhao, 2020; Sargis, 2008). Scholars comment that quality democracy is not only about autonomy and voting but also the appropriation of gender skills, values and validating civic responsibilities for equitable and peaceful living devoid of militarized and political environments with market ideology (Kovač, 2018).

Schools and higher education sometimes suffer from military, economic ideological forces which often narrow their scope as spaces for critical knowledge production, creative learning and transformation. But within this narrow spaces of contradictions, there are possibilities for gender change, ethics and social justice (Giroux, 1992, 2009; Riddle & Apple, 2019). As Arendt insisted,

> A meaningful conception of politics appears only when concrete spaces exist for people to come together to talk, think critically, and act on their capacities for empathy, judgment, and social responsibility (Arendt 1971, p. 417).

In this sense, science educators and pre-service teachers can be democratic and political agents of change in the college of education space. They could invoke their autonomy to re-negotiate the schooling process and come together to critically think, collaborate, and share ideas for gender equity and equality in the contradictory and patriarchal education space. This discourse is summarised in the critical consciousness pedagogy model (Figure 7.1) thus

Figure 7.1 Model of Critical Consciousness Pedagogy for Science Educators and PST



7.5 RE-NEGOTIATING COMPLEX GENDER, SEXUALITY AND PATRIARCHAL CLASSROOM DYNAMICS IN THE SCIENCE CLASS

Navigating classrooms is vital since science educators found themselves in a contradictory and complex gender, sexual and patriarchal physical science, and life science classrooms. They have to rethink alternative ways to negotiate and re-negotiate to gain control of the class. This will situate them to appropriate better condition for their lives and PST, possible by reflecting on forces sustaining stereotypic beliefs and practices and then challenging the cultural elements that oppress males and females. The science educators used power to challenge the male PST when they stereotyped the female PST in the science class. This the male PST do by dominating group discussions and activities. In the same science education class, there are forces of production and reproduction, because the male PST and science educators sometimes collude to stereotype the females in the life and physical science classes by bringing cultural and historical forces to bear (Kelly & Nihlen, 1996; Makama, 2013). The science educators employed negotiation strategy as a way of telling the female PST to 'sit up' thus boosting their confidence and motivating them to learn. For instance, Zima said that one of the women science educators informed the women student in her class not to engage in any sexual relationship with boys and teachers that could ruin their future educational pursuits. Bodam, a male science educator, cautioned the girls against commodification of their sexuality that could entice younger science educators into giving illicit examination scores. This production and reproductive power of subversion may have been culturally and historically acquired and hence transferred to the PS and LS classes by the science educators for promoting morality, learning and transformation. So, science teachers have been doing discrimination and subversive things in the science class without noticing it" -Boko. "I believe gender equity can be achieved if women stand up to talk about their discrimination and oppressive ideology in the college and the general public"- Zima. "Women are mostly socializing agents at home and the college- Tengo. Educators, students and administrators are to share the blame because they contribute to females 'oppression and subordination"-Nagam. "Subversive act such as counter-hegemony could drive equity and feminism ideals in science classrooms"- Tengo. Educators could re-negotiate complex gender and patriarchal classrooms"- Tengo.

Despite the gender, sexual and patriarchal elements in the college of education, science educators negotiated and renegotiated to find meaning for their existence and for their PST. This is necessary because they were faced with the challenge of controlling themselves, of refusing to be controlled by others at home or at workplace, but were conscious of gaining self-determination and confidence (Akgul, 2017; Arnot, 2002).

7.6 SCHOOLS AS IN COLLEGES OF EDUCATION ARE CONTRADICTORY AND POLITICAL SPACES FOR LEARNING

Giroux (1983a) theorizes that schools are contradictory and complex spaces for teachers and students. This because, schools are interwoven with latent and overt cultural and historical power elements of domination, gender, sexuality and patriarchal ideology. Therefore, within these contradictions, there are possibilities for change and transformation, when classrooms are democratized and have political edge for emancipation and transformation. Concurring with Giroux's assertion, researchers argue that schools where genuine learning takes place transform the learner or student, who is changed cognitively from a spectator/onlooker to a thinking and acting individual with autonomy (Louis, 2006; Noe & Ellingson, 2017; Sargis, 2008). Some researchers comment that though schools are engine sites for learning, knowledge and democracy, are sometimes embodiment of cultural danger, and are institutions whose curricular models, teaching and learning practices sometime threaten the moral universe of the students with hidden curricular practices such as commodification, concern for utility value of degrees for students as consumers and competition for grades rather than civility and critical skills for just and peaceful living and empowerment (Mbembe, 2016). Of course, schools as colleges of education are in crisis, which makes innovation, creativity and democracy principles difficult to implement, due to the imposition of commercial baggage in the form of capitalism and profit-making (Apple, 2017; Giroux, 2009). In this space, teaching, academic disciplines and research are politicized, prioritized and valued in terms of capitalistic market outcomes, measurable standards of assessment and scores for certification (Giroux, 2014, 2017b; Raymond, 2019).

A critical examination into a college of education of life science and physical science classes reveals the complexities ranging from science educators' and PST' gender consciousness and stereotypic practices which are underpinned by historical, political, economic and socio-cultural domains. Therefore, science educators in the web of these contradictions and complexities navigated and re-negotiated the classes to gain control of their lives and that of

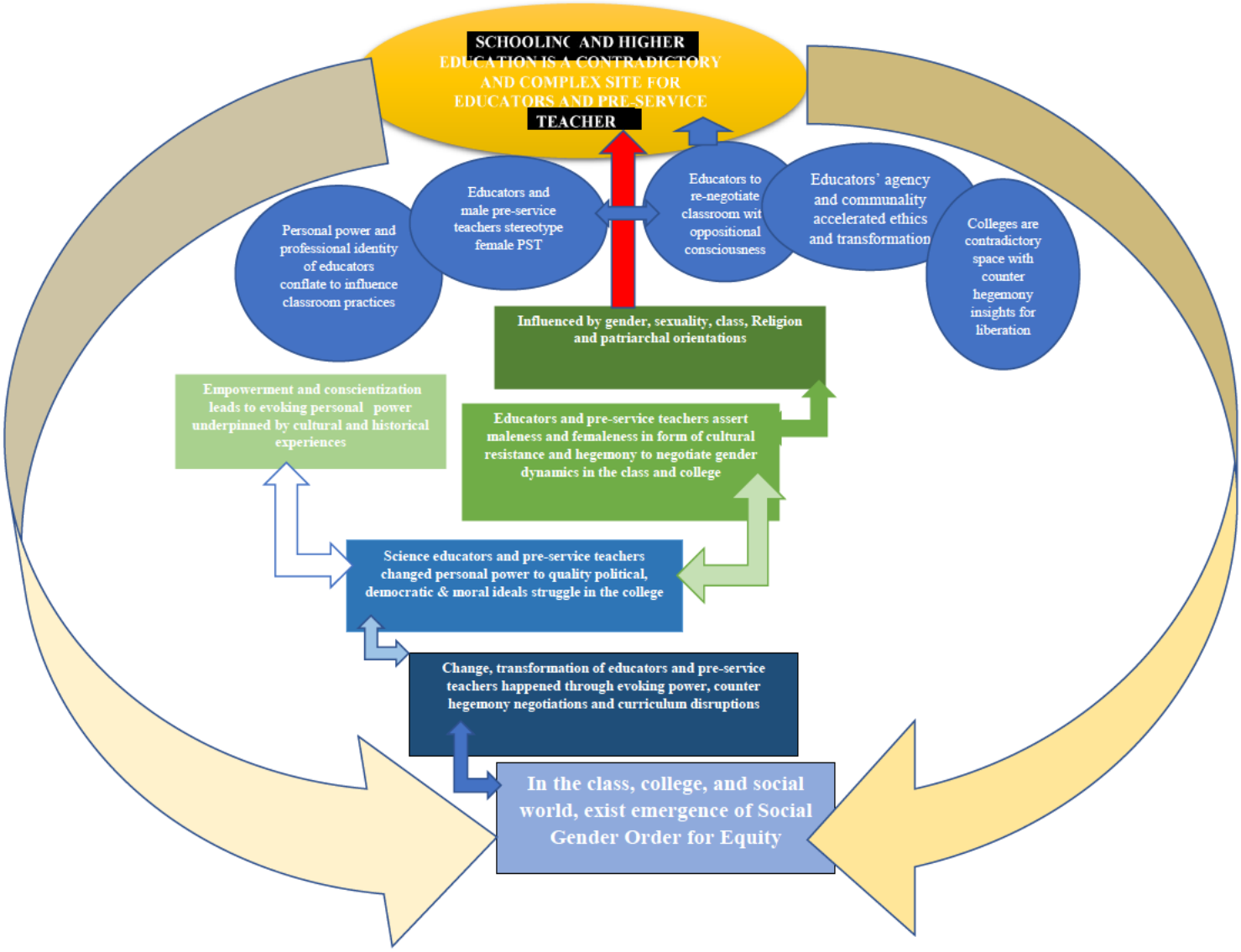
their PST using conscious critical thinking and transformation insights. This was done by subverting male PSTs' acts of domination or females' acceptance of subordination and submissiveness and by challenging other science educators' ways of stereotyping the PSTs' forms of resistance. However, some female science educators found themselves in a contradictory but male dominated institution, characterized with skewed gender enrolment and appointments, an environment unfavourable. These women intellectuals used ingrained personal power from their home background and transformed it into political struggle to re-negotiate dynamics of the college political settings to gaining control of their humanity and that of their PST. Their strong political and gender stances primed them for senior positions in the college. For instance, Zima, a female science educator from the college, negotiated and re-negotiated gender equity dynamics in the college. She became the departmental head, then dean and currently she is the deputy provost of the college of education and likely to become the provost in the future. Further, teacher Boko addressed gender contradictions and became the head of the chemistry department for four years. For instance, the following excerpts emanate from educators' responses: "I became head of department by negotiating political gender spaces"-Dula. To become Dean of a school, negotiation and re-negotiation tactics could be vital"- Boko. I would like to break the politically stereotypic spaces for higher positions in the college-Tengo. Females could drive equity through collaborations and political consciousness"-Zima. Educators' personal power, science identity and political stances could disrupt gendered curriculum and institutional structures.

It is interesting to argue that when male and female science educators are entangled in a web of gender contradictions and complexities of schooling or college of education, they could first evoke their democratic power in form of autonomy, then navigate and re-negotiate using both personal and political powers to appropriate gender dynamics to gain control of their lives and that of their PSTs for transformation. In this web of contradictions, science educators as agents of change re-defined their personal struggle into political power and re-negotiated the politics of inherent in the college of education and schooling by countering ideological messages and gender norms that have been produced and reproduced in the curriculum and school structures, to give meaning to their lives. Sargis comments that educators must understand that learning can take place only in an environment free from the ambiguous values, beliefs, morals, of the dominant social paradigm that oppresses and dominates them (Sargis, 2008, p. 66). In this ambiguous sphere, there are possibilities for change and transformation which science

educators utilized in the college of education to subvert stereotypic, dominant and oppressive practices for empowerment and transformation. Excerpts from educators depict change and transformation possibilities- "Transformative resistance could be possible for change and empowerment"- Boko. "The dominant space of males' pre-service teachers could be challenged for intellectual and political transformation"-Tengo. Patriarchy, sociocultural and historical environments could be spaces to create awareness on stereotypic practices and equity"- Nagam.

The model in Figure 7.2 depicts a complex school space and the possibility of negotiation for historical, sociocultural, political, patriarchal and intellectual transformation in the emerging gender order.

Figure 7.2: A Model of Contradictory, Transformative and Political College Space for Science Educators



Schools and schooling process as in colleges of education are perceived to be contradictory and complex spaces for educators, males and females' pre-service teachers due to influence of gender, sexuality, class, patriarchal and moral elements. However, science educators and students sometimes use gender, class, sexuality, and patriarchal orientations in the contradictory spaces to negotiate the science classroom by posing resistance to teaching and learning. Both educators and pre-service teachers sometime consciously and unconsciously used power underpinned culturally and historically in form of resistance to gain control of their personal lives through political, democratic, and moral ideals' negotiations in the college. Therefore, transmitting change and transformative potentials to both educators and pre-service teachers in the science classes and the social world. Of course, within the transformation spaces there are likely new possibilities for social gender order to promote equity.

7.7 IMPLICATIONS FOR EDUCATIONAL PRACTICE

> Teachers need to "educate students but not train them into credentializing factory" (Giroux, 2010a, p. 33).

In other words, education is meant to prepare pre-service teachers as other students with critical skills, rationality, political, morality, creativity and scientific capacities for survival in the society, not just space for grades and certification for job placement, commercial centres, and excitement (Apple, 2017; Giroux, 1983a). In an education undergirded by business principles, Mbembe argued that students become less interested to study and acquire citizenship and critical knowledge, but more interested in material pay off, or utility, which their studies and degree have in the open market. Also, in this system, the students become the "consumers of vendible educational commodities, primarily courses, credits, certification and degree. The task of colleges of education and universities from then on is to make them happy as consumers" (Mbembe, 2016, p. 33).

Undoubtedly, feminist politics in education, although compromised by ingrained neoliberal ideology, has filtered into the school, science education sphere and the social world as a dominant movement for change. Considering males' and females' lives of oppression and domination, rethinking from a critical feminist reproduction perspective will reposition women/ girls' and men/ boys, thus appropriate possibilities and spaces where women and men feminists

can negotiate the political and democratic terrain to gain control for their existence in a gendered social world for change and transformation (Arnot, 1984; hooks, 2010; Khonje, 2020; Weiler, 2003).

Within Nigerian society, the study aims to re-awaken individual consciousness to promote females' value in the social space for economic mobility and development. In this sense, women and girls will be aware that they are not limited to being domestic servants with skills for cooking, nurturing, and hosting, with little paid or unpaid wages, but have the potential to enter the political and economic world. Within the Nigerian education context and the world over, I suggest science education curriculum be decolonized and indigenized for critical skills, creativity, citizenship, moral values for transformation. Disrupting science education curricula will emancipate and transform educators, teachers and pre-service teachers (Govender, Mudaly, & James, 2016; Opoku & James, 2021).

Due to the limited gender education agenda and awareness in Nigeria, this study suggests transformative, economic, and political possibilities for teacher education for the new gender order, and revival of nuanced personal and political powers for gender equity and equality. Science educators, pre-service teachers and researchers reflecting on the shift from gendered patriarchal teacher education can thus re-negotiate the curriculum to enhance and enlighten pre-service teachers' deeper understanding of the unequal power relations linked to the economic, political, ethical, and patriarchal forces in education. In this sense, critical consciousness, insights and critical feminist pedagogies can be incorporated into teacher education gender programme for change and transformation of colleges of education and the society. Furthermore, to break the prevailing cycle of male dominated hierarchical pedagogies in education, we should consider the possibility for the preparation of feminist science educators, pre-service teachers, students and teachers who have learned to use critical feminist skills and who can change classroom methods to align with the importance of the changing and transforming gendered world. This is possible by using personal power and professional experience to distribute authority with their students to influence classroom gender dynamics for change and transformation.

This study puts forth a new initiative or paradigm shift in science education, to prepare educators, pre-service teachers and students globally to become agents of social change (Cane, 2015; Giroux, 2016; Schoeman, 2015). Science educators and PSTs with personal power,

political and professional identity can disrupt the dominant resistive forces and transform the elusive or/and oppressive behaviours and actions in the school environment (Lather, 1984a; Schoeman, 2015).

Integrating the goals of critical theory, critical feminist reproduction theory and counter-hegemonic pedagogy will equip science educators, pre-service teachers and policy makers with resistive power in form of political struggle to make sense of and identify ways of disrupting educational exclusions and inequalities and to appropriate an open attitude of critique of the market-driven dominant neoliberal paradigm in education (Freire, 1973; Giroux, 2010a; Hoffmann & Stake, 1998; Schoeman, 2015). The issues highlighted in this study will encourage active engagement with "professional and personal experience, identity construction then create transformative consciousness through political struggle, using power of critical thinking" (Hoffmann & Stake, 1998, p. 97). More so, power as a politically productive and repressive force is re-echoed by Weedon thus,

> Power is created by society using history and politics based on the circumstances surrounding events. All social relationships are power relationships and power is viewed as both productive and repressive force (Weedon, 1987, p. 136).

In this sense, gender knowledge is a powerful tool in the society to produce critical ideas. The same power can be used to resist uncritical knowledge that could slow the transformation of the gendered world. There is little critical consciousness of counter-hegemonic pedagogies and oppositional consciousness in education for political and democratic moments for gender equality. Thus, the study's findings, if adopted, will encourage science educators, pre-service-teachers, and students to mediate between received versions of reality and lived contradictions that have oppressed and dominated them for years. This raises the consciousness that market-driven capitalist ideology is a hegemonic force that has been copied by intellectuals in education and elites in the society to oppress and dominate students and science educators. Then, educators may instead focus on its counter-hegemonic potential for emancipation and social justice (Khonje, 2020).

This echoes hooks' (1989) assertion on critical consciousness in education:

> Much feminist education for critical consciousness takes place in women's studies classes or at conferences which focus on gender. It would further feminist

> movement if new feminist thinking could be once again shared in small group contexts, integrating critical analysis with discussion of personal experience. It would be useful to promote anew the small group setting as an arena for education for critical consciousness (hooks, 1989, p. 24).

7.8 CONCLUSION

In this chapter, I presented an account of counter-hegemony and oppositional consciousness as the space for feminist teaching. Also, I argue that sexuality driven by power dictates some gender behaviours in the college of education where the study was conducted. Personal power intersects with professional work to dictate educational practices in the college. However, the power of science educators and pre-service teachers carries the possibility of political and moral transformation. Renegotiating gender, sexual and patriarchal classroom dynamics is a vital possibility for regaining human existence. Schools as in college of education are contradictory and political spaces for learning. The chapter ended with implications for educational practice.

CHAPTER 8
SUMMARY OF FINDINGS, CONCLUSION, RECOMMENDATIONS, CONTRIBUTIONS TO KNOWLEDGE, LIMITATIONS AND PERSONAL JOURNEY

INTRODUCTION

In this chapter, I foregrounded summary of findings and discussed the conclusions based on available findings which resonated around the transformative, political, and democratic potential of science educators and how they collude sometime with male pre-service teachers to stereotype and marginalize the females in the college of education. I discussed the recommendations and suggestions for administrators, educators, and pre-service teachers. I explored how science educators, with feminist critical consciousness, could negotiate to change and transform themselves and pre-service teachers. Then, I provided the contribution of this study to education, then limitations, and personal journey, drawing insights from my experiences.

The purpose of this study is to explore the nature of science educators' reproduction and subversion of gender stereotyping and how science educators negotiate and renegotiate reproduction or subversion of gender stereotypes and why science educators navigate to reproduce and subvert gender stereotype the way they do in science classrooms. The research questions for this study are: **What is the nature of science educators' reproduction and subversion of gender stereotype beliefs and views in a college of education in Nigeria? How do science educators reproduce and subvert gender stereotype beliefs and views in a college of education in Nigeria? Why do science educators reproduce and subvert gender stereotype beliefs and views in a college of education in Nigeria the way they do?**

In this study, critical interpretive paradigm and qualitative approach were used. Semi-structured interviews, classroom observations, reflective journals, collective journals and a questionnaire were the sources for data collection, using six science educators as participants. Purposive and convenience sampling techniques were adopted to select the study participants based on their awareness of gender oppression and domination in the college of education where the study was conducted. The centrality of the college of education in the North-Central geo-political

zone of Nigeria, and support for gender workshops and conferences over the years position this the college of education to be chosen as a case for the research work.

In chapter 6, I highlighted some basic theories such as social reproduction and liberal feminists' and critical feminist reproduction theories that align with the study. I discussed major assertions emanating from this study. These assertions provided answers to the three research questions as stated earlier. The assertions capture the college of education as being political, contradictory, subversive, democratic, and moral space for emancipation and transformation of entrenched stereotypic practices, neoliberal dominant oppressive and economic ideology. Also, in chapter 6, I discussed how the college of education is influenced by pre-service teachers' science engagement and educators' personal power, professional identity underpinned by gender, sexuality, history, and sociocultural, economic, political and patriarchal orientations. In chapter 7, I discussed the study's implications for research and ended the chapter with implications for educational practice.

8.1 SUMMARY OF FINDINGS

Herein are findings generated from this study

Science educators as agents of change stereotype pre-service teachers consciously-*explicitly* and unconsciously- *implicitly,* due to ingrained historical, sociocultural, political and coded economic oppressive norms, including the hidden curriculum. This they do by reinforcing stereotypic intellectual activities and unconscious discriminatory practices and beliefs in the science classes. The educators being socialising force sometime challenge stereotypic gender practices, beliefs and views amongst themselves and the pre-service teachers during complex science engagements. This is because the science education environment is contradictory space for gender equity awareness which needs negotiation and renegotiation possibilities. Also, in this complex environment it is established that sexuality determines gender relations and attitude in the science classes. Therefore, gender orientations, patriarchal dispositions, socialization process, attitudes and curriculum content conflate to drive science educator's positionality to collude with male pre-service teachers to stereotype the female pre-service teachers during life science and physical science engagements. Undoubtedly findings revealed that the female pre-service teachers were complicit in their oppression based on lesson observation and interviews conducted with science educators. This was evident because, most of the time, male pre-service teachers volunteer answers and activities hence dominate

classroom engagements, while female pre-service teachers sometime remain silent, passive and reluctant to intellectual activities, due to entrenched historical, sociocultural, political, economic beliefs and socialization process linked to subordination mechanisms in their diverse cultures as it is in the college structures when the study was conducted. The conscious and unconscious acts led to female educators and pre-service teachers' multiple subordinations in the college but democratic, collaborative, organized political activism and ethical ideals could drive emancipation, change and human capital development.

Therefore, liberation and transformation could be possible through productive resistance, counter-hegemony tactics, advocacy and political awareness to reconfigure their personal, political, democratic and collective power for change, peaceful co-existence and sustainable development.

8.2 CONCLUSION OF THE STUDY

In this study, findings reveal that the nature of educators' reproduction of gender stereotype and subversion is more consciously practiced and less unconsciously done during science engagements. This is because, educators consciously reproduced and sometimes subverted educators' and pre-service teachers' stereotypic actions in the science classroom. Educators sometimes were not aware that the stereotypic engagements were unconsciously reproduced and subverted because some discriminatory actions were implicitly reproduced. Undoubtedly, the lack of adequate awareness of gender discrimination and equity stances has led educators to reproduce and subvert stereotypic practices of pre-service teachers during science engagement. This is because, educators and male pre-service teachers perceive subordination of female pre-service teachers to be natural thus exhibit such stereotypic actions during science engagement consciously and unconsciously.

How do science educators reproduce gender stereotype and subvert stereotypic actions of pre-service teachers? Educators reproduce the discriminatory gender practices by unequal distribution of intellectual activities and questions to pre-service teachers. In this sense, they favour male pre-service teachers most of the time by allowing the boys to dominate classroom engagements. This was traced to the entrenched historical, cultural, religious, and patriarchal socialization differentials in education and in society in the past as being practiced today.

Why do they reproduce and subvert stereotypic gender practices the way they do? The science educators reproduced the cultural discriminatory gender norms beliefs in the science classroom

because they were unaware of the impact of stereotypes on pre-service teachers. Also, the educators were sometime conscious and unconscious of the combined forces from history, sociocultural, political, religion and patriarchy driving their actions. This is because they were socialized in the entrenched patriarchal community or society to treat males and females differently which has become a norm in the society and science education setting. The educators consciously or unconsciously then conveyed the stereotypic cultural actions to the science classrooms to dominate and subordinate females. I strongly believe that gender equity can be achieved if women stand up to talk about their discrimination and oppressive ideology perpetrated against them in the college and the general public. This is because females are socialising agents at home and the college thus, have both political and economic potentials and capacities to destabilise oppression in science education and the social world. Undoubtedly, educators, students and administrators are to share the blame because they consciously and unconsciously contribute to females 'oppression and subordination in the ecosphere.

Therefore, this study will create equity awareness for science educators to negotiate and re-negotiate science classrooms within the critical feminist reproduction lens and counter-hegemonic pedagogy in a complex and contradictory college of education space such as in Nigeria and the broader social world.

8.3 RECOMMENDATIONS

The following recommendations emanate from this study:

The Nigeria government needs to enact and implement critical gender consciousness actions in education. These actions should include granting females' equal employment and political representations, creating robust mechanisms and structures with a specific focus on inclusion and accelerating females' empowerment for economic change and transformation (Alade, 2012; Jemal, 2017). The findings of this study should be embraced by policy makers and teachers as it raises the prevalent gender inequities, stereotyping and reproduction. It is recommended that greater articulation of an alternative gender world view will undermine the dominant neoliberal gender discourse, thus, tying gender theory and practice together for emancipation and transformation (Weiler, 2017). It is recommended that critical feminist reproduction debates be used to help science educators understand the oppressive mechanism of gender stereotyping and reproduction and rethink their current practices in aiming towards

true emancipatory and transformative gender education. Therefore, when a critical feminist perspective is envisioned, there may be a deeper understanding of knowledge, power and spaces of gender empowerment and transformation with regard to democracy, politics and the economy (Bussey**,** 2021; Cleaver, 2000). It is recommended that policies on gender equity and equality should be implemented by both federal, local, and state governments. All extant gender discriminating laws that still exist on the pages of statute books should be reviewed to help eradicate gender inequality in Nigeria. Government should set up a gender commission with a mandate to disrupt and reform existing unfavourable gender policies and conscientize Nigerians of the vital impact of gender equality on Nigeria economy and security (Mazibuko & Umejesi, 2015). Universities and colleges of education administrators, educators, psychologists, and counsellors should fully assume the role of critical feminist guidance and effective mentoring to ensuring females develop positive perception of themselves despite persisting relegation, stereotyping, and discrimination against them (Yuan, 2017). Empirical researchers should focus on the elusive social, political, economic, cultural, and institutional constraints to unpack/ reveal the mythological powers of men that undermine women/girls' potentials and self-esteem. Human rights crusaders/activists should be conscious of transformation and development of females for educational and economic repositioning. By creating awareness on the potential, they have and why they need to use power for political, intellectual and democratic struggle to achieve their individuality. Females need to re-construct their identity based on the pressure of the context they encounter to navigate the dynamics of gender equality because gender inequality and the oppression of women and men is a violation of human rights and is synonymous to gender violence (Chamberlain, 2017). Institutional groupings such as the staff and Student Union Governments (SUG- Nigeria context), Student Representative Council (SRC- South African context) should develop gender workshops, debates, and conferences. They should be made aware that the cultural reproduction of gender stereotypes in schools, colleges of education and universities and the society have more devastating effects on women/ girls educational and career progression that exclude them from the main science career pipelines and the economy, thus impacting also on the country's Gross Domestic Product (GDP), (Black, 2016; McKinsey, 2018).

Further, feminist science educators and students should explore transgressive knowledge to disrupt socially accepted oppressive gender norms in the name of social justice and human rights. Critical gender knowledge may have liberatory force that could reposition them come

out of social mythologies and religious superstition for change and transformation. Uncritical minds could lead to ignorance, silence and fear, consenting to oppression and domination. (Freire, 1972; Sagis, 2008). Schools, colleges of education and universities should be envisioned as contradictory and complex sites for teachers, educators, pre-service teachers' students and within the ambiguous spaces there are possibilities for a different gender order. Thus, curriculum should be committed to citizenship, critical skills, creativity, emancipation, and empowerment of the marginalized and focus on challenging gender, class, patriarchal and racial inequality (Famunyam & Khoza, 2020; Giroux, 2010; Omirin & Adewunmi, 2022). Counter- hegemony as a collective political and democratic struggle for transformation should be embraced by science educators, pre-service teachers and students to negotiate the gender dynamics of science classrooms (Deem, 2012; Weiler, 2017).

8.4 SUGGESTIONS FOR FURTHER STUDIES

i) Those who wish to research gender oppression and domination should focus on power relations that impact the subjectivities of teachers, parents, and pre-service teachers. In this regard, interviews should be designed for them to express their lived oppressive experiences.

ii) Experiential research should be conducted as to explore why some children cross from their parents' working class to another class and others not.

iii) Are all antisocial conduct and misbehaviours in the school, colleges and universities demonstrated by students a way of exercising power to gain control of their lives? Further empirical research is needed in this area.

iv) Could classroom counter-hegemony as a collective political force lead to true emancipation and transformation? This will be an interesting question to explore the application of gender theories.

v) More empirical studies should focus on how historically and culturally ingrained gender power relations can be disrupted for total freedom and transformation of the marginalized individuals in the society. Furthermore, a probe into critical consciousness pedagogy model I designed is needed.

8.5 CONTRIBUTIONS OF THIS STUDY TO GENDER IN SCIENCE EDUCATION

- This study has the potential to provide power such as useable knowledge and emancipatory consciousness for educators to use political activism, advocacy, academic discourse and democratic paths to challenge subordination of males and females in the ecosphere. This could enhance the liberation of science educators, pre-service teachers in an environment characterized with oppression. The transformative awareness could help educators and pre-service teachers to be liberated from intellectual and economic discriminations to regain their existence for a sustainable development.
- Fusing critical theory, critical feminist reproduction theory and critical consciousness pedagogy illuminate transformative basis for women's emancipation from entrenched oppression for a drive toward equality and liberation.
- Fusing interpretive paradigm and critical paradigm stances clarify possibilities of not only understanding the world but to change the total world for economic growth and development.
- Rethinking critical feminist agenda for empowerment and political insights undergirded by descriptive quantitative analysis and qualitative methodology is vital. Thus, provides a shift from superficial understanding of women experiences of oppression and marginalization that leaked them from scientific pipelines. Therefore, providing a nuance lived experiences of women's oppression and knowledge production for critical thinking, citizenship, emancipation, and science engagements.
- This study set the tone for a new model of pedagogical consciousness for political and work career struggles for both women of colour and white females to invoke complimentary feminism. This is likely to disrupt the world's oppression and subjugation against women to reclaim their existence.
- The study theorisation could evoke the consciousness of both men and women globally and nationally. That, it is difficult to change and transform the world for peaceful co-existence without liberating and emancipating women from marginalization and domination.
- This study also informs us those women/girls have hidden potentials that are yet untapped for economic growth, peace and prosperity of the world.
- This study account for fourth wave feminism and the age of technology and internet platforms for women struggle. This could be a motivating site for women to propel their

political and democratic movement devoid of self-stereotyping and / or further oppression likely due to ignorance and silences.

- More so, this study creates awareness that the school curriculum with dominant capitalist ideology that endangers humanity especially, female students co-operate existence should be dismantled or disrupted. Thus, a new model of curriculum reforms which is not prescriptive or oppressive, but normative and rhizomatic which embraces cultural diversities of individual be enacted for critical skills. This new curriculum could validate critical insights, political knowledge, and moral orientation for science education teaching /learning engagements. This interconnected curriculum model should aim at embracing multiplicity of voices that relate educators' and students' personal, professional, and social lives for liberation and transformation. This is necessary since science education curriculum theories in Nigeria and likely in the world present few methods and principles directing critical answers to solve different cultural and educational problems.
- The prevailing discourse /scholarship filtering into education and the social le codified as oppression and / or subjugated knowledge about women incapability and oppression from equality of opportunities in science endeavour is not only false but may not stand, because it is elusive, discomforting to women thus, endangers human co-operate existence.
- Though Moyo (2020) argues for indigenisation of knowledge and a model for African feminism that could trace and redress the roots of oppression and inequality in African society, he ignores the material and historical apparatuses/bases of power that informed the western elites to normalize oppression and marginalization of women in the global scene. Therefore, I suspect that the consistent cultural reproduction of gender stereotypes in the traditional Western and Anglo-American knowledge spaces of "one-size fits - all approach" is likely responsible for the entrenched oppression of women in Africa and world over (Moyo, 2020, p. 71). This capitalist market consciousness and curriculum ideals possibly infiltrated the African societies and became entrenched over time and seems difficult to be overturned. Therefore, this calls for an Indigenous knowledge (IK) model that is contextual or peculiar to African people. This might likely resolve overreliance on Western knowledge space and the oppressive curriculum

handed to Africans and consumed by Africans (Fomunyam & Khoza, 2020; Ndlovu, Govender, & James, 2020).

Therefore, critical feminist reproduction model and critical consciousness pedagogy could offer possibilities for a global complimentary feminism with the power of love as a technology for social transformation. This perhaps may drive revolutionary consciousness ideals that can penetrate deeply neoliberalism in education for a new Western, Anglo- American and African gender order for transformation and collective economic growth.

8.6 LIMITATIONS OF THE STUDY

This study is limited in the following ways:

i) Methodologically, the study is limited because, out of 58 science educators from the physical and life science classes who indicated an interest, only six participants were involved in the study were selected through purposive sampling. The six educators were given questionnaires, and then interviewed for data generation. The data production collection from the questionnaire, classroom observations, reflective journals, collective journals and semi structured interviews provided 'thick descriptions' that can mitigate the lack of larger numbers. The four months period of data production was characterized with strike action embarked upon by staff of the college of education, leading to reluctance and a lukewarm attitude of science educators to submit and complete their questionnaires. Also, their readiness for interview due to work pressure was difficult to manoeuvre. Nevertheless, I convinced them to believe that the study will enrich their scope of reasoning on gender issues. I also motivated the six participants with refreshments that further rekindled their interest and energy to participate.

ii) Also, the study was limited due to financial incapacity to acquire text materials, travel, and attend conferences and workshops on gender issues, in some cases due to COVID, to strengthen and appropriate more nuanced insights into the research work.

iii) Sexual orientations and gender categories such as being Lesbian, Gay, Bisexual, Transgender, Queer, Intersex and Asexual (LGBTQIA) are not addressed in this research work.

8.7 MY JOURNEY – PERSONAL INSIGHTS

My experience in the new field of gender research is undoubtedly rewarding, because I started as a science educator with a skewed mind-set against women as being inferior, subordinate and lacking the intellectual ability to compete favourably with their male counterparts in education and the social world. Through interactions with colleagues, supervisors and attending several PhD cohorts and workshops with experienced professors and doctors who helped me shift my scope of intellectual reasoning to nuanced critical thinking, I unlearnt my patriarchal understanding and skewed beliefs to learn that women are beings capable of changing and transforming the world if given the moral, political, and democratic spaces and support, free from cultural reproduction of gender stereotyping in the social sphere. This changed me from a biased science educator to an educational researcher with critical insights for emancipation and survival in a just society.

Also, during this period, I had to travel to my home country each year to see and take care of family members including ten siblings, after my three brothers passed away, leaving them under my care as the first born of the family. Visa processing and renewal contradictions and lack of tertiary education sponsorship funding from my country Nigerian government, made the journey even rougher. Today, I am a free conscious intellectual who can theorize philosophically about women's transformative, autonomous, and moral potential to change the world through using a critical lens and counter-hegemony as political pathways to human survival and peace in education and society. More so, with a rekindled consciousness, I perceived gender violence as a colonial tool to strip the indigenous Africa and Nigeria of its sovereignty and economic powers. This is because a decolonial feminist framework has deepened my critical understandings of historical and present entrenched gender stereotyping that has impacted on humanity because of coded dominant ideology of oppression and marginalization in economic terms.

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APPENDIX 1: ETHICAL CLEARANCE CERTIFICATE

31 August 2018

Mr Daniel Allu 215082629 **School** of Education **Howard College Campus**

Dear Mr Allu

Protocol Reference Number: OSS/1028/018D

Project title: Exploring Science educators' reproduction and subversion of gender stereotyping in Science classes in Nigeria

Full Approval — Expedited Application

In response to your application received 31 July 2018, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted FULL APPROVAL.

Any alteration/s to the approved research protocol i.e., Questionnaire/interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

Dr Shamila Naidoo (Deputy Chair)

Humanities & Social Sciences Research Ethics Committee

Cc Supervisor: Professor Nadaraj Govender cc Academic Leader Research: Dr SB Khoza

cc School Administrators: Ms Sheryl Jeenarain

Humanities & Social Sciences Research Ethics Committee

Dr Shenuka Singh (Chair) **Westville** Campus, Govan **Mbeki Building** Postal Address' Private Bag X54001, Durban 4000

Telephone: +27 (0) 31 260 3587/8350/4557 Facsimile: +27 (0) 31 260 4609

APPENDIX 2A: INFORMED CONSENT LETTER- SCIENCE EDUCATORS

Science and Technology Cluster, College of Humanities, Edgewood Campus

University of KwaZulu-Natal

Dear Participant

My name is Allu Daniel Asilika, I am a PhD candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa.

I am interested in understanding how and why science educators seem to reproduce and subvert gender stereotyping in science classes in Federal College of Education, Pankshin. I am studying cases from Biology, Chemistry and physics departments. Your department is one of my case studies. To gather the information, I am requesting you to respond to the questions contain herein.

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person but reported only as a population member opinion.
- The questionnaire is divided into three sections (A, B and C).
- Any information given by you cannot be used against you, and the produced data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- The research aims at knowing what, how and why science educators reproduce and subvert gender stereotyping in science classes in federal college of education Pankshin, Nigeria.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.

I can be contacted at:

Email: danielasilikaallu@yahoo.com

Cell: 0788829378

My main supervisor is Professor Govender Nadaraj and co- supervisor is Dr James who are both located at Science and Technology Cluster, School of Education, Edgewood Campus University of KwaZulu-Natal.

Contact details: email: Govendern37@ukzn.ac.za Phone number: +27743733259 and jamesa1@ukzn.ac.za

You may also contact the Research Office through:

P. Mohun

HSSREC Research Office,

Tel: 031 260 4557 E-mail: mohunp@ukzn.ac.za

DECLARATION

I…… (full names of participant) hereby

confirm that I understand the contents of this document and the nature of the research project, and I consent to

Participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF PARTICIPANT DATE

…… …….

APPENDIX 2B: SCIENCE EDUCATOR'S QUESTIONNAIRE (SEQ)

Title: Exploring Science Educators' Reproduction and Subversion of Gender Stereotyping in Science Classes in a College of Education in Nigeria.

Part A: Biographical Data.

Please provide the following information about yourself and the college/school you are currently teaching science at.

1.1. Personal information. Use a cross or tick to indicate what is appropriate to you

Name (not compulsory)	
Gender	Male Female
What is your qualification (s)?	B.Ed., BSc. Ed, BSc, M.Ed., MSc MSc. Ed PhD others specify…….
What is your highest qualification in Biology/Chemistry/Physics?	BSc, BSc. Ed, MSc, MSc. Ed Ph.D. others specify……
What subject are you presently teaching?	Biology/ Chemistry/ Physics/…….
Number of years teaching Biology/ Chemistry/Physics	1-5 years 6-10 years 11-15 years 16-19 years others specify ……

1.2. List the subjects/ courses that you are currently teaching and year of grouping or levels/ Gender.

Subject(s)	Year of grouping or level	No of courses teaching	M	F	Total number of students

Part B: Questionnaire

1a. What comes to mind when you come across these terms? Briefly explain please.

(i) Sex

(ii) Gender

1b. Stereotypes are preconceived assumptions of roles about males and females in society, these roles may or may not be correct. So, what comes to mind when you come across the term stereotype in science classes?

2.1 Gender Stereotypes

Use the Likert scale rating to answer the following questions by ticking the appropriate response to you

Strongly Agree = **SA** Agree = **A** Neutral = **N** Disagree = **D** Strongly Disagree = **SD**

2a. I intentionally bring to the science class, assumptions or beliefs concerning male and female learners	SA	A	N	D	SD
2b. I unintentionally bring to the science class assumptions or beliefs concerning male and female learners/pre-service teachers	SA	A	N	D	SD
2c. I intentionally and unintentionally bring to the science class, assumptions or beliefs concerning male and female learners / pre-service teachers	SA	A	N	D	SD

2d. I usually allow boys to head group activities during teaching and learning of Biology, Chemistry and Physics.	SA	A	N	D	SD
2e. I do not interact equally with boys and girls during teaching and learning of Biology, Chemistry and Physics	SA	A	N	D	SD
2f. I do not interact equally with boys and girls during Biology, Chemistry and Physics lessons	SA	A	N	D	SD

Tick the correct response appropriate to you "Yes or No" and explain where necessary.

3a. Do you treat the boys and girls differently in Biology/ Chemistry/ Physics class? Yes/No please explain.

3b. How do you treat the boys and girls differently? Give examples

3c. Why do you do or not do that? Briefly explain

4a. Do you teach the male and female pre-service teachers differently? Yes/No. Please explain

4b. How do you teach the male and female pre- service teachers differently? Give examples

4c. Why do you do or not do that? Briefly explain

4d. list the things you do that show gender stereotypes in the science class

5a**.** Who do you mostly help during demonstration experiments, boys or girls? Please explain

5b. Who do you mostly rebuke in the science class, boys or girls? Please explain

2.2 (Reproduction) of Gender Stereotypes

1. What comes to mind when you come across the term "reproduction" with respect to gender stereotyping?

2. More men than women are represented/reflected/ transmitted in science textbooks I use for teaching.	SA	A	N	D	SD
3. I do not interact equally with boys and girls during teaching and learning in science class.	SA	A	N	D	SD
4. I do interact equally with boys and girls during teaching and learning /out of science class	SA	A	N	D	SD
5. I do not interact equally with my learners outside science class	SA	A	N	D	SD

Tick the appropriate option to you

5. Do you reflect/ transmit / represent (reproduce) gender stereotypes?	NO	YES	NOT SURE	SELDOM

6. List the things you do to reflect / represent / reinforce (reproduce) gender stereotypes and discuss how you do so.

2.3 Countering/ Combating / Disrupting (Subversion) of Gender Stereotypes

1**.** What comes to mind when you come across the term challenging (subversion) of gender stereotyping?

2. As a female/ male science educator I usually challenge, counter gender stereotyping in the classroom	SA	A	N	D	SD

3. Do you counter, challenge/combat gender stereotypes in your science classroom?	YES	NO	NOT SURE	SELDOM

4. How do you counter, challenge or combat (subvert) gender stereotypes in the science classroom?

5a. List the things you do to counter, challenge/combat gender stereotyping.

5b. Explain ways in which you do so.

Part C: Beliefs About Gender in Education

Strongly Agree **= SA** Agree = **A** Neutral = **N** Disagree = **D** Strongly Disagree = **SD**

1. Many textbooks in science education I use in teaching pre-service teachers reflect more men than women	SA	A	N	D	SD
2. Authors of science education textbooks for the subject I teach mostly use ‘he’ more than ‘she’	SA	A	N	D	SD

3. Science education textbooks/ journals currently used in the department always show images of males than images of females	SA	A	N	D	SD
4. Male pre-service teachers perform better than female pre-service teachers in the subject I am currently teaching	SA	A	N	D	SD
5. As a science educator I mostly ask male pre-service teachers difficult questions than female pre-service teachers during theory lessons	SA	A	N	D	SD
6. As a male/female science educator I mostly help female pre-service teachers than male pre-service teachers during problem solving exercise in the class.	SA	A	N	D	SD
7. As a female/ male science educator I always ask female pre-service teachers simple questions during practical lessons	SA	A	N	D	SD
8. I often ask male students to lead female students during practical activities in science class	SA	A	N	D	SD
9. As a male / female science educator I often ask male pre-service teachers to set experiments in the laboratory while the female pre-service teachers watch	SA	A	N	D	SD
10. As a male / female science educator I often cite examples with female role models than male role models during teaching and learning	SA	A	N	D	SD
11. Male pre-service teachers do not perform better in practical lessons than female pre-service teachers taught by me.	SA	A	N	D	SD
12. As a male/female science educator I tend to help female pre-service teachers more than male pre-service teachers during practical lessons.	SA	A	N	D	SD
13. As a female/male science educator I always assign female pre-service teachers to lead project work/ field work.	SA	A	N	D	SD

14. As a male / female science educator I always cite negative/ bad examples with female pre-service teachers in the class e.g., she is always sleeping as a pregnant woman.	SA	A	N	D	SD
15. As a female/male science educator I always cite positive/good examples with male pre-service teachers e.g., he is brilliant as a scientist	SA	A	N	D	SD
16. As a male/female Biology/ Chemistry /Physics science educator, I always respect male pre- service teachers than female pre-service teachers in the class.	SA	A	N	D	SD
17. Male pre-service teachers receive better praises from me than female pre-service-teachers	SA	A	N	D	SD
18. As a female/male science educator, I consider male pre-service teachers intelligent and female pre-service teachers dull in the class	SA	A	N	D	SD
19. Female pre-service teachers always ask their male pre-service teachers to lead group activities during teaching and learning while I always watch them	SA	A	N	D	SD
20. Male pre-service teachers always want to lead group activities during teaching and learning but I always rebuke them	SA	A	N	D	SD

Thank you for your contribution to this research.

APPENDIX 3: SEMI-STRUCTURED INTERVIEW SCHEDULE FOR SCIENCE EDUCATORS (SSISE)

RQ1 What is the nature of science educators, reproduction and subversion of gender stereotyping? RQ2 How do science educators reproduce and subvert gender stereotyping in science classes? RQ3 Why do science educators reproduce and subvert gender stereotyping in science classes?

Exploring Science Educators' Reproduction and Subversion of Gender Stereotyping in Science Classes in a Federal College of Education in Nigeria

1. What comes to mind when you come across the terms "sex and gender" Please elaborate?

2a. When we use the term stereotype what comes to your mind?

2b. Tell me some of your experiences related to "gender equality/ inequality/ biases / beliefs or preconceived assumptions" about females and males in the society at:

- Home
- Culture
- Community/church
- Your schooling (primary school, secondary school, tertiary institution)
- Federal college of education Pankshin.

2b. Do girls (female pre-service teachers) in science classes respond to learning differently in:

- Lectures
- Whole class discursion?

- Small group discussions?
- Practical
- Field trips?

2c. Which learning styles engagement are more effective with girls?

2d. Which learning styles are more effective with boys (male pre-service teachers)?

2e. Why the differences in learning styles?

3. Do you engage boys and girls equally in teaching science? Please elaborate
4. Are you aware of gender stereotyping? Please briefly explain
5. How do you think you participate or not participate in gender stereotyping?

6a. Observing / looking at these textbooks:

(i) STAN books

(ii) STAN Proceedings

(iii) Science Journals

(iv) Biology textbooks

(v) Chemistry textbooks

(vi) Physics textbooks

(vii) What can you say about gender equality, inequality, bias, stereotypes, representation/reflection and combating / challenging of gender stereotypes in these reference books and journal materials 6ai- vi above?

6b. What can you observe with respect to images, language and words reflected/ represented in the reference books and journals materials 6ai-vi above?

(i) How are these images, language and words reflected or reinforced and challenged in theses reference books and journals materials 6ai-vi above?

(ii) Why are these images, language and words reflected or represented and challenged or not challenged in the reference books and journals 6ai-iv above?

Some Gender Practice Scenarios in Science Teaching

1. Women are weak in studying science. Science is meant for the strong and intelligent men.

- How would you respond to this statement?
- Why is it so?

2. Girl's population is declining in physics, and chemistry classes / subjects due a number of reasons.

- State some of these reasons why girl's population is declining from these subjects?

3. More girls than boys enjoy studying biology and chemistry than physics. Do you agree or disagree? Briefly explain your answer.

- What could be the possible reasons for this?
- Why do you think so?

4. When conducting demonstration activities, how do you response to boys and girls asking questions?

5a. Girls sometimes complain that science educators do not pick them to respond to questions in the class rather allow only boys to respond more frequently

- How would you respond to 5a above as an experienced science educator?

5b. Boys always take control of class activities as group leaders in science classes while girls participate only in discursions and in few cases serve as secretaries.

- Do you think this happens in your class?
- Why is it so?
- If not, what happens in your class?
- Why is it so?

6. During subject-concept demonstrations, science educators call on boys mostly / frequently to help them carry out the demonstration while the whole students watch.

- Does this scenario take place in your class? Yes /No. please briefly explain
- Why is it so?
- If not, what happens in your class?

- Why is it so?

Visualizing Gender engagement in science

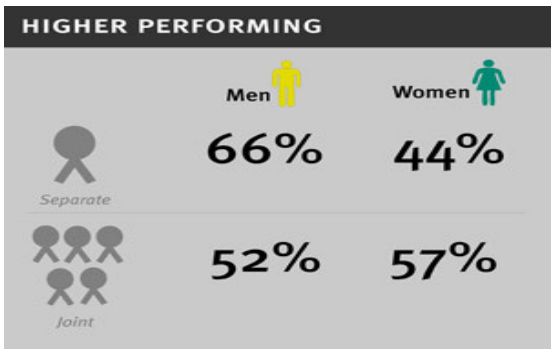

Fig 1: Showing single and group performance

of females and males **Fig 2**: Showing females raising up their hands

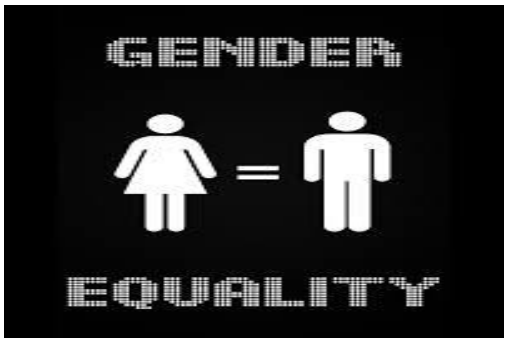

Fig 3: Showing teacher and the students

interacting in a class.

Fig 4: Showing gender equality

Fig 5: Practical activity in Biology

For each of the figure above comment or make some observations concerning them.

Thank you for sharing your thought with us. Enjoy your teaching.

APPENDIX 4A: CLASSROOM OBSERVATION SCHEDULE FOR SCIENCE EDUCATORS

This classroom observation schedule will be completed during classroom engagement with pre-service teachers (PST).

The observer is expected to complete this instrument during the lesson.

Date of observation: ----------

Start time: ----------

End time: ----------

Section A: Biographic Information

What is the subject being observed? ----------

What is your sex? ----------

What is your age? ----------

What is your highest qualification? ----------

What is your teaching workload per week? ----------

What is the average number of pre-service teachers in the class? ---

What is the number of males and females in the class? ----------

Section B: Classroom Observation Schedule for Theory Lesson.

No	Items (Indicators)	Detailed explanation of what was observed during the lesson.
1.	Introduction of the lesson is gender sensitive	
2.	Language used is gender sensitive/ conscious	

3.	Equal interaction with males and females	
4.	More questions were usually directed at males	
5.	Females / males were asked fewer questions	
6.	Difficult task given to males	
7.	Females answer more questions than males PST	
8.	Lesson is friendly to males and females	
9.	Male PSTs were involved / encouraged more during lesson group work/ activity	
10.	Educators' motivation (praises males or females).	
11.	Educator focuses more on female PST to respond to questions asked	
12.	Educator attends to male PST problem areas than female PST	
13.	Performance of students is gender sensitive	
14.	Educator rebuke female PST more than male PST in the class.	
15.	Educator is assigning roles	

APPENDIX 4B: CLASSROOM OBSERVATION COMMENTS / REMARKS FOR EDUCATORS

EDUCATORS	First observation	Second observation	Third observation	Comments/ Remarks
Educator - **ZIMA** (Biology)				
Educator- **TENGO** (Biology)				
Educator- **BOKO** (Chemistry)				
Educator- **NAGAM**				

(Chemistry)				
Educator- **BODAM** (Physics)				
Educator - **DULA** (Physics)				

APPENDIX 5A: INFORMED CONSENT DOCUMENT-PROVOST AND DEAN SCHOOL OF SCIENCE

Project Information Statement/Letter of Invitation to College Provost

My name is Allu Daniel Asilika, a PhD student at the University of KwaZulu-Natal (UKZN) in South Africa. I am conducting research on exploring Nigerian science educators' reproduction and subversion of gender stereotyping in science classes. I am requesting you to consider allowing me to conduct this research in your college. *I am requesting permission from the Dean and Heads of Department in School of Science as well.* This study will meet the requirements of the Research Ethics Committee of UKZN.

Title: Exploring Science Educators' Reproduction and Subversion of Gender Stereotyping in Federal College of Education Pankshin, Nigeria

The aims of the research include:

- It is hoped that this study will provide an understanding and awareness of the nature, how and why science educators reproduce and subvert gender stereotypes in science classes.
- The intention is to explore how science educators reproduce and subvert gender stereotypes in the subjects they teach and how they may become aware of pedagogic gender inequalities in the science curriculum.
- It is hoped that this research will help develop a conscious understanding of why science educators reproduce and subvert gender stereotypes the way they do and so support programmes of gender equality in science teaching.

Benefits of the Research to Schools /Colleges

- There is a global emphasis on gender equality as a panacea for socio-economic growth, peace and sustainable development (SDG's, 2017). Therefore, the role of education and particularly science educators in teaching and learning of gender equity/equality is greatly significant today. Keeping this in mind, it is important to question how science educators' pedagogies have influenced science classrooms positively.
- Gender equality is UNESCO's second priority gender Action Plan. This is because there is existence, persistence and worsening of inequalities in research documents and

evidence-based programmes. Therefore, gender equality has been identified as an accelerator for sustainable development and transformation (UNESCO, 2014). The Nigerian National Policy on Education (NPE, 2013) stresses the importance of gender equity/equality for all students during teaching and learning. The role of science educators is no longer just about imparting content, but to develop critical thinking individuals who will be creative, democratic and self-sustaining ready for a life outside of college environment.

- Currently, there are a few gender studies in Federal and State colleges of education in Nigeria that have examined in-depth what science educators in gender contexts do when they integrate gender equity/equality, power and stereotyping into teaching and learning process in science classes.

Research Plan and Method

The four types of data generation / production that will be used in this study are questionnaires, semi-structured interviews, videorecording and reflections. Permission will be sought from science educators prior to their participation in the research. Only those who consent will participate. All information collected will be treated in strictest confidence and neither the college, nor individual science educators will be identifiable in any reports that are written. Participants may withdraw from the study at any time without penalty. The role of the college is voluntary, and the college provost may decide to withdraw the college's participation at any time without penalty.

School Involvement

Once I have received your consent to approach science educators to participate in the study, I will arrange for informed consent to be obtained from participants and arrange with your college, and the participants for data production to take place at a convenient time. Attached for your information is a copy of the participant's Informed Consent Form. **It will be appreciated if you would please complete and return the attached form should you consent to your college participation in this research.**

Thank you for taking the time to read this information.

[redacted]

Allu Daniel Asilika — Researcher UKZN

Professor Nadaraj Govender — Supervisor UKZN

Further information

I can be contacted at: University of KwaZulu-Natal, Edgewood Campus, Pinetown ,Email: danielasilikaallu@yahoo.com Cell: 08060642975/0788829378

My supervisors Professor Nadaraj Govender (0743733259/ email govendern37@ukzn.ac.za) and Dr Angela James (0735114558) email jamesa1@ukzn.ac.za can be located at the Edgewood College Campus of the University of KwaZulu-Natal.

The Humanities and Social Sciences Research Ethics Committee contact details are as follows:

Ms Phumelele Ximba, University of KwaZulu-Natal, Research Office,

Email: ximbap@ukzn.ac.za, Phone number +27312603587

APPENDIX 5Bi: PROVOST CONSENT DOCUMENT

College Provost Consent Form

I give consent for you to approach the Science educators to participate in the above research.

Title: Exploring Science Educators' Reproduction and Subversion of Gender Stereotyping in Science Classes in Federal College of Education Pankshin, Nigeria

I have read the Project Information Statement explaining the purpose of the research project and understand that:

- The role of the college is voluntary.
- I may decide to withdraw the college participation at any time without penalty.
- The college science educators will be invited to participate and permission will be sought from them.
- Only science educators who consent will participate in the project.
- All information obtained will be treated in strictest confidence.
- The science educators' names will not be used and individual science educator will not be identifiable in any written reports about the study.
- The college, school of science and department will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty.
- A report of the findings will be made available to the college.
- Further information on the project may be sought from Allu Daniel Asilika on 08060642975/0788829378.

Dr A.B. CIROAT

Provost

Signature

28/08/2018

Date

Provost
FEDERAL COLLEGE OF EDUCATION
P.M.B. 27, Pankshin
Plateau State - Nigeria
Sign.....Date.....

STAMP

APPENDIX 5Bii: DEAN SCHOOL OF SCIENCE CONSENT DOCUMENT

I give consent for you to approach the Science educators to participate in the above research.

Title: Exploring Science Educators' Reproduction and Subversion of Gender Stereotyping in Science Classes in Federal College of Education Pankshin, Nigeria

I have read the Project Information Statement explaining the purpose of the research project and understand that:

- The role of the college /school is voluntary.
- I may decide to withdraw the college /school participation at any time without penalty.
- The college / school science educators will be invited to participate, and permission will be sought from them.

» Only science educators who consent will participate in the project.

- All information obtained will be treated in strictest confidence.
- The science educators' names will not be used, and individual science educator will not be

identifiable in any written reports about the study.

- The college / school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty.

A report of the findings will be made available to the college / school

- Further information on the project may be sought from Allu Daniel Asilika on 08060642975/0788829378 (email: danielasilikaallu@yahoo.com)

Date

DR AYUBA PEWAT DUGURYIL _____

Dean School of DEAN SCHOOL OF SCIENCES Federal College of Educ Signatu

26th JUNE, 2018 DateSTAMP

APPENDIX 5C: INFORMED CONSENT LETTER-HEAD OF DEPARTMENTS (BIOLOGY, CHEMISTRY AND PHYSICS)

Enquires: Mr Daniel Asilika Allu

Tel: 0788829378/ 08060642975

Email: danielasilikaallu@yahoo.com

Mr Daniel Asilika Allu

University of Kwazulu-Natal

College of Humanities

Edgewood Campus

Private Bag X03

Ashwood 3605

Dear Sir / Madam

I am Mr Daniel Asilika Allu, a student at the University of KwaZulu-Natal, studying for a Doctor of Philosophy degree in Science Education.

I am currently conducting research in Biology, Chemistry and Physics departments, Federal College of Education Pankshin, Nigeria.

The outcome of my study will be used to fulfil the requirements of the PhD degree. Assist me in my work as a science educator, inform the teaching and learning of Physical Sciences and support the development and implementation of science curriculum policy for pre-service science teachers. It is also anticipated that the results of this study will be beneficial as local research results on critical issues of female's emancipation and transformation regarding colleges of education Life and Physical Sciences policy and implementation likely inform future education curriculum reforms in Nigeria.

The sources of data for this study will include the following:

a. Current National Policy on Education and Curriculum Statement.
b. Curriculum and Assessment Policy Statement of 100, 200, 400 level life and Physical Sciences.
c. Video and audio recordings of interviews classroom observations of six science educators, two each from three subject's biology, chemistry and physics will be conducted.
d. STAN books, science Journals, biology, chemistry and physics textbooks

I am requesting:

1. Your approval to utilize the classroom and/or laboratory for collection of data for the research I am conducting towards a PhD degree.
2. Your approval to administer questionnaire to all the science educators in the department.
3. Your approval to interview only two science educators from the department that will be sampled.
4. Your approval to bring a video/ audio recorder personnel to the class regarding the video coverage interview classroom observations if you approve points 1, and 3 above.

Kindly note that the researcher, Daniel Asilika Allu will only give questionnaire, interview and video/ audio record on your approval and at his own cost.

I will ensure that the names of the science educators will not be recorded during the process of data collection. Furthermore, the name of the college, school and the department will also be kept confidential and will be coded so as to generate fictitious numbers and/or names. The interviews and questionnaire will be coded to ensure confidentiality of science educators. This

will prevent any form of stigmatisation or victimisation of science educators. The data will be stored in my computer that is secured with a password. The questionnaire, interview, videos/ audios will be destroyed (shredded) 2 years after the study has been completed and, on a date, agreed to by my supervisors and myself.

I will ensure confidentiality of all participants by using good data storage practices. Data will be stored in a safe/or locked cupboard and electronic data will be accessed via a password. The data will be stored in my personal computer which is protected with a password. I will also store a backup of the data in a location separate from my personal computer. This location is also password protected. Access to information about individual participants will be restricted, access only to my supervisors (who will get access to the password for electronic data and will also keep data in a locked cupboard safe).

In all publications, identities of participants (learners, teachers, college, schools, and department, districts and the state) will be protected by using codes and pseudonyms.

In case you need further clarification or have any questions kindly contact me via email at danielasilika@yahoo.com, telephone 0788829378/ 08060642975.

You may also contact my supervisors Prof Govender Nadaraj and Dr Angela James at University of KwaZulu-Natal, School of Education, Edgewood Campus at 031 260 3469 or govendern37@ukzn.ac.za and ……put her email here ….

You may also contact the Humanities and Social Sciences Research Ethics Committee whose contact details are as follows: Premlall Mohan, University of KwaZulu-Natal, Research Office,

Email: mohunp@ukzn.ac.za

Tel: 031 260 4557

Fax: 031 260 4609

It would be greatly appreciated if you could respond to my request at your earliest convenience.

Daniel Asilika Allu

Kind Regards

Cell: 0788829378 / 08060642975

Email: danielasilikaallu@yahoo.com

APPENDIX 5D: CONSENT DOCUMENT HEAD OF DEPARTMENT BIOLOGY

I give consent for you to approach the Science educators to participate in the above research.

Title: Exploring Science Educators' Reproduction and Subversion of Gender Stereotyping in Science Classes in Federal College of Education Pankshin, Nigeria

I have read the Project Information Statement explaining the purpose of the research project and understand that:

- The role of the college/ department is voluntary.
- I may decide to withdraw the college/ department participation at any time without penalty.
- The college / department science educators will be invited to participate, and permission will be sought from them.
- Only science educators who consent will participate in the project.
- All information obtained will be treated in strictest confidence.
- The science educators' names will not be used, and individual science educator will not be in any written reports about the study.
- The college/ department will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty.
- A report of the findings will be made available to the college *I* department
- Further information on the project may be sought from Allu Daniel Asilika on 08060642975/0788829378 (email danielasilikaallu@yahoo.com)

DR. FULANI G. JELTEN

Head of Department Signature

STAMP 26/06/2018.

Date

APPENDIX 5E: CONSENT DOCUMENT HEAD OF DEPARTMENT CHEMISTRY

I give consent for you to approach the Science educators to participate in the above research. **Title:** Exploring Science Educators' Reproduction and Subversion of Gender Stereotyping in Science Classes in Federal College of Education Pankshin, Nigeria

I have read the Project Information Statement explaining the purpose of the research project and understand that:

- The role of the college/ department is voluntary.
- I may decide to withdraw the college/ department participation at any time without penalty.
- The college / department science educators will be invited to participate, and permission will be sought from them.
- Only science educators who consent will participate in the project.
- All information obtained will be treated in strictest confidence.
- The science educators' names will not be used, and individual science educator will not be identifiable in any written reports about the study.
- The college/ department will not be identifiable in any written reports about the study.
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- A report of the findings will be made available to the college/ department
- Further information on the project may be sought from Allu Daniel Asilika on 08060642975/0788829378 (email danielasilikaallu@yahoo.com)

Head of Department

Gosomji Andrew

H.O.D. Chemistry Dept. F.C.E. Pankshin Plateau State Sign.....Date.....

Signature

?. C:,-- 06 2018

Date

STAMP

APPENDIX 5F: CONSENT DOCUMENT HEAD OF DEPARTMENT PHYSICS

I give consent for you to approach the Science educators to participate in the above research. **Title:** Exploring Science Educators' Reproduction and Subversion of Gender Stereotyping in Science Classes in Federal College of Education Pankshin, Nigeria. I have read the Project Information Statement explaining the purpose of the research projectand understand that:

- The role of the college/ department is voluntary.
- I may decide to withdraw the college/ department participation at any time without penalty.
- The college / department science educators will be invited to participate, and permissionwill be sought from them.
- Only science educators who consent will participate in the project.
- All information obtained will be treated in strictest confidence.
- The science educators' names will not be used, and individual science educator will not beidentifiable in any written reports about the study.
- The college/ department will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty.
- A report of the findings will be made available to the college *I* department.
- Further information on the project may be sought from Allu Daniel Asilika on08060642975/0788829378 (email danielasilikaallu@yahoo.com).

t_.., \.\-e.'N\ _____

Head of Department Signature

27/06/2018

PHYS
F.C.E. PA
STAMP

Date

APPENDIX 5 G: EDITOR'S REPORT

Crispin Hemson15
Morris Place
Glenwood Durban
4001
082 926 5333
icon@dut.ac.za

Allu Daniel Asilika-PhD Editing

TAX INVOICE 2021/11

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c/o Prof N. Govender
School of Education
UKZN

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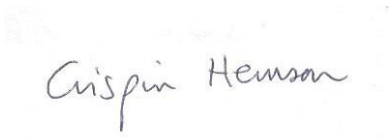

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APPENDIX 5 H: PLAGIARISM REPORT