

Exploring Gender Representations in selected Science Textbooks

By

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Declaration

I, Penelope Princess Zandile Ndlovu, declare that this dissertation is my own work. I also declare that it has not been submitted for degree purposes at any other University, and I have indicated and acknowledged all the sources used accordingly.



Student's signature

21/03/2019

Date

Supervisor's Signature

Date

Dedication

I dedicate this thesis to God the Almighty, for the strength and intellectual capacity, without which I would have not survived. In Jesus Christ's name.

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Writing this thesis was a journey, and a learning experience.

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Abstract

South African education policies such as Curriculum and Assessment Policy Statements of 2010, and legislation such as National Education Policy Act of 1997, and South African Schools Act of 1996, were established after 1994 to deal with (among other things) gender inequalities in education. However, women continue to be under-represented in Science, Technology, Engineering, and Mathematics (STEM) careers, while men dominate in these fields. This study provides the analysis of selected science textbooks that are used to teach science in South Africa, to establish if science textbooks could be the reason for women's under-representation in STEM fields. This qualitative study was located in the critical paradigm and Critical Discourse Analysis was adopted as the method of data generation and analysis. The sample comprised of four purposefully selected science textbooks that are used for teaching and learning from the Intermediate Phase to Further Education and Training phase in the South African context. The Feminist Post-Structuralist Discourse Analysis was used as a lens to guide the interpretation of the findings. The implication of the findings is that science education continues to be permeated with patriarchy. Science teachers have the responsibility to critically evaluate science textbooks to verify whether they are gender inclusive or possess gender bias. In the cases where there is evidence of gender bias, teachers need to point out the bias to the learners. They must then work with learners to develop strategies of how to resist symbolic violence and political ideology presented by print media. This study concludes by proposing that science textbooks portray males and females as producers of scientific knowledge and as possessors of scientific inventions, to address masculinist science that is presented in patriarchal view. In this way conducive environments for science teaching and learning will be attained, and possibly advance women's representation and participation in STEM fields.

Keywords: Gender inequality, science active, science passive, STEM, representation.

Table of contents

Declaration	ii
Dedication	iii
Acknowledgements	iv
Abstract	v
Table of contents	vi
List of tables	xii
List of figures	xiii
List of graphs	xv
GLOSSARY OF ACRONYMS AND ABBREVIATIONS	xvi
CHAPTER 1 ORIENTATION TO THE STUDY	1
1.1 Introduction	1
1.2 Background	1
1.3 Purpose of this study	3
1.4 Location of the Study	3
1.5 Rationale for the study	3
1.6 Significance of the study	5
1.7 Research Aim	6
1.8 Research Question.....	6
1.9 Research Design.....	6
1.10 Overview of chapters	7
1.11 Conclusion.....	7
CHAPTER 2 LITERATURE REVIEW	8
2.1 Introduction	8
2.2 Education and gender inequality in South Africa	8
2.3 History of textbook evaluation and research.....	10
2.4 The need for textbooks and their place in the curriculum.....	10

2.5 Significance of textbook evaluation and revision	11
2.6 Functions of textbooks	12
2.7 Forms of gender bias in textbooks	14
2.8 Role played by textbooks to promote gender in/equality.....	14
2.9 Stereotypes in textbooks.....	15
2.10 The concept of hegemonic masculinities	16
2.11 Gender aligned power	17
2.12 The concept of ideology.....	18
2.13 Implications of the literature	19
2.14 Theoretical framework	20
2.14.1 Background of Feminist Post-Structuralist Discourse Analysis (FPDA).	20
2.14.2 Feminist Theory	21
2.14.3 Feminism in Science	22
2.14.4 Feminist theory developed into Feminist Post-Structuralist theory.....	23
2.15 Conclusion.....	24
CHAPTER 3	26
RESEARCH DESIGN AND METHODOLOGY	26
3.1 Introduction	26
3.2 Paradigm.....	26
3.2.1 Ontological assumptions of the critical paradigm.....	27
3.2.2 Epistemological assumptions of the critical paradigm:.....	27
3.2.3 My position as a researcher	28
3.3 Approach	29
3.4 Design.....	30
3.5 Sampling.....	30
3.6 Data collection methods	31
3.7 Data analysis, procedures and tools	34

3.8 Rigour in research	40
3.8.1 Credibility.....	41
3.8.2 Confirmability	41
3.8.3 Documentation	42
3.8.4 Orderliness	42
3.9 Conclusion	44
CHAPTER 4 DATA PRESENTATION AND ANALYSIS	45
4.1 Introduction	45
4.2 Analysis of the Study and Master Physical Sciences textbook grade 12	46
4.2.1 Analysis of the textbook cover: Study and Master Physical Sciences textbook for grade twelve	47
4.2.2 Overview of analysis in the introductory part: Study and Master Physical Sciences textbook for grade 12	48
4.2.3 Textual description of the introductory part in the Physical Sciences textbook	49
4.2.4 Overview of analysis of module one: Mechanics (Physical Sciences)	53
4.2.5 Textual description of gender representation in module one: Mechanics (Physical Sciences).....	54
4.2.6 Overview of analysis in module two: Matter and Materials (Physical Sciences) grade 12.....	63
4.2.7 Textual description of module two: Matter and Materials (Physical Sciences).....	64
4.2.8 Overview of analysis of module three: Waves, Sound and Light (Physical Sciences)	67
4.2.9 Textual description of module three: Waves, Sound and Light (Physical Sciences)	68
4.2.10 Overview of analysis of module four: Chemical Change (Physical Sciences)	70
4.2.11 Textual description of module four: Chemical Change (Physical Sciences).....	71
4.2.12 Overview of analysis of module five: Electricity and magnetism (Physical Sciences) grade 12	77
4.2.13 Textual description of module five: Electricity and Magnetism (Physical Sciences)	79
4.2.14 Concluding discussion: Study and Master Physical Sciences CAPS textbook for	

grade 12.....	81
4.3 Analysis of the Study and Master Life Sciences textbook for grade 11.....	82
4.3.1 Analysis of the textbook cover for Life Sciences	83
4.3.2 Overview of the analysis of strand one: Diversity, Continuity and Change (Life Sciences).....	84
4.3.3 Textual description of strand one: Diversity, Continuity, and Change (Life Sciences)	86
4.3.4 Overview of analysis of strand two: Life Processes in Plants and Animals (Life Sciences).....	89
4.3.5 Textual description of strand two: Life Processes in Plants and Animals (Life Sciences).....	90
4.3.6 Overview of analysis of strand three: Environmental studies (Life Sciences)	92
4.3.7 Textual description of strand three: Environmental Studies (Life Sciences).....	93
4.3.8 Concluding discussion: Study and Master Life Sciences CAPS textbook	97
4.4 Analysis of the Oxford Successful Natural Sciences textbook for grade 9.....	97
4.4.1 Analysis of the textbook cover for Natural Sciences	98
4.4.2 Overview of analysis of text and visual images in Natural Sciences textbook.....	99
4.4.3 Overview of the analysis of strand one: Life and Living (Natural Sciences)	99
4.4.4 Textual description of Life and Living strand in the Natural Sciences textbook...	100
4.4.5 Overview of analysis of strand two: Matter and materials (Natural Sciences).....	103
grade 9	103
4.4.6 Textual description in Matter and Materials module (Natural Sciences).....	104
4.4.7 Overview of analysis of strand three: Energy and Change (Natural Sciences)	108
4.4.8 Textual description of strand three using visual images: Energy and Change (Natural Sciences).....	109
4.4.9 Overview of analysis in Planet Earth and Beyond (Natural Sciences)	111
4.4.10 Textual description of strand four, Planet Earth and Beyond strand in Natural Sciences textbook.....	112
4.4.11 Concluding discussion: Oxford Successful Natural Sciences CAPS textbook for grade 9	113

4.5 Analysis of Oxford Successful Natural Sciences and Technology textbook for grade 6	115
4.5.1 Analysis of the textbook cover for Natural Sciences and Technology Learner’s book for grade six.....	116
4.5.2 Overview of the analysis of strand one: Life and living/ Processing (Natural Sciences and Technology textbook for grade six)	116
4.5.3 Textual description of Life and living /Processing strand (Natural Sciences and Technology textbook)	117
4.5.4 Overview of analysis of strand two: Matter and Materials in the Natural Sciences / Technology textbook.....	120
4.5.5 Textual description of strand two: Matter and Materials (Natural Sciences and Technology)	121
4.5.6 Overview of the analysis of strand four, Planet Earth and Beyond/ Systems and Control.....	126
4.5.7 Textual description of strand four: Planet Earth and Beyond/Systems and Control	127
4.5.8 Concluding discussion: Oxford Successful Natural Sciences and Technology textbook for grade six.....	130
4.6 Discussion of the findings of the four textbooks that were analysed.....	130
4.8 Conclusion	138
CHAPTER FIVE	139
5.1 Introduction	139
5.1.1 Summary of the findings	139
5.2 Limitations of the study.....	140
5.3 Implication of the study.....	140
5.4 Suggestions for future research	142
5.5 Recommendations	142
5.6 Conclusion.....	143
REFERENCES	145
LIST OF APPENDICES.....	154
Appendix A: Turnitin Report	154

Appendix B: Ethical Clearance Certificate 155

List of tables

<i>Table 3.1 Names of textbooks analysed</i>	30
<i>Table 3.2 The framework guiding analysis of textbooks</i>	35
<i>Table 4.1 Gender representation in introductory section of Physical Sciences textbook</i>	47
<i>Table 4.2 Gender representation in Mechanics module of Physical Sciences textbook</i>	52
<i>Table 4.3 Gender representation in Matter and Materials module in the Physical Sciences textbook</i>	63
<i>Table 4.4 Gender representation in Waves, Sound and Light module in the Physical Sciences textbook</i>	66
<i>Table 4.5 Gender representation in the Chemical Change module in the Physical Sciences textbook</i>	71
<i>Table 4.6 Gender representation in the Electricity and Magnetism module</i>	78
<i>Table 4.7 Scientists portrayed in Physical Sciences textbook</i>	81
<i>Table 4.8 Gender representation in the Diversity, Continuity and Change in the Life Sciences textbook</i>	85
<i>Table 4.9 Gender representation in the Life Processes in Plants and Animals strand in the Life Sciences textbook</i>	90
<i>Table 4.10 Gender representation in the Environmental Studies strand in the Life Sciences textbook</i>	93
<i>Table 4.11 Gender representations in the Life and Living strand in the Natural Sciences textbook</i>	99
<i>Table 4.12 Gender representation in the Matter and Materials in the Natural Sciences textbook</i>	103
<i>Table 4.13 Gender representation in Energy and Change strand in the Natural Sciences textbook</i>	107
<i>Table 4.14 Gender representation in the Planet Earth and Beyond strand in the Natural Sciences textbook</i>	112
<i>Table 4.15 Scientists portrayed in the Natural Sciences textbook</i>	115
<i>Table 4.16 Gender representation in the Life and living strand in the Natural Sciences and Technology textbook</i>	117
<i>Table 4.17 Gender representation in the Matter and Materials strand in the Natural Sciences and Technology textbook</i>	121
<i>Table 4.18 Gender representation in the Planet Earth and Beyond/Systems and Control in the Natural Sciences and Technology textbook</i>	128
<i>Table 4.19 Scientists portrayed in Natural Sciences and Technology textbook</i>	132

List of figures

<i>Figure 2.1 Impact of practices in textbook design (Bruillard, 2011, p. 21)</i>	13
<i>Figure 3.1 Constructing Ground Theory, adapted from Charmaz (2006)</i>	43
<i>Figure 4.1 Cover for Physical Sciences textbook</i>	47
<i>Figure 4.2 Male scientists from the introductory part of the textbook</i>	50
<i>Figure 4.3 Male scientist represented to suggest superiority</i>	51
<i>Figure 4.4 A boy demonstrates science laboratory rules</i>	52
<i>Figure 4.5 A male is an astronaut</i>	54
<i>Figure 4.6 A woman investigates a motion in a plane</i>	55
<i>Figure 4.7 A woman is jogging</i>	55
<i>Figure 4.8 A boy illustrating a motion</i>	56
<i>Figure 4.9 A girl handling a 5kg mass</i>	57
<i>Figure 4.10 A boy pushing unspecified mass</i>	58
<i>Figure 4.11 A woman in caring role</i>	59
<i>Figure 4.12 A girl illustrating a motion</i>	59
<i>Figure 4.13 A man drives carefully</i>	60
<i>Figure 4.14 A woman is portrayed as a lawbreaker</i>	60
<i>Figure 4.15 Male scientist Wohler</i>	64
<i>Figure 4.16 A male using potent cultural symbol</i>	65
<i>Figure 4.17 Wright and Warrick</i>	66
<i>Figure 4.18 Austrian physicist Doppler</i>	68
<i>Figure 4.19 A male investigates Doppler effect</i>	68
<i>Figure 4.20 A boy is mentioned first</i>	69
<i>Figure 4.21 A girl is illustrating frequency</i>	70
<i>Figure 4.22 Male scientist Sorensen</i>	72
<i>Figure 4.23 Male scientist Faraday</i>	72
<i>Figure 4.24 A woman is science active</i>	72
<i>Figure 4.25 Male experimenting with a new idea</i>	75
<i>Figure 4.26 Male is awarded a Nobel Prize</i>	76
<i>Figure 4.27 Women in salon using a science product</i>	74
<i>Figure 4.28 Woman as a consumer of science product</i>	76
<i>Figure 4.29 Males in Electricity and magnetism</i>	79
<i>Figure 4.30 Cover for Life Sciences textbook</i>	83
<i>Figure 4.31 Woman using potent cultural symbol</i>	86
<i>Figure 4.32 Woman in nursing role</i>	86
<i>Figure 4.33 Males with late blight of potato</i>	87
<i>Figure 4.34 Women brewing beer</i>	88
<i>Figure 4.35 Males with whooping cough</i>	88
<i>Figure 4.36 Male and female depicted science active</i>	90
<i>Figure 4.37 Not naming a female scientist is a gender bias</i>	91
<i>Figure 4.38 A woman with anorexia versus an obese man</i>	92
<i>Figure 4.39 A boy experimenting with lungs</i>	94
<i>Figure 4.40 Woman portrayed viewing microscopic slides</i>	94
<i>Figure 4.41 Female's body used as a teaching aid</i>	95
<i>Figure 4.42 Sex role stereotype of women in caring role</i>	96
<i>Figure 4.43 Cover for Natural Sciences textbook</i>	98
<i>Figure 4.44 Male scientists Leeuwenhoek and Hooke</i>	100
<i>Figure 4.45 Representation of a male and a female with a disease</i>	101
<i>Figure 4.46 Males and females as teaching aids</i>	102
<i>Figure 4.47 Representation of a male scientist as mining engineer</i>	107

<i>Figure 4.48 A female scientist as the chemical engineer</i>	107
<i>Figure 4.49 Female scientist as the pharmacist is backgrounded</i>	105
<i>Figure 4.50 A woman scientist is not named</i>	106
<i>Figure 4.51 A male described as attentive chemistry student</i>	107
<i>Figure 4.52 Boys and girls exerting forces</i>	110
<i>Figure 4.53 Boys pushing a car</i>	110
<i>Figure 4.54 Girls in frictional and non – contact forces</i>	110
<i>Figure 4.55 A boy portrayed as adventurous</i>	110
<i>Figure 4.56 A woman travels from East London to Johannesburg, confined to local settings</i>	111
<i>Figure 4.57 A female scientist is described as lonely</i>	112
<i>Figure 4.58 Cover for Natural Sciences and Technology grade 6</i>	116
<i>Figure 4.59 Boys and girls investigating the ecosystem</i>	117
<i>Figure 4.60 An obese man measures his waist</i>	118
<i>Figure 4.61 A girl illustrates breathing</i>	119
<i>Figure 4.62 A girl depicted as a consumer of science product, food</i>	119
<i>Figure 4.63 A girl demonstrating that paper has 10 000 particles</i>	121
<i>Figure 4.64 Boys and girls representing the state of matter</i>	122
<i>Figure 4.65 Girls observing mixtures separating</i>	122
<i>Figure 4.66 Boys and girls investigating the rate of dissolving</i>	123
<i>Figure 4.67 South African female scientist Stephens</i>	124
<i>Figure 4.68 A man represented with low modality</i>	125
<i>Figure 4.69 Galileo Galilei</i>	128
<i>Figure 4.70 Male Scientist Buzz Aldrin</i>	129
<i>Figure 4.71 Male scientist George Pratley</i>	129

List of graphs

<i>Graph 4.1 Gender representation as science active in selected science textbooks.....</i>	<i>132</i>
<i>Graph 4.2 Gender representations as science passive in selected science textbooks.....</i>	<i>133</i>

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

STEM – Science Technology Engineering and Mathematics

IP - Intermediate Phase

FET- Further Education and Training

SP - Senior Phase

CAPS- Curriculum and Assessment Policy Statements

CDA- Critical Discourse Analysis

FPDA – Feminist Post –Structuralist Discourse Analysis

NS- Natural Sciences

LTSM – Learner Teacher Support Material

UNESCO – United Nations Educational Scientific and Cultural Organisation

DBE – Department of Basic Education

HEIs – Higher Education Institutions

USA – United States of America

US – United States

DA –Discourse Analysis

CHAPTER 1 ORIENTATION TO THE STUDY

1.1 Introduction

Textbooks are considered as the tools that are used by social structures to maintain political ideologies in the society (Machin & Mayr, 2012; UNESCO, 2011). Fairclough (2003) argues that texts possess the ability to disseminate ideology in subtle ways. Education policies inform the textbook authors and publishers on how to design textbooks to perpetuate such political ideologies (Pingel, 2010). Apart from the content knowledge, texts are loaded with assumptions. “What is ‘said’ in a text is ‘said’ against a background of what is ‘unsaid’, but taken as given” (Fairclough, 2003, p. 11). This argument confirms that texts can be strategically used to express and impose ideologies that are not obvious to readers. Hence this study explores gender representations in selected science textbooks to uncover such ideologies, in order to reveal their possible impact on boys and girls as lifelong learners.

In the background section of this study, I firstly outline a brief history of South African education, to demonstrate how policies of the government were used before 1994 to lay the foundation for textbook writing. This study investigates gender representations in textbooks, therefore it is important to show the connection or link between what is depicted in textbooks, and the prescriptions of the government and its education policies. I have also outlined how the post-1994 government of South Africa has established policies and legislation to address gender representations in education. These policies and legislation are outlined in this study because they inform textbooks as part of the curriculum.

After the background, I present purpose, rationale, significance, and context of the study. I also provide the brief outline of the research objective and research question, research design and findings of the study as well as overview of the chapters.

1.2 Background

South African education provisioning before 1994 marginalised women of all races, and they were treated as second class citizens (De Wet, 2011; Maringe & Prew, 2015; Volovitz, Vichyanond, & Zhong, 2004). Angie Motshekga, the minister of education in South Africa, mentioned that South Africa’s education curriculum before 1994 reinforced inequality, and the roles to play in the wider society. The policy of apartheid in South Africa was designed such

that girls were schooled for domesticity to occupy inferior positions in the society as women, while boys were schooled to take managerial positions and to be dominant in the economic, social and political fields in the society (De Wet, 2011; Keddie, 2012; Mbeki, 2001; Simpson, 2004; Volovitz et al., 2004). Schools and schooling were deeply rooted in patriarchal ideology (Chisholm, 2005; Coetzee, 2001; Volovitz et al., 2004). Coetzee proposes that structures of domination that perpetuate patriarchal ideology should be addressed first and foremost, then strategies be devised and implemented to eliminate gender discrimination. He argues that an ideology relates to the promotion of some norm, value, idea, motive or goal to a position of supreme importance in society fields. He further states that in South Africa patriarchal ideology make women to be restricted to specific jobs, inferior to those assigned to men. “Women become to accept their subservient position in society and presumed inferiority as natural...” (Coetzee, 2001, p. 302).

Women are under-represented in highly valued science fields (Su & Rounds, 2015). It has been noted that the representation of women is greater in health, education, and social sciences than in science and engineering subject areas, where rewards and career prospects are better (Biemmi, 2015; Mbeki, 2001). Men are largely seen in occupations that involve major decisions in the society (De Wet, 2011; Isaacs, 2015). “In the instance of gender oppression, ideology can be seen as a tool consciously (or unconsciously) implemented in the struggle for social supremacy” (Coetzee, 2001, p. 300). Mbeki (2001) mentions that increasing numbers of women that partake in science and technology will not only benefit women, as this will enhance their productivity, but will also impact positively on the country’s economic and social development. He further states that empowered citizens are innovative and contribute to the country’s national productivity and sustainability. In his article “*South Africa’s National Policy Framework for women’s empowerment and gender equality*”, he mentions that South Africans focused and became successful in addressing racism, while neglecting the issue of gender discrimination. Within the South African context, the curriculum, with its textbooks, have been used to achieve the aims of the social justice ideology which strongly underpin the Constitution.

The Curriculum and Assessment Policy Statements (CAPS), is the fundamental curriculum policy document. It emphasizes the significance of textbooks, and that every learner should acquire his or her own textbook (DBE, 2011; Motshekga, 2013a). The Natural Sciences (NS) CAPS document encourages teachers to select the content carefully, in order to promote the understanding of science, social justice and societal development. Textbooks are one of the

resources that contain a large percentage of content that is taught in science subjects. Many schools in South Africa are located in rural areas, and these areas are underdeveloped. Learners in these areas do not have access to internet facilities. Therefore, textbooks are the only resources learners rely on for content knowledge, and to prepare for assessment (Motshekga, 2013a). In the CAPS document for Natural Sciences grades seven to nine, the content to be taught in each grade is summarized in a tabular format and the last column of the table specifies resources to be used. The CAPS document mentions textbooks as the main Learner Teacher Support Materials (LTSM) for teaching theoretical content (DBE, 2011). Textbooks dominate teaching and learning, therefore teachers depend on them when planning their lessons (Chiponda, 2014; DBE, 2011).

Scientists are portrayed in many science textbooks as white males, for example in the textbook “*Study and Master Physical Sciences Grade 12 learner’s book*” (published by Cambridge University Press in 2013). Therefore, this textbook lacks gender inclusivity. This is possibly why STEM fields are dominated by white males (Riegle-Crumb, Moore, & Ramos-Wada, 2011). Based on a review of literature, and my professional experience as a science teacher, this motivated me to pursue this study. I purposed to uncover the different forms of gender representations, and possible gender discrimination in selected science textbooks.

1.3 Purpose of this study

The literature reveals that several studies have been conducted locally and internationally on women’s under-representation in STEM fields. The purpose of this study, then, is to examine how gender representations are manifested in South African science textbooks, i.e. whether science textbooks represent the genders fairly or not.

1.4 Location of the Study

This study was conducted in South Africa. Textbooks which are used by science students from primary schools to secondary schools in the province of KwaZulu - Natal were examined. These are textbooks that are used by diverse learners to their racial, political and socio – economic contexts.

1.5 Rationale for the study

Three reasons underpin the motivation for this study. The first is based on my experiences of girls’ choice of science subjects at school, the second, on the literature I reviewed, and the third,

on the place of textbooks within the educational policy and the curriculum.

I have noticed that (based on my experience as a science teacher for eleven years) there are fewer girls who choose science subjects at high school as compared to boys. I have also realised that although many girls adopt a positive attitude to Life Sciences as a subject, they do not perform well academically. As a science teacher, I am concerned that girls perform well in science in junior years but most of them pursue Life Sciences in higher grades, while a higher percentage of boys pursue Physical Sciences. I have observed that at the tertiary level, the number of women students who pursue science decreases rapidly. Some women students who express interest in science careers, change their minds when applying to universities and choose other areas of study (Clark Blickenstaff*, 2005; Zastavker et al., 2009). Others who start learning the courses in STEM streams change their minds before graduation and switch to non-science courses. These women students believe that STEM subjects are traditionally male and are difficult for females (Bix, 2000; Clark Blickenstaff*, 2005). Bix (2000) argues that, in certain universities, education is designed to prepare men for particular fields in engineering. This empowers them to become self-reliant, responsible citizens. Women on the other hand, are prepared for the so called white apron jobs in foods and hospitals (Bix, 2000), despite the fact that they are academically proficient to pursue STEM fields (Mudaly & Van Wyk, 2015).

Literature reveals that unequal gender representations in education have become a norm and I believe that this needs to be challenged. Textbooks, teaching methods, classroom processes, and curriculum contexts have been found to be gender biased, and this disadvantages girls' learning (DBE, 2011). Addressing gender inequality should be demonstrated by reducing sexism, gender biases and stereotypes in children's reading material (Davies, 2018). The type of socialisation in textbooks, prepare women for inappropriate and dysfunctional role in the society (Chisholm, 2018; Warren, 1990; Warren & Rogers, 1988). Women are socialised to be in lower status in careers, especially those in science and technology fields which provide highest prestige. According to the "*South Africa's National Policy Framework for Women's Empowerment*", South Africa possesses a historical legacy of patriarchy which has a negative effect at the workplace (Mbeki, 2001). When comparing men and women, majority of women were found to be concentrated in the fields of employment with low wages and fewer promotional opportunities than men (Heleta, 2016; Mbeki, 2001; Warren, 1990). These societal stereotypes of male and female occupations are reinforced in textbooks (Biemmi, 2015).

Textbooks are an integral LTSM (within the South African context) because they contain

general components of the curriculum in details, including the teaching sequence (DBE,2011). They also provide samples of assessment tasks ranging from simple to complex ones. This ensures that different cognitive levels of thinking are adequately assessed (Budden, 2007; UNESCO, 2002). The policies of South African education, such as the National Education Policy Act 27 of 1996, aim to achieve the promotion of gender equality and advancement of the status of women. This has heightened my interest towards finding out whether this policy has been considered by the authors of science textbooks, based on my analysis of science textbooks. The South African Schools Act emphasizes that the State opposes unfair discrimination against anyone on the grounds of gender (Potgieter, Visser, Van der Bank, Mothata, & Squelch, 1997; Ramaahlo, Tönsing, & Bornman, 2018). It is therefore imperative that science textbooks be critically analysed in order to determine their role in promoting advancement of women in science.

1.6 Significance of the study

This study will be significant because it will heighten awareness to gender discrimination of teachers, curriculum designers and those who are entrusted with selection of school textbooks.

The findings of this study will help policy makers to set criteria for textbook authors, publishers and editors that considers gender equality. It also will inform the teachers about the importance of gender inclusivity in textbooks. Science teachers evaluate the textbook catalogue released by the Department of Basic Education (DBE) annually. It is therefore imperative that teachers critically examine textbooks in order to make informed choices. This study will guide science teachers on how to select gender inclusive textbooks.

Fairclough (2013) argues that teachers have the responsibility to make learners aware of the ideological content in texts. He further recommends that teachers should equip learners with strategies on how to resist continuing assaults in print media. Hence this study will also influence staff from tertiary institutions who recruit students, and promote careers during career exhibitions. They will be able to motivate and guide girls to aspire to engage in highly valued science fields.

At the management level, subject advisors are tasked to supervise and motivate teachers to maximise opportunities for learners' academic achievement and progress. Subject advisors are also tasked by DBE to evaluate textbook samples before they are approved to be included in school catalogues. At the end of their evaluations, they compile a report justifying why the

textbook is or is not recommended. One of the criteria that subject advisors consider is gender inclusivity (Pingel, 2010). Hence this study seeks to inform subject advisors about the political ideologies in texts. This will enable them to make responsible and informed decisions on whether or not to approve the textbook, based on outcomes of gender evaluations. It will also empower them to provide sound arguments when they write a report justifying their decisions on why they or did not approve samples of textbooks.

1.7 Research Aim

The aim of this study is to explore gender representations in selected science textbooks. I purposed to evaluate science textbooks, to determine whether they disseminate patriarchy, hegemonic masculinity and gender discrimination or not.

1.8 Research Question

The research question that underpin this study is:

How is gender represented in selected science textbooks?

1.9 Research Design

This study followed the qualitative approach to gain the understanding of how gender is represented in selected science textbooks (Creswell, 2009). The critical paradigm was used as a worldview to guide the study. Critical Discourse Analysis (CDA) was used as a method of data generation. Words and visuals that were analysed were largely guided by the framework provided by Machin and Mayr (2012). However, other literature studies were also used as a frame of reference on the deliberations of the study, for example, Kress and van Leeuwen (2006) and Fitzgibbon (2013). The sample of this study included four textbooks of science that are included on the DBE's prescribed list of textbooks and are used for teaching and learning in South African schools. Each textbook represented a specific grade from the Foundation to Further Education and Training phase. The sample included the Natural Sciences and Technology textbook for grade six, the Natural Sciences textbook for grade nine, the Life Sciences textbook for grade eleven, and the Physical Sciences textbook for grade twelve. The textbooks that were analysed were from different publishers to triangulate in order to enhance trustworthiness.

1.10 Overview of chapters

Chapter one sets the scene for the study. I introduced chapter one by outlining the background of South African education, to demonstrate how the policies of education prior to 1994 informed the curriculum. I have also highlighted how the current policy of education, Curriculum and Assessment Policy Statements (CAPS), endorses textbooks as the main Learner Teacher Support Materials (LTSM). The purpose, rationale and significance of the study were also delineated. I have also introduced the research objective and research question. I concluded chapter one by providing the brief outline of the research design for the study, and a few insights to the findings of the study.

In chapter two, I discussed the literature that I reviewed in order to locate the study within the ongoing dialogue, and to identify the research gaps. Both local and international literature were reviewed.

In chapter three, I discussed the methodological approach that I adopted. I provided details of the paradigm, design, and sample for the study. Critical Discourse Analysis is discussed in detail as the method that I used for data generation and analysis. I also outlined how rigour was achieved through applying the principles of trustworthiness.

In chapter four I presented the findings of the study. I employed CDA as a method for data generation in the four textbooks that I analysed. The CDA empowered me to answer the main research question, “How is gender represented in selected science textbooks?”

In chapter five I presented the summary of the findings of this study. I also provided limitations, and recommendations for further research.

1.11 Conclusion

In this chapter (chapter one), I have laid the background for the study, and then outlined the purpose, rationale, and significance thereof. This led to the development of the research objective and question. I have also highlighted the research methodology that I used to generate data. I then provided the outline of the remaining chapters. In the next chapter I discuss the literature that I reviewed.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

In the previous chapter, I presented the background to the study, rationale, significance of the study, research objective and question as well as the brief outline of the research design and findings of the study. In this chapter, I present the literature that I reviewed that informs my study, as well as the theoretical framework that underpins this study. Hart (2018) states that reviewing the literature enables the researcher to acquire deeper understanding of the topic that has been researched, thereby disclosing the key issues of the topic.

The first theme of the literature review of this study discusses the history of gender inequalities in South African education. This theme reveals that South African education prior to 1994 was rooted in patriarchal ideology. It also discusses the legislative framework and policies that were adopted by the first democratic government of South Africa to address the injustices of the past, one of which was gender inequalities in education. For example, the South African Schools Act of 1996 was specifically implemented to identify and address gender inequalities and discrimination in schools and schooling (De Wet, 2011). Other themes include the history of textbook evaluation and their place in the curriculum, the need for textbooks and their place in the curriculum, the significance of textbook evaluation and revision, the functions of textbooks, the forms of gender bias in textbooks, the role played by textbooks to promote gender inequality both locally and internationally. I also present themes on stereotypes in textbooks, the concept of hegemonic masculinity, gender aligned power, and finally the concept of ideology. I conclude the chapter by discussing the theoretical framework that I adopted, which is the Feminist Post-Structuralist Discourse Analysis (FPDA).

2.2 Education and gender inequality in South Africa

Volovitz et al. (2004) and De Wet (2011) argue that before 1994 in South Africa, girls and women of all races were subjected to patriarchal forms of oppression. Schools were defined in terms of race, gender and sexual orientation. For example, it was the decision of school management structures as to which subjects could be learnt by girls, who were channelled into subject areas away from science. Boys dominated science classes (Volovitz et al., 2004). Girls' performances at primary schools were equal to and sometimes better than that of boys, yet

when girls reached high school, their performance declined sharply (De Wet, 2011; Volovitz et al., 2004).

After the election of the first democratic government of South Africa in 1994, when the late and former president Nelson Mandela came into power, he mentioned in his inaugural speech that emancipation of South Africa relied on ensuring that women are emancipated from all forms of oppression (Mandela, 2013; Mandela & Boatman, 2012) .

New policies were implemented to address racial and gender discrimination. The Constitution of the Republic of South Africa was adopted to heal injustices and divisions of the past, and to establish a society based on democratic values, social justice, and fundamental human rights (Moloi & Chetty, 2012). The new Constitution of the Republic of South Africa was adopted to ensure achievement of equality, and advancement of non – sexism (Badat, 2010).

After 1994, the South African Schools Act of 1996 was implemented as a strategy of dealing with, among other things, gender discrimination (De Wet, 2011). This Act empowered the educational institutions to identify and address gender inequalities in schools. By 1999, the policy of apartheid was successfully removed. CAPS grades R -12 commits to addressing gender inequalities at schools through improving the manner, and the context in which knowledge and skills are acquired (DBE, 2011).

At Higher Education Institutions (HEIs), women students continue to be underrepresented in the Engineering faculty, and there has been very little transformation in the gender composition of staff (Shackleton, Riordan, & Simonis, 2006). By 2008 there was continued evidence of under-representation of women in doctoral graduate programmes. Only 41% of students in these programmes at South African universities were females. This signals a need to encourage participation of female South Africans in post-graduate studies in order to give effect to redress and social equity. Strategies of inclusion in HEIs should focus on de -masculinising, and de – gendering (Badat, 2010; Mbeki, 2001).

Recent studies in science related careers in South Africa, such as that conducted by Mudaly and Van Wyk (2015), reveal that transformation has partially taken place in South Africa. The findings of their study reveal that there has been a dramatic increase in the number of women who enrol, and graduate in medicine profession. However, they state that gender discrimination persists in these fields. Women continue to be marginalised from highly prestigious fields.

2.3 History of textbook evaluation and research

Smith (2010) states that after the Second World War, nations which were members of the league of nations, launched an international programme for textbook comparison and revision as a scholarly activity. He further mentions that members of the league of nations established, and adopted strategies to revise and remove one sided images, and address controversial issues in textbooks. This also encompassed addressing portrayals that exhibited inequalities between men and women (Smith, 2010).

UNESCO began to evaluate reading materials in order to identify and address sexism and gender stereotypes during the 1970s (Pingel, 2010). Sadker and Sadker (2010) state that as early as 1970s, textbook companies such American Psychological Association, launched guidelines for non - sexist books. They recommended fair portrayals of different genders in the curriculum. This led to a remarkable achievement of production of more gender balanced textbooks. UNESCO (2011) states that a research programme on the image of woman was launched after the “*1980 Copenhagen World Conference of the United Nations*” for women. It revealed that sexism in textbooks characterised failure to acknowledge a variety of actual roles played by men and women in the society.

2.4 The need for textbooks and their place in the curriculum

Lee (2018) advocates that despite being vessels of the intended curriculum, textbooks serve as a form of the hidden curriculum, shaping learner’s values, attitudes and social skills. He states that the hidden curriculum can exhibit prejudices against particular gender groups. He further mentions that textbooks, as a form hidden curriculum, contribute to children’s personal development, shaping how they perceive themselves, which ultimately affects their academic and career choices. Turner and Oakes (1986) state that images in textbooks provide learners with sources of references for career choices.

Textbooks also serve as a channel for achieving the intended curriculum goals in many nations (Foulds, 2013; Lawrence, 2011). Here in South Africa, the CAPS document (in different subjects) outlines the topics to be covered for a specific grade curriculum, but the content curriculum is detailed in prescribed textbooks and the educator is advised to use a variety of textbooks to ensure maximum content coverage (DBE, 2011). In most countries children can access internet, browse e-books in different websites. However, in small towns and rural areas, textbooks continue to be the main LTSM, because they serve as an important repository of

knowledge that teachers and learners rely on, and have proven to produce excellent results especially in matric final examinations (Motshekga, 2013b).

Nakagawa and Wotipka (2016) mention that textbooks guide teaching and learning because they provide detailed subject matter. Hence teachers regard them as the main source of information (Chiponda, 2014; Nakagawa & Wotipka, 2016). They continue to mention that making women invisible in curricula is a form of marginalisation. Topics to be covered for curriculum planning are summarized in the CAPS document in South African education (Motshekga, 2013b), and most textbook authors have ensured that all the components of the curriculum are well covered in textbooks. Sections of the textbook content are organised such that all work to be taught in the term is arranged together, and this tallies with requirements of the CAPS document (DBE,2011). Therefore, textbooks are reliable to guide the teaching and learning processes (Brugelles & Cromer, 2009). Textbooks also improve the quality of teaching and learning (Motshekga, 2013a), because their illustrations, particularly in science subjects, make the subject matter more understandable.

2.5 Significance of textbook evaluation and revision

Foster (2011) states that textbooks are regarded as the means through which nations seek to propagate and underpin accounts that delineate conceptions of nationhood, and national identity. UNESCO (2011) states that textbooks are of value in nation states because they possess statements that either exalt their own nations, ruling groups within one nation and society, or ridicule the minority groups. It further states that textbooks communicate political ideologies, and justify political trends that the nation follows by permeating them with historical legitimacy. Since textbooks are regarded as the universal tool of teaching, it is imperative that they be designed in manner that is sensitive to the needs of students (Pingel, 2010).

Morgan (2012) states that textbook research was also meant to eradicate stereotypes from children's reading material, so that they (children) would have a better understanding of foreign communities. He further states that effective textbook revision will help eliminate biases, misrepresentations, and hate messages. Repoussi and Tutiaux-Guillon (2010) argue that nations use textbooks as tools of power whereby cultures and ideologies are disseminated. Pingel (2010) mentions that in addition to transmitting social norms and norms of living with other people, unprejudiced textbooks can be used to promote global understanding.

Bruillard (2011) mentions that textbooks contribute to the process of socialisation and acculturation of the younger generation. Foster (2011) regards textbooks as powerful cultural artefacts, embodying ideas, values and knowledge that societies anticipate learners to know and embrace.

UNESCO (2011) proposes that textbooks should offer a range of role models for female and male genders in order to exhibit that every type of skill is open to all sexes. This document further recommends that processes of marginalisation and equality be expounded to learners. In this way learners will be empowered to conquer the ideology of designated gender roles (Fairclough, 2003). Learners will also envisage themselves permeating roles that otherwise seemed forbidden to them. UNESCO (2011) further proposes that a quality textbook be stereotype-free in order to attain quality education. In addition to being effective and innovative, textbooks have to be inclusive (Srivastava, 2014). The authors, editors, illustrators, designers and publishers need to ensure that textbooks that are produced are gender-balanced and stereotype-free (Fairclough, 2013).

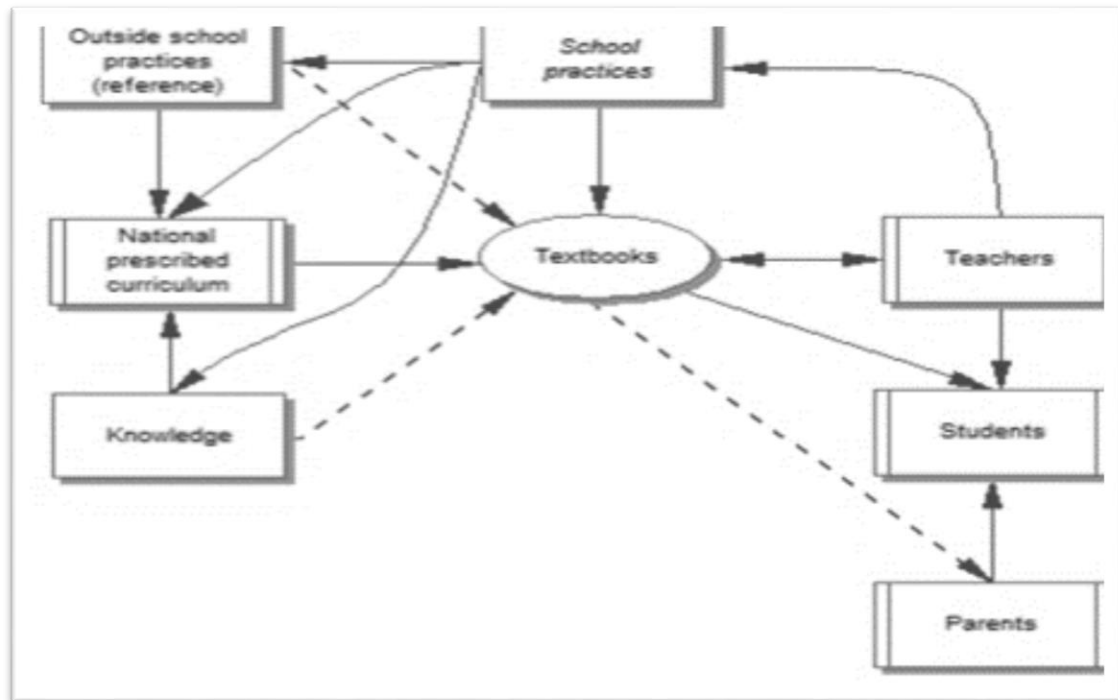
2.6 Functions of textbooks

Apart from developing intellectual capacity of learners, textbooks bring cultural awareness to learners as societal members (Tomalin & Stempleski, 2013). In most societies, textbooks serve as tools for transformation because they convey culture, values and societal beliefs (Mirza, 2004). Children learn the concept of gender and consequently self-image, behaviour, aspirations, and expectations through the manner in which the images of males and females are portrayed in textbooks (Biemmi, 2015).

Bruillard (2011) mentions four functions of textbooks. He states that the first function of the textbook is that it serves as a “referential”. He elaborates that this means that sometimes the textbook becomes the main document that provides the educational content in detail. He further mentions that textbooks are instrumental, providing teaching methods and activities. He elaborates that textbooks serve the ideological and cultural function, contributing in socialisation and acculturation processes. Lastly, he mentions that textbooks play a documentary role, providing learners with archives and symbols from which they develop critical thinking skills.

In figure 2.1 below, Bruillard (2011) presents the flow diagram that demonstrates how textbooks, as the national curriculum, prescribe to teachers what to teach, and to learners what

to learn.



Keys: Dotted lines represent blurred relationships

Arrows represent determining relationships

Figure 2.1 Impact of practices in textbook design (Bruillard, 2011, p. 21)

The figure 2.1 reveals that who the learners become outside the classroom is largely shaped by textbooks. There is a reciprocal relationship between textbooks and teachers. This means that every knowledge area that the Department of Basic Education deems necessary to be transmitted to the learner, is embodied in the textbook. Teachers are expected to transfer this knowledge to learners. Sometimes teachers do not even challenge such information. Arrows indicate that teachers are mandated to transmit the textbook knowledge as it is, irrespective of whether it is obscured or not. Textbooks may also present blurred perceptions of who learners must become after schooling.

Other function of texts include expressive function (Bazerman, 2003). Bazerman (2003) mentions that the reader has to discover how the writer uses text to express his feelings, for example it can be through authoritative statements. Cap (2016) mentions that texts possess vocative function. This means that texts must be written in the language that is understandable to the reader. He further mentions the aesthetic function, whereby language is used to please

the reader through actual and imagined sound as well as through metaphors. Lastly, Porter (2017) mentions the phatic function, where language is used to maintain friendly contact with the reader instead of imparting the foreign information.

2.7 Forms of gender bias in textbooks

Sadker and Sadker (2010) mention that sexism in textbooks channels girls into secretarial vocations, cosmetology, and other low paying occupations. They further state that girls are found to be abundant in Biology, Chemistry, Algebra, and Precalculus courses. On the contrary, boys dominate the Calculus, Physics, and Computer Science classes. They argue that textbooks portray men as shakers of history, and scientists of achievement. Zittleman and Sadker (2015) state that gender bias in textbooks also manifests in the form of deliberate omissions of particularly famous women, those with disabilities, and men in parenting roles. They also mention that gender bias can also take the form of linguistic bias, where the text exclusively uses masculine terms such as mankind, forefathers, etc., depriving women full participation and recognition. Lastly, they mention that cosmetic bias is another form of gender bias. One example is the case where a woman scientist is featured in a superficially attractive publication, but the author then provides little narratives of her scientific contributions.

Kahveci (2010) conducted a quantitative analysis study on science, and chemistry textbooks in Turkey. The purpose of the study was to explore the effectiveness of textbooks in terms of their reflection of reform. One of the themes for the study was gender issues. The sample comprised ten science and ten chemistry textbooks that were selected and analysed using content analysis. The content, photographs and illustrations were carefully scrutinised. As the study was located in the quantitative approach, photographs and illustrations were counted. They were then classified according to whether they depicted males only, females only or both. In the analysis of text, people mentioned were counted and classified according to whether they were males or females. Pronouns and generic nouns were considered. The findings revealed that science textbooks lacked gender inclusivity. Males dominated in texts, photographs and drawings. Gender parity was only found in the use of nouns, with female nouns slightly exceeding male nouns.

2.8 Role played by textbooks to promote gender in/equality

Williams and Bennett (2016) conducted the study titled "*How American History textbooks' visuals represent women*". They discovered that whenever women are fitted in American

history textbooks, they only suit the patriarchal view. They argue that textbooks negatively affect how girls view history. Taylor-Mendes (2009) mentions that portrayals in textbooks contribute to girls' low self-esteem, and their withdrawal during lessons. This ultimately impacts negatively on their academic performance. Furthermore, they perpetuate women's position of subordination and passivity. Hill, Corbett, and St Rose (2010) state that the detrimental factors that negatively affect students' attitudes towards Science, Mathematics and Technology are curricula, school textbooks, teachers and their teaching practice. Sadker and Sadker (2010) propose that teachers and learners should confront bias in texts, and work jointly in evaluating textbooks critically, in order to uncover ideologies. The Minister of Education in South Africa, Angie Motshekga, advocates that textbooks be improved because they contribute to bringing about the ideal world envisaged by the Constitution (Motshekga, 2013a).

Studies on textbook evaluation confirm that there is evidence of patriarchal values in textbooks as LTSM (Srivastava, 2012). The message articulated by textbook portrayals is, there are jobs reserved for men, which are better and best paying compared to those that are reserved for women (Biemmi, 2015; Chikunda & Chikunda, 2016; Chiponda, 2014). For example, women are portrayed as victims and in caring roles more often than men (Chikunda & Chikunda, 2016; Kerkhoven, Russo, Land-Zandstra, Saxena, & Rodenburg, 2016). Careers pursued by women outside the home are seen in textbooks as an extension of domestic activities, while men are depicted as decision makers in the society (DBE, 2011).

Khvilon and Patru (2018) state that textbook authors should eliminate provocative statements, and flawed ideas from textbooks. Pingel (2010) argues that improvement of textbooks will foster principles of equality and democracy in learners. He advocates that authors must refrain from publishing textbooks that are one-sided, and with obvious prejudices. Teachers are encouraged to examine documents and discursive practices "...that are taken for granted in schools and universities to find out what conditions they are possibly maintaining" (Davies, 2006, p. 6).

2.9 Stereotypes in textbooks

Fiske (2018) defines a stereotype as a universal idea that is strongly held in people's minds about the category of the specific group of people. He states that the generalised belief of the category of a particular person may be erroneous. He mentions that stereotypes promote prejudices. Sleeter and Grant (2017) therefore recommends that textbooks be evaluated regularly in order to identify and remove stereotypes. Blumberg (2015) mention that the

findings of textbook analysis by UNESCO revealed that the Turkish textbook depicted a girl dreaming of her wedding day. On the contrary, a boy was depicted dreaming of becoming a doctor. In Chinese social studies textbooks, all scientists were depicted as males, while women were depicted as teachers and service personnel (Blumberg, 2015). In the previous study, Blumberg (2008) states that in addition to the stereotypes that depicted women in caring and domestic roles in American textbooks, there was a lack of portrayals of working women. He further mentions that analysis revealed that for every three males that were depicted, there was only one woman. Blumberg (2008) elaborates that in almost all portrayals, males were depicted in the positions of power more frequently than women. Women were also portrayed either as shrewd mothers, confused or incapable. Kerkhoven et al. (2016) conducted a study to determine gender representations in science education resources. They used content analysis as a method of data collection. The findings revealed that there were more males than females depicted within the science profession. Women were mainly depicted as teachers. They suggest that teachers should create and conduct gender balanced lessons, in order to increase enthusiasm for science, particularly in girls.

Brugelles and Cromer (2009) mention that the absence of girls from textbooks is linked to the high drop out rate of girls from schools in many countries. They elaborate that exclusion of girls from textbooks contribute to their lack of confidence and low self esteem in science subjects.

Knudsen (2005) mentions that femininity and masculinity are formed by society and its institutions. He therefore encourages textbook researchers to analyse textbooks from gender perspective. For this reason, in the subsections below, I provide the discussion of how societies promote masculinity in order to maintain the dominion of men over women, and how this ultimately informs textbook production.

2.10 The concept of hegemonic masculinities

Hegemony intertwines the political, economic, and military dominance of one state over another. The concept of “hegemonic masculinity” dates back to the 1980s in Australia from the debates over the role of Australian men in labour politics. These debates developed into systematised articles, and male sex role in literature (Connell & Messerschmidt, 2005). Although Gramsci, who is the founder of the term “hegemony”, did not formulate its precise definition, he used it to describe how the ruling groups, which he referred to as dominant fundamental group, exploited and manipulated their subordinates. Gramsci described the act

of manipulation as “imposing the direction of social life” 9 (Gramsci, 2009). Lung and Ball (2015) mention that Gramsci linked hegemony to the concept of power whereby one social group benefits, thereby maintaining its power. Gramsci referred to the subordinates as the oppressed group that cannot resist the oppression by the dominant group or ruling class, because existing class relations have been made acceptable to the society. In other words, people accept oppression as normal, even though it only benefits the interest of those in power. They further state that hegemony is not just manipulation, but it shapes how we perceive ourselves and the world. That is why hegemony becomes extremely difficult to resist and overcome.

Hence, hegemonic masculinity is the dominance of men over women. It is characterised by viewing women as subservient and most apt for domestic duties. It encourages women subordination and their voices are often ignored. It advocates that men should be tough, brave to face danger, and to dominate over others. In patriarchal societies men are viewed as superior beings, while women are regarded as inferior and submissive beings (Kareithi, 2014). The greater part of the population is persuaded through print media to maintain women’s subordination (Park, 2015). Tollefson and Pérez-Milans (2018) state that education curricula may be found perpetuating social inequality and hegemonic masculinity. They further mention that when one gender is portrayed as subordinates in textbooks, learners may eventually become disinterested and distance themselves from the representations of the world textbooks. They propose that a strategy for reducing hegemonic domination by privileged groups be designed and implemented in order to deal with one sided prejudices. Baker (2016) views Biology (as a university course) as female predominated. The findings of his study in USA revealed that only thirty to forty percent of male learners enrolled for Biology, while in Physics classes male learners constituted seventy to eighty percent compared to girls.

2.11 Gender aligned power

Connell (2013) states that power in societies is mandated according to class, race and gender. Mirembe and Davies (2001) confirm Connell’s statement and further mentions that messages of the official curriculum promote male domination and power imbalances. They argue that in schools, power is demonstrated through hegemonic masculinity, which is one form of exercising control in schools.

Evidence of gender aligned power is confirmed by Knudsen (2005) who indicate that women’s position of subordination is dual, linked to their status at work, and family. She mentions that

segregation of occupation is remarkably noticeable in engineering profession. She conducted her study in Norway, including men and women in engineering in the sample. The findings revealed that engineering is still a male dominated occupation, and a high paying job. Analysis of questionnaires revealed that women are doing well in engineering studies. However, when they are employed, they are sidelined into low status positions, with little or no chances of moving into managerial positions. Women's status in the workforce is largely shaped by gender linked roles portrayed in textbooks (Blumberg, 2008). Science textbooks and curricula do not depict enough female scientists, and girls are rarely given opportunities to handle scientific equipment at high schools. This has resulted in a culture that conveys a message to girls that, science is anti feminine (Sadker & Zittleman, 2009). Stout, Dasgupta, Hunsinger, and McManus (2011) argue that this is one of the reasons why there is gender disparity in STEM majors in colleges and universities.

2.12 The concept of ideology

The concept "ideology" was first coined by the French philosopher Destutt de Tracy in 1796 (Eagleton, 2014), who referred to it as the science of ideas. The term is used nowadays to refer to the cultural blueprint for a social order. Croteau and Hoynes (2013) argue that ideologies are used by those in power to defend their actions by perverting and misrepresenting the truth. Van Dijk (2015) in his study, "*Critical Discourse Studies: A Socio - cognitive approach*", states that ideologies signal how groups, and their members interpret a specific domain of the society. He further mentions that one of the functions of ideologies is to legitimate power and inequality. The truth is concealed in order to empower the dominating groups while oppressing others. Furthermore, he elaborates that, ideologies protect the interests, and resources of dominating groups irrespective of how this unjustly privileges them. In a later study, Van Dijk (2016) argues that ideologies are not socially developed or shared by groups, instead they are developed by the ruling classes or power elite, who exercise their power to disseminate inequality. Downey, Titley, and Toynbee (2014) concur with Van Dijk by describing ideology as capable of producing a social world characterized by social inequality, unequal distribution of wealth, and authority.

Fairclough (2003) simplifies ideology as the means of maintaining domination, and the medium through which social relations are reproduced. He mentions the examples of men dominating women. He elaborates that it is impossible not to find ideologies in texts. As a result, meaning is derived through interpreting texts. He recommends the Critical Discourse

Analysis (CDA) as one method that can be used to interpret texts. Through analysis of texts one is able to discover ideological processes. Machin and Mayr (2012) in their book titled “*How to do Critical Discourse Analysis*”, advocate that CDA is used to challenge and expose the ideologies that are hidden in language (either spoken or written), in order to emancipate the oppressed. They further clarify that a word is carefully and purposefully chosen by ruling powers to suggest power relations.

Media scholars believe that, not only do media texts shape our world, they also provide role models for appropriate social behaviour (Coupland, 2010; Downey et al., 2014; Engesser, Ernst, Esser, & Büchel, 2017). Fairclough (2003) states that texts are the effects of other social structures. He elaborates that texts are multifunctional, possessing ideational, interpersonal, and textual functions. He states that “texts enact social relations between participants in social events and attitudes, desires and values of participants” (Fairclough, 2003, p. 27). Mayr and Machin (2012) also mention that ideologies can be communicated through other semiotic modes such as visual images. They mention that one of the intentions of the use of these semiotic modes may be to marginalise. Since underlying meaning in text is not explicitly expressed, it is important to critically analyse texts to uncover the intentions of the authors (Van Leeuwen, 2005). Brugelles and Cromer (2009) state that apart from carrying ideological implications, textbooks are the means of socialisation, transmitting societal norms and values.

2.13 Implications of the literature

Several studies that have been conducted on gender representations in textbooks locally and internationally. However, based on the literature I reviewed, I did not find studies that were conducted specifically on gender representations on CAPS science textbooks. This gap indicates scarcity of literature on representation of gender in CAPS science textbooks. Therefore, it paved the way for my study in which I have analysed gender representations in science textbooks in the context of South Africa.

Researchers of construction of gender identities in textbooks have applied Critical Discourse Analysis as a method of data generation (Fairclough, 2003, 2013; Mayr & Machin, 2012; Van Dijk, 2015, 2016). However, my review found none that have applied CDA in the context of South Africa, in science CAPS textbooks. This informed me to also use CDA as a method of data generation to verify the findings in a different context. I have provided details of CDA as a method of data generation for this study in chapter three.

The literature I have reviewed also revealed that many scholars of CDA in gender and language studies, have used it in conjunction with Feminist Post- Structuralist Discourse Analysis as a theoretical framework. Their aim was to understand the underlying reasons and assumptions behind the manner in which texts are written. Hence, in addition to choosing CDA as a method of data generation, I matched it with Feminist Post-Structuralist Discourse Analysis (FPDA) as a lens. I wanted to understand the particular reasons behind the manner in which texts are written. I did not do this to replicate the studies that have used FPDA as a lens. Instead, it provided me with an opportunity to substantiate the findings in the context of South Africa, in CAPS science textbooks.

Although Mudaly and Van Wyk (2015) conducted a qualitative study on gender in South African context, the focus of their study was not on textbooks. Instead it focussed on challenges and opportunities experienced by male and female medical students. Furthermore, they also adopted feminism as a theoretical framework for their study. Feminism also focusses on gender issues, and is an aspect of the FPDA I have adopted. However, I found feminism inadequate for my study because I was analysing discursive practices in texts. Hence I chose FPDA which encompasses discourse analysis, because it enabled me to analyse gender in discourse.

In the subsections below I discuss the FPDA as a theoretical framework for this study in detail.

2.14 Theoretical framework

Theoretical framework is defined as a specially designed set of lenses that a researcher uses to understand or view the world in a specific manner (Creswell, 2009; Shahadat, 2014). It guides the study, reflects the researcher's stand intellectually, justifies the researcher's understanding of the concept being researched, and shapes what is looked at as well as questions asked (Creswell, 2009). Theory becomes the sets of meanings which yield insight and understanding of people's behaviour (Creswell, Hanson, Clark Plano & Morales, 2007). Hence the theoretical framework I adopted for this study was the Feminist Post-Structuralist Discourse Analysis (FPDA).

2.14.1 Background of Feminist Post-Structuralist Discourse Analysis (FPDA).

Feminist Post-Structuralist Discourse Analysis was developed by Chris Weedon based on Feminist Post-Structuralist theories (Weedon, 1997a). Since FPDA is a bricolage of Feminist, Feminist Post-Structuralist, and Discourse Analysis theories, the details of each of these theories are outlined below respectively.

2.14.2 Feminist Theory

Feminist theory stems from feminism which emerged firstly in France, then in Great Britain and later in USA between the years 1760 and 1890 (Duchen, 2013). It started as the struggle of women's liberation for legal and domestic rights. Later it promoted equality in education and employment as well as resistance to gender inequality, stereotypes, discrimination and sexism in literature (Showalter, 1985). It has been especially designed to address the marginalisation of poor women and women of colour (Allen, 2018).

Feminist discourse reveals numerous views under the basic concept of gender inequality, including the liberal feminism, radical feminism and Marxist feminism (Loke, Bachmann, & Harp, 2017). In the subsequent paragraphs I discuss these types of feminism respectively.

The development of the liberal feminism dates back to the years between 1750 and 1850 in Britain (Mudaly, 2006; Sanders, 2004). A small group of women based in London launched the women's struggle for education and employment rights. They also protested for equal rights to vote as their male counterparts (Mudaly, 2006; Sanders, 2004). Mudaly states that liberal feminists are also concerned with "girls' underachievement in schooling system and education in general" (Mudaly, 2006, p. 61). In addition, Baehr (2003) mentions that liberal feminism is concerned with women's autonomy. He argues that women's needs and interests are not adequately reflected in the basic conditions under which they live, and that their representations are insufficiently reflected in the processes of democratic self-determination. Liberal feminist lens, enabled me to detect that women scientists, particularly in the Physical Sciences textbook, are deprived their privilege to be represented as inventors and producers of scientific knowledge. Woman scientist were not portrayed in the Physical Sciences textbook.

Radical feminism developed during the 1960s in the United States (Mudaly, 2006). It included the issues of domestic violence, sexuality and workplace discrimination (Bradnock, 2014). Radical feminists challenge patriarchy (Daly, 2016), and they seek to provide strategies to fight women's oppression. Radical feminists believe that the root cause of women's oppression is sexism, particularly the fear of violation by men. Their political agenda is to expose male domination that is exercised in every domain of women's lives. They are opposed to emancipation and equality that is defined in masculine terms. They are of the view that women should be agents of change that they desire, and that change is possible. They propose that structures of male domination be disrupted, and that biological differences should not mean

different gender roles (Chambers, 2005; Mackay, 2015). Hence radical feminist lens empowered me to expose the underlying meaning and assumptions behind the manner in gender was represented in textbooks that I analysed.

The Marxist feminism emerged from the theory of Karl Marx during the 1960s. It developed as a result of women's protest against exploitation by Capitalists (Chiponda, 2014; Mudaly, 2006). Chiponda (2014) mentions that gender inequality is exacerbated by hierarchical class system in societies and Capitalism. She further mentions that apart from sex and class, private wealth is used by social structures to maintain power. Marxist feminists oppose Capitalism because it promotes women exploitation through unpaid labour of domestic chores (Barrett, 2014; Chiponda, 2014; Mudaly, 2006).

Marxist feminist lens empowered me to expose hegemonic practices that were concealed in textbooks that I studied. For example, the Physical Sciences textbook depicted only male scientists. The South African scientist in the Natural Sciences and Technology textbook was rendered invisible. His portrayal was not accompanied by a colourful image. It also enabled me to challenge visual images that reinforced portrayal of only women in nurturing roles, and activities associated with domesticity. On the contrary, men were cast venturing out of the planet.

Scholars of feminist theory use it as a lens to understand gender inequality. They seek to problematize theoretical hegemony and to deal with the effects of sexism, classism, and racism (Allen, 2018; Davis, 2008; Roberts & Connell, 2016). These scholars critically analyse men's and women's social roles and the influence of these social roles in their economic and political spheres of life.

Feminism inspires women to engage in deliberations to oppose discriminatory practices, and empowers women with tools they can use to resist male domination. For example, media, including print media, are regarded as appropriate tools for addressing gender violence against women, and to promote feminist ideals (Flores, Gómez, Roa, & Whitson, 2018). Feminists have also challenged masculinized writings that use male language and symbols while excluding women's writings.

2.14.3 Feminism in Science

McNeil (2000) mentions that science has been another site for contestation by feminists. She

argues that feminists seek to ensure that espoused ideals of gender inclusive and gender neutral science are more fully realized. She further states that feminists' initiatives in the USA include exhibiting all investigations of women scientists, from encyclopaedic projects of the eighteenth century to the recovery projects of the 1970s. The latter is contained in the book *"Has feminism changed science"* by Schiebinger (2000). Schiebinger (2000) argues that paradigms that were used in medicinal and other behavioural sciences, have been excuses for marginalising and subordinating women. However, she mentions that feminism has brought remarkable positive change for women in America. She compares the era of the 1960s, where no women received PhDs in science to today where about seventy eight percent of women receive PhDs in Primatology.

Bix (2000) argues that most women who finished their degrees in science and engineering found it difficult to be employed because male employers argued that they would not cope mixing house chores and employment. Women united their voices to declare that they were committed to their jobs. Girls were encouraged to pursue science and engineering degrees, and the numbers of women who enrolled in these fields gradually increased (Bix, 2000).

In the next section I provide the background of how the Feminist theory developed into Feminist Post – Structuralist theory, which later amalgamated with Discourse Analysis to become Feminist Post – Structuralist Discourse Analysis, the key theory for this study.

2.14.4 Feminist theory developed into Feminist Post-Structuralist theory

Feminist Post-Structuralist theory stems from Feminist theory, and is associated with the works of philosophers and critical theorists such as Derrida, Foucault, Deleuze, Butler and Kristeva (Agger, 1991; Butler, 1990; Harcourt, 2007). These philosophers believed that human culture may be understood by means of a structure modelled on language. Pierre (2000, p. 477) advocates that Feminists used Post Structuralism to challenge discourse, in order to uncover ideologies in texts that hinders critical thinking.

Post-Structuralism rejects the ideology of hierarchical power of the dominant. It seeks to expose these dominant relations in the hierarchy of power, and the dependency of the dominant on the subordinate counterpart (Cooper, 2016). Post-Structuralism recognises that the power of discourse shapes reality. While Structuralism studied underlying structures in texts (Balzer & Moulines, 2011), Post-Structuralism seeks to investigate how knowledge is produced (Foucault, 1980; Mayr & Machin, 2012). Post-Structuralism is for the notion that, to understand

text, the researcher needs understand both the text and systems of knowledge that produced it. Post-Structuralists argue that intentions of an individual can be better understood if studied within the concept of social reality (Cooper, 2016; Fox, Dingwall, & Quah, 2014; Spivak, 1990). They consider patriarchy as an obstacle to women's emancipation. Hence Post-Structuralism encompasses literary theory, as it seeks to investigate production of texts, and systems involved in text production. It also encompasses critical theory as it seeks to emancipate individuals through Discourse Analysis and ideology critique. Weedon (1997b) argues that the structure of the language shapes people's minds, how they develop meanings and ultimately the social world. Post-Structuralism therefore empowered me with cognitive tools, that I employed to justify my assumptions on the motives behind the portrayal of men, and women in visual images, and content knowledge in selected science textbooks.

Feminist Post-Structuralist Discourse Analysis (FPDA) as a theoretical framework enabled me to analyse gender and language in texts simultaneously (Baxter, 2008). Feminist theory, although it is a theory that addresses gender issues, would have been inadequate for this study because I examined gender in the context of language. Therefore, there would have been a need to find another theoretical framework that would examine discourse in text. Since FPDA was developed by blending three theories (Feminist, Feminist Post-Structuralist and DA), each contributed its strengths, such that the weaknesses or shortcomings of one were overcome by the strengths of the other. Baxter (2016) argues that feminists view Post-Structuralist Discourse Analysis as the overriding discourse when analysing all types of texts.

Therefore, FPDA became suitable for this study because it matched my method of data collection, namely, the CDA. I used FPDA as a lens, to uncover how language and symbols are used in textbooks to perpetuate gender inequalities. It enabled me to expose how gender representations in textbooks promote patriarchal ideology (Baxter, 2008; Pierre, 2000).

2.15 Conclusion

In this chapter, I presented the literature that I reviewed, and the theoretical framework that I adopted as a lens to understand gender representations in selected science textbooks. I organised the literature review into themes. These themes included: education and gender inequality in South Africa; history of textbook evaluation and research, need for textbooks and their place in the curriculum, the significance of textbook evaluation and revision, functions of the textbook, the role played by textbooks to promote gender inequalities in education, the concept of hegemonic masculinity, gender aligned power, and the concept of ideology. I

concluded this chapter by discussing FPDA as a theoretical framework for this study. In the next chapter I discuss the research design and methodology.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

In the previous chapter I presented the literature which I reviewed to identify the research gaps. I also provided details of the theoretical framework that I used as a lens to understand gender representations in textbooks that I analysed. In this chapter, I present the research design, and methodology that I employed to generate data. This study adopted the qualitative approach, and the discussion thereof is provided in subsection 3.3 of this chapter. I have also provided the outline of the world view that this study adopted, which is the critical paradigm. I have also elaborated in detail the purposive sampling that I adopted as a strategy for this study. The method of data generation that this study employed was the Critical Discourse Analysis, details are discussed in sub – section 3.6. I have provided the outline of the data analysis, procedures and tools in sub – section 3.7. Lastly, I discussed how rigour is achieved through applying the principles of trustworthiness in sub – section 3.8.

Research design is the research structure that shows how all major parts of the research project work together to address the central research questions (Cohen, Manion, & Morrison, 2013; Creswell, 2009). Research design comprises the paradigm, research methods and instruments, and data analysis procedures. This section is organised into the following sub – themes: paradigm, approach, design of the study, sampling, data collection methods and data analysis methods.

3.2 Paradigm

A paradigm is a world view that includes the major assumptions about the nature of reality (ontology), the nature of knowledge (epistemology), the research methodology (technique used by researcher to investigate reality), and axiology (values and beliefs that we hold) (Cohen, Manion, & Morrison, 2013). The paradigm that guided this study is the critical paradigm. The critical paradigm stems from critical theory, which has the agenda of emancipation of individuals and groups in a democratic society (Creswell, 2007). Croucher and Cronn-Mills (2014) argue that critical paradigm aims to challenge reproduction of inequalities and dominant discourses in educational research. They argue that education serves the interests of those who have power, usually rich white males. The critical paradigm therefore became suitable for this study, which sought to uncover gender representations in science textbooks, and to understand

the influence of these gendered assumptions on women's roles in the different spheres of life.

3.2.1 Ontological assumptions of the critical paradigm

Ontology is defined as the nature of reality (Scotland, 2012). If someone studies ontology, he or she is studying what do we mean when we say something exists. In other words, it is about giving an account as to why we say something exists (Mack, 2010, p. 5). Goertz and Mahoney (2012) argue that the ontology of the critical paradigm is that, multiple beliefs and values are shaped by politics to perpetuate the interests of one social power, that is privileged and dominating over the other, who is also under-represented. Scotland (2012) argues that besides politics, there are also social, cultural, economic, and gender values that form part of the reality in the critical paradigm. He further argues that the critical paradigm views language as the tool that shapes reality because it contains power relations, so it is used to sanction or disempower.

Hence, in line with ontology of the critical paradigm, this study sought to provide evidence on what we mean when we say gender is represented in the manner that is described by the findings of the research question, "How is gender represented in selected science textbooks." This was done by analysing language usage, and analysing visual images, in selected science textbooks, to verify if there was any evidence of power sanctioning or disempowering of individuals using gender representations.

3.2.2 Epistemological assumptions of the critical paradigm:

Goertz and Mahoney (2012) state that epistemology is about the very basis of knowledge, how it can be acquired and communicated to human beings. Epistemology is about answering the question, what approaches we choose to apply, in our attempt of knowing the truth. Burrell and Morgan (2017) argue that according to the critical paradigm, there are multiple ways of knowing the truth, and truth is socially constructed by communities of practice through media, institutions and society. Hence, this study interrogated textbooks as print media, that communicates to the society the information about who are the advocates of power, in order to discover whose interests (between male and female gender) are served by political ideology in textbooks, and whose interests are negated.

Scotland (2012) argues that epistemology of the critical paradigm restricts knowledge to subjective experience, which is linked with societal ideology. Hence in the sub-section below, I outline how my stance is subjective in this study, and how I constantly reflected on my position to eliminate becoming biased during analysis processes.

3.2.3 My position as a researcher

Many scholars who adopt the qualitative approach mention that it is important for a researcher to declare his or her position upfront. They argue that this sheds light to the reader, clarifying how the researcher came to the conclusion about the findings of the phenomenon being investigated (Bourke, 2014; Fairclough, 2013; Lindlof & Taylor, 2017; Malterud, 2001). Bourke (2014) argues that when a researcher declares his or her position upfront, he or she becomes cautious of his or her own biases as well as assumptions about the phenomenon that is being investigated. This enables him or her to eliminate biases in the study conducted. This is also confirmed by Cohen, et al., who states that, “what counts as worthwhile knowledge, is determined by the social and positional power of the advocates of that knowledge” (Cohen, Manion & Morrison, 2007, p.7).

Therefore, declaring my position helped me to be aware of my own subjectivity, so that I would recurrently reflect on my own stance, to ensure that my subjectivity did not corrupt the study. Subjectivity enabled me to draw from my own inner experience, to better understand the phenomenon of gender representations (Drapeau, 2002; Whitley, 2015).

I took the position of the critical realist, which is in line with the ontology of critical paradigm. Realists argue that the natural and the social world exist autonomously from human action and observation. The critical paradigm empowers individuals with knowledge so that they can use it to challenge the status quo, and bring transformation. According to this paradigm, knowledge is subjective. What one sees depends on whose perspective it comes from. Therefore, I was not neutral in this undertaking, because I was also interested in the issues of gender I was investigating. I was hoping that the findings of the study would emancipate me first of all, as I sought redress from the consequences of the apartheid regime as a Black female South African citizen.

I am also the victim of patriarchal education like other Black South Africans. As a Black woman I did not receive the same type of education like other South African women. Apartheid policy of education ensured that education was the worst in Black schools. In our schools, we (as Biology learners) did not have resourced science laboratories as other former model C schools. As a girl I was channelled to the class that did not have Physical Sciences and Mathematics. During those years there was no career guidance in Black schools. We studied to get jobs. Although there were few girls that took Physical Sciences as a subject, the class

would become full quickly. Since I was joining the secondary school from a different school, I could not be admitted in the Physical Sciences class, because it was already full. Boys dominated science classes, and the science subjects were taught by male teachers only. In other classes, which were termed general classes, there were no restrictions of admissions. Our class was overcrowded, so teachers could not assist learners individually.

When I finished my matric with results that enabled me to study at the university, I wanted to become a dietician. I was disappointed to learn that I could not pursue dietetics because Physical Sciences was a prerequisite to be admitted in this science field. However, I then took the teaching profession and specialised in Biology and Home Economics because I also had passion for teaching. My parents did not have money to pay for my studies at the university. Also the bursary that I received from the then Department of Education was for teaching. I hoped that one day I would become a university lecturer. I purposed to influence future teachers to inspire girls to pursue science subjects during and beyond schooling. For this reason, I was motivated by the FPDA as a woman to be emancipated from gender oppression and discrimination that I experienced from the time I was a learner of science until now.

However, I ensured that my existing preconceptions did not interfere with the manner in which I derived hidden meaning from language in selected science textbooks (Scotland, 2012). To ensure the valid use of subjectivity, I asked peers from my research cohort, to validate the findings which emerged from my analysis, as suggested by Drapeau (2002). I also used triangulation, whereby I analysed science textbooks from different authors and publishers, so that I could attain a reasonable judgement. Lastly, I scanned passages from textbooks that I analysed into the thesis, for reader's reanalysis in order to confirm the findings (Wood & Kroger, 2000).

3.3 Approach

This study adopted the qualitative approach, which is exploratory in nature (Cohen, Manion, & Morrison, 2013). It is used to gain an understanding of underlying reasons, opinions and motivation (Creswell, 2009). The focus of this study was the Critical Discourse Analysis (which is one of the methods of qualitative research) of visual and textual material. The CDA constructs were used to analyse social life by interpreting words and images from documents (Cohen, Manion & Morrison, 2013). The documents in this study refer to the selected science textbooks. I analysed how words and images are used, and the context in which they are used in order to draw inferences about gender representations in selected science textbooks. This

approach was appropriate for my research question, which sought representations of gender in science textbooks and the possible implications of these on learners as life long - learners.

3.4 Design

I adopted phenomenology as the strategy for this study. Tunceren (2017) defines phenomenology as the study of appearances of things. This study sought to investigate how gender representations appear in textbooks. “Phenomenology is an approach to qualitative research that the specific focus is to identify the inherent and unchanging meaning of the issue under study” (Chan, Fung, & Chien, 2013, p. 2). Willis argues that “...the outcomes of the phenomenological reflection are thoughts, discourses, and written texts” (Willis, 2004, p. 8). Phenomenology therefore became suitable for this study, because of its purpose to explore how gender representations in written texts influence the roles played by women and men in the social, political and economic spheres of life.

3.5 Sampling

I employed purposive sampling to select four science textbooks that are used to teach science from Foundation phase to Further Education and Training (FET) phase. These included the textbook from the Intermediate Phase where science is introduced as Natural Sciences and Technology, the Natural Sciences textbook from the Senior Phase (SP), the Life Sciences textbook, and the Physical Sciences textbook from the FET phase, which precedes tertiary education. All these textbooks were learners’ books, Curriculum and Assessment Policy Statements (CAPS) aligned, and the ones that are used in South Africa where the study was conducted. The criteria for their selection was that they should be on the list of textbooks prescribed by the Department of Basic Education.

The reason for this was to explore whether gender discrimination was evident at all levels of schooling in science textbooks. In the FET phase, Life Sciences and Physical Sciences textbooks were selected intentionally because a review of literature reveals that boys outperform girls in Physical Sciences, while girls achieve comparatively greater academic success in Life Sciences. Therefore, ways in which females were portrayed in textbooks of both these subjects could reveal underlying ideologies which influence learners’ performance and career trajectories. The table 3.1 below provides summary on the sample of textbooks that were selected.

Table 3.1 *Names of textbooks analysed*

Name of textbook	Phase	Grade	Subject	Author	Publisher
Oxford Successful Natural Sciences	Intermediate	6	Natural Sciences-Technology	Baxter, Collett & Snyman	Oxford University Press
Oxford Successful Natural Sciences	SP	9	Natural Sciences	Clitheroe & Dilley	Oxford University Press
Study and Master Life Sciences	FET	11	Life Sciences	Annemarie, et al	Cambridge University Press
Study and Master Physical Sciences	FET	12	Physical Sciences	Kelder, Govender & Govender	Cambridge University Press

3.6 Data collection methods

Data collection methods are strategies that are used to collect data. In line with the critical paradigm, Scotland (2012) argues that critical methodology is aimed at exposing hegemony and injustice by interrogating values and assumptions, and by challenging conventional social structures. He further mentions that critical methodology seeks to find out what means are utilized as the underlying aim. Hence, Critical Discourse Analysis (CDA), which stems from critical theory of language (Mayr & Machin, 2012), informed the methodology for this study.

It is important to highlight that Critical Discourse Analysis emerged from Discourse Analysis (DA), and that the two are not synonymous. Discourse refers to communication of thoughts through words that were spoken or written. Discourse analysis is a method that was used originally in the branches of philosophy, sociology, linguistics and literary theory. It has been carried to a variety of other disciplines like anthropology, communication, education and psychology. It originated from the branches of philosophy, sociology, linguistics, and literary theory (Fairclough, 2003; Mayr & Machin, 2012). It has been transformed to Critical Discourse Analysis. The reason for this transformation was the fact that Discourse Analysis lacked the critical aspect that was deemed by discourse analysts as necessary to interpret texts. Rogers, Malancharuvil-Berkes, Mosley, Hui, and Joseph (2005) argue that, during the 1970s, linguistic theories, and methods in social sciences experienced transformation. Van Dijk (2015) reveals that in the early 1990s, scholars such as Wodak, Fairclough, Van Dijk, Kress, and van Leeuwen

spent two days discussing methods specific to CDA. They concluded that an interdisciplinary approach be embedded to CDA.

Critical Discourse Analysis is a term that is used to cover all spoken and written forms of language used as social practice (Wood & Kroger, 2000). Critical Discourse Analysis is about analysing media such as texts to reveal how authors and speakers subtly use grammatical features and language to persuade and manipulate people to think in particular way, while they conceal these intentions to the untrained eye. Scholars of discourse are motivated to uncover these subtle forms of language manipulation by the fact that, they can be used to maintain political ideologies in society, which are usually communicated through texts. They argue that behind texts are language, ideologies and power (Mayr & Machin, 2012). Mayr (2008) state that ideologies are established in ideas and images that are embedded in and inhabiting individual's mind. He elaborates that power is about members of one group exercising control over another. Critical Discourse Analysts aim to understand the nature of social power and dominance, and how commands in texts may be used to either enact or reproduce dominance. They also critically analyse how language and visual images in texts and speech can be used to control minds in subtle forms. They argue that effective reading involves challenging ideological assumptions in written texts (Fairclough, 2013; Mayr & Machin, 2012; Van Dijk, 2011, 2013). Linguists deemed it necessary that traditional linguistics consider the social aspect in the formulation of the theories and methods of discourse analysis. Critical Discourse Analysis embodies social theory and textual analysis.

Words in language, either written or spoken, can be used to intimidate, abuse, entice, persuade, encourage, etc. However, this depends on who utters them, and the manner in which they are articulated (Wodak & Meyer, 2009). As discursive analyses are moulded in diagnostic practices, my purpose was to diagnose textbooks of science to uncover the relationship between power and knowledge communicated. I evaluated texts to understand how objects and ideas are spoken about. I engaged in ideology critique, to uncover social rules by which particular statements are made while others are excluded. I challenged texts to expose institutions that control the production and circulation of discourse.

Wood and Kroger (2000) argue that CDA analyses how discourse, power, dominance, and social inequality are utilised in social practice. It is an approach that is used to expose the relationship between language and society. Critical Discourse Analysis analyses how text positioning promotes the interests of one social class that is dominant, while refuting the

interests of the other, which is also weakened by this social act (Wood and Kroger, 2000). Critical Discourse Analysis also encompasses semiotic practice which is the study of visual images and non-verbal movements as part of text (Fairclough, 2013). Analysis of visual images and graphics in notions of text and discourse is used to reveal gender inequalities (Wood & Kroger, 2000). Written texts are interrogated to uncover ideological assumptions, thereby empowering teachers to guide learners on how to resist media assaults (Fairclough, 2014). Scholars of CDA are of the view that injustice and oppression shape the social world. They engage with critical theory to detect various ways in which power and domination are exercised. Critical discourse analysts expose and transform conditions of inequality.

I selected CDA because I wanted to uncover subtle strategies by which language and symbols in texts can be used as instruments of reinforcing gender inequalities. Critical Discourse Analysis seeks to expose the repressive forces through critically analysing ideology which is used to distort information. Hence it requires careful reading and interpretation of textual material whereby a researcher examines the text to discover intentions, functions and consequences of the discourse (Cohen et al., 2013; Fairclough, 2013).

There are three processes of analysis in CDA, namely textual description (text analysis), processing analysis (textual interpretation) and social analysis (explanation) (Fairclough, 2013). Critical Discourse Analysis suited this study because it was used to generate data in order to uncover gender representations found in selected science textbooks. So textual description (text analysis), processing analysis (textual interpretation) and social analysis (explanation) were applied in selected science textbooks which I have mentioned in sampling section.

Description of text (textual analysis) and processing (textual interpretation) answered my research question, “how is gender represented in selected science textbooks”? Explanation (social analysis) is linked to FPDA as a lens that I used to view how gender representations in selected science textbooks could impact the lives of learners as life- long learners.

Semiotic Analysis as an aspect of CDA

When Critical Discourse Analysts engage in the process of studying the meaning of symbols and signs in order to make communication meaningful the process is called semiotics. They study how authors use semiotic resources in specific contexts, and how they justify their actions (Van Leeuwen, 2005, 2011). Halliday (2014) refers to grammar of language as the semiotic

resources for meaning making. Van Leeuwen (2005) argues that semiotic resources are context specific, and that in social semiotics, resources include signifiers, objects and observable actions. He further states that, since semiotic resources are not limited to talk, text, and images, but encompasses everything that we do, all of these activities possess a so called “semiotic potential”. This is confirmed by Halliday (2014) who makes an example of a frown on a person’s face as the symbol for disapproval. Halliday further mentions that children express their feelings or emotions through writing and pictures. Van Leeuwen (2011) mentions that investigating the semiotic potential of a given resource is about determining how the resource is, has, and can be used in communication.

Hence, semiotic analysis empowered me to understand the possible motives behind the manner in which the visual images were depicted. For example, I challenged the human images that were small in comparison to those that were large in size, with clearly visible features of a person. I also challenged images to find out which gender was represented by black and white pictures, in comparison to those that were colourful. I also derived meaning on why visual images of specific gender lacked positive gaze, etc.

3.7 Data analysis, procedures and tools

I adopted coding as a strategy for data analysis. A code is a label or name that the researcher gives to a piece of text that contains an idea or piece of information. It enabled me as a researcher to identify similar information and to search and retrieve data in terms of those items that bear the same code (Cohen, 2007; Fairclough, 2013). The codes that I used in identifying and describing gender representations, to answer research question, “how is gender represented in selected science textbooks”, in this study were, female, male, scientific activity, science active, science passive, scientist, man, woman, girl or boy, etc. This study analysed language used in text (which Wodak and Chilton termed linguistic analysis of text), and visual images as part of text (which they termed “analysis of other semiotic modalities such as visual images”) (Wodak & Chilton, 2005, p. 74). Wodak, et al. (2005) also point out the importance of the relations between text and context. They refer to the context in discourse analysis as based on the concept of social environment or situation of language use, which involve time and place, participants in various roles, actions, and cognitions.

Analysis in this study was conducted by looking at a single category at a time, e.g. I identified the representation of gender in text (linguistic analysis of text) including activities (that are usually used by teachers for homework and classwork). I also identified the representations of

gender in visual images (analysis of semiotic modalities) used in each textbook. I also determined whether the participants used in images and text identified were science active or science passive (role of participants), I also looked at the gender of scientists (i.e. whether the scientist depicted is a male or female) used in scientific knowledge construction or production.

I adopted the linguistic aspects illustrated in the table 3.2 below, and I used them as criteria for analysing discourse in selected texts.

Table 3.2 *Framework guiding analysis of textbooks*

Criteria for CDA	Explanation / Meaning and Application to the study
Salience	It is used by authors to attract readers' attention to specific features. Ways in which salience is achieved in images include foregrounding, backgrounding, size, potent cultural symbols, focus, etc. (Machin & Mayr, 2012).
Potent-cultural symbol	Objects carry cultural symbolism, e.g. stethoscope signify medical practice. In this study, I will verify which gender is depicted with science cultural symbols more often to determine the underlying assumptions and locate where ideologies are buried in texts (Machin & Mayr, 2012).
Size	Size can be used to indicate whether the participant is recognised as important or not. For example, photographs of unimportant participants may be small in size. In this study, I will check how gender in images are depicted, looking specifically at the size of e.g. boys that are photographed together with or next to girls (Machin & Mayr, 2012).
Foregrounding	Foregrounding refers to the manner in which words or images can be used to convey importance of the person or object. In this study I will check who (between males and females) is foregrounded by the manner in which language is used or image is depicting (Machin & Mayr, 2012).
Backgrounding	Elements that are further back or mentioned after the other (foregrounded) may become subordinate. Backgrounding also includes ignoring the element that is there, e.g. failure to acknowledge either a male or female scientist. In this study, I will check which gender is backgrounded, i.e. who between males and females are backgrounded to convey that they are subordinates of their counterparts (Machin & Mayr, 2012).

Focus	Focus can be achieved through exaggerating details to draw attention or by reducing to conceal. In this study I will check which gender is receiving attention, by the manner in which persons are portrayed, e.g. enlarged size of a person versus decreased size of another (of the different gender) to create certain impressions to the readers (Machin & Mayr, 2012).
Overlapping	Is about "...determining which are elements are placed in front of others, giving an impression that they come first" (Machin & Mayr, 2012, p.56). In this study I will be checking who, between males and females are mentioned first in the language usage, and in photographs of groups; and in which position, front or back they are placed (Machin & Mayr, 2012).
Gaze	Is analysed by determining whether or not persons depicted look at the viewer. For example, whether they look downwards or upwards. Machin and Mayr (2012) mention that images are used to offer or demand services, goods, information, etc., and there is a response that is expected. Where the person is looking at the viewer, the image is called a 'demand image'. Therefore, it used to imply that viewer is acknowledged, secondly to create an imaginary relationship with the viewer, and is a sign of being welcoming or invitational to the activity or to be like a person depicted. On the other hand, when the person does not look at the viewer or looks downwards, no demand is made on the viewer and no response is expected. In other words, the viewer is invited to look at the activity or person portrayed but not welcome or invited into interaction. In this study I will use gaze to determine which gender is depicted inviting learners to emulate for example a scientist, and which pictures of scientists (males or females) are depicted as an illustration of the concept taught but not inviting learners to emulate the person or scientist depicted. This aspect will enable me to conclude as to which gender has or lacks role models in science (Machin & Mayr, 2012).
Iconography	Refers to a pictorial material or an image illustrating a subject. Machin and Mayr (2012) argue that images can document, meaning they show particular events, particular places, people and things. In other words, they denote or connote. They continue to mention that asking what an image denotes, is asking who and what is depicted. They argue that authors use images to connote ideas and concepts. Asking what an image connotes, is asking what ideas are communicated through what is represented. Hence, they argue that images are not neutral. I will use iconography to challenge images, to find out what they denote and connote, in order to conclude about ideology disseminated by selected science textbooks (Machin & Mayr, 2012).

Overlexicalisation	<p>Machin and Mayr (2012) define overlexicalisation as overemphasis on terms that connote change. They state that it results when there is an excessive use of synonymous terms in discourse. It suggests over-persuasion and is evidence of ideological controversy. It is usually seen when the subjects or job titles are elucidated in terms of gender. Overlexicalisation will be a useful feature in this study to analyse how language has been used to persuade learners into specific ideology and how the term or concept that is gender specific has been used to suggest that something is problematic or controversial (Machin & Mayr, 2012).</p> <p>This criterion will also be used to determine how scientists of different genders have been addressed or described using over-persuasion or over-emphasis either to elevate to the position of power or to suppress (Machin & Mayr, 2012).</p>
Suppression	<p>Occurs when terms that are expected to be in the text are absent as a result of paraphrasing the original text.</p> <p>I will use suppression to determine which gender has been excluded with the purpose of suppressing, while elevating another gender to the position of power or absolute importance to the readers of selected text (Machin & Mayr, 2012).</p>
Lexical choices	<p>Machin and Mayr state that lexical choices refer to authors' use of specific, official sounding terms to convey authority and to claim to be specialists of knowledge such as scientists where in fact they are not, or through hierarchical means. They influence readers through claims to having power over them (Machin & Mayr, 2012).</p>
Settings	<p>Discourse analyst looks at how the author used settings to communicate general ideas, connote discourse and their values, identities and actions. This grammatical feature is used to analyse both language and visual images. I will analyse settings in pictures for example to determine which gender is participating in science active roles, and which one is not (Machin & Mayr, 2012).</p>
Honorifics	<p>It involves the use of terms that suggest superiority or a role that requires a degree of reverence. In science these may include the use of Sir or Lord to refer to certain scientists. I will use this linguistic aspect as a criterion to determine which scientists (between males and females) are addressed with the use of honorifics and which ones are not, in order to conclude whether there is gender inequality, stereotypes, discrimination, or not (Machin & Mayr, 2012).</p>
Pronouns	<p>Subject pronouns may be used to rename the subject. I will use nouns and pronouns to</p>

	determine the gender of the participants in activities or scientists hidden, e.g. he, his, etc. to uncover male gender or she, her to uncover female gender. (Machin & Mayr, 2012).
Low angle	Kress and van Leeuwen (2005) and Fitzgibbon (2013) state that photographs taken from low angle make the represented participant to look large and closer to the viewers. They further mention that represented participants seen from high angle are rendered powerless, making the viewers as the interactive participants to exercise symbolic power to the represented participant (in the image). I will use this this criterion to explore how power is exercised by the represented participants in the image.
High angle	Kress and Van Leeuwen (2005) continues to mention that photographs taken from high angle may result in decreased size of the represented participant and may be further away from the viewers. They conclude by stating that represented participants depicted from low angle exercise power over viewers as the interactive participants. I will use this criterion to explore how symbolic power is exercised by interactive participants over the person depicted.
Low modality	Semioticians such as Van Leeuwen (2005) and Fitzgibbon (2013) state that the small size of the participants in the photograph is the result of low modality. Low modality occurs when the photographer is further away from the person being photographed. They further elaborate that when participants in discourse are represented in a manner that shows low modality in photographs, it is a subtle form of expression that they are not important. They mention that participants represented with low modality may look unreal to the viewers, and so they will be less memorable.
High modality	Van Leeuwen (2005) and Fitzgibbon (2013) state that when the camera is close to the person when the photograph is taken, high modality is achieved. The person depicted in the photograph will be in the front, so his or her size will be large, and all the features that identify the person will be clearly visible. This connotes that person depicted is an important participant. They mention that such participants will be more memorable to the interactive participants.
Irony	Irony is a linguistic term that is used to describe the statement in which the surface meaning is the opposite of the underlying meaning. The example may be using a statement to praise a person while criticizing him or her at the same time. The purpose is to disempower the person in subtle form (Stanel, 2006).

Rhetoric	Rhetoric is a linguistic noun that is used in discourse to refer to the art of writing or speaking that is intended to persuade readers or listeners through emphasis. It may also involve exaggeration and stating facts in an insincere manner (Van Dijk, 2016). Van Dijk elaborates that rhetoric is used to reproduce inequalities through ideological messages to legitimate power. Wodak and Chilton (2005) mention that rhetoric is a pervasive manner of stating ideas to insinuate and convey prejudices.
Language abstraction	It is a term that is used to cast a person as more suitable for specific roles to reproduce inequalities and perpetuate gender discrimination. Another way of applying language abstraction in texts is using a word to make one gender disappear in mental representations (Rubini & Menegatti, 2008).
Determinism	Determinism is a linguistic term that refers to how aspects of texts inevitably shape the readers' thoughts, decisions or actions in response to how text is portrayed (Machin & Mayr, 2012). “...that the way we perceive the world is predetermined by the structure of the language...” (Van Troyer, 1994, p.164). I will use this criterion to detect how portrayal of visual images in text channel the readers of textbook to think and perceive their world.

The codes and criteria for analysis I have described above authenticates that, depicting the equal numbers of males and females portrayed in texts is not the only criterion that makes a textbook gender inclusive. It is sometimes possible that one gender may not be depicted for example as science active. Hence, I used this criterion (science active) to scrutinize persons depicted, to draw conclusion on the message conveyed by the manner in which a specific gender is represented. In some instances, scientists of both genders may be present, but one may be portrayed in a controversial manner to weaken, while the scientist of the other gender is elevated and empowered. This is the reason why I chose to adopt a qualitative approach, which does not draw conclusions based on numbers of persons depicted only. Instead, “Qualitative research is used to gain an understanding of the underlying reasons, opinions and motivations...” (DeFranzo, 2011, p. 8), behind the manner in which reality is exhibited. It is important to highlight that, although each criterion that has been mentioned above was discussed individually during analysis, each of them was used in conjunction with the rest to draw inferences about, how gender is represented in texts.

3.8 Rigour in research

In this section I have provided arguments on why trustworthiness became suitable for this study, by demonstrating how the aspects of validity and reliability provide inadequate reasons for them to be used in discursive practices. I have also explained in detail how rigour was achieved in this study through following the principles of trustworthiness.

Wood and Kroger (2000) argue that reliability refers to the fact that the study can be repeated in different contexts, and is reliable if the findings are the same. However, in Critical Discourse Analysis (CDA), the utterances of words can have different meanings in different contexts. Therefore, they mention that it is difficult to assess whether there is reliability on the level of concepts from a discursive perspective because repetition depends on the particular context. Wood and Kroger (2000) argue that even if the same results are obtained in two different studies, CDA will not use such results for generalisability (how the results or findings can be used in other situations), because there is always a possibility of a new interpretation and the context always changes. They propose that repetition should be seen as part of careful attention to detail, and concern for refinement as major features of discourse analytic work.

Therefore I read the text recurrently, analysed and reanalysed the same text and reviewed my own stance frequently to warrant that the study is worth paying attention to (Wood & Kroger, 2000).

While validity is understood as the ability of the research to produce findings that match as closely as possible the real state of the world, discourse analysts dispute this. They argue that since discourse is socially constructed, it has shifting and different meanings. Discourse analysts are concerned to show that their analyses are sound, well-grounded on principles or evidence, and are able to withstand criticism or objection. Wood and Kroger (2000) argue that the discourse analysts' objection to validity is based on the grounds that it is confusing and misleading, and therefore recommends trustworthiness. Given the above arguments, I decided to use trustworthiness instead of validity and reliability.

A trustworthy inquiry is the one that demonstrates that an inquirer can persuade his or her audience that the study is worth paying attention to, and is worth taking account of (Guba & Lincoln, 2015). I followed the criteria that are proposed by Guba and Lincoln (2015) to establish trustworthiness in this study. These criteria include: credibility, transferability, dependability, and confirmability. Due to the nature of this study, which investigated the

discourse in texts, only credibility and confirmability were applied. In addition, Wood and Kroger (2000) mention orderliness and documentation as criteria for trustworthiness. So, in the paragraphs below I explained how credibility, confirmability, orderliness and documentation were considered as the criteria for trustworthiness.

3.8.1 Credibility

Credibility is achieved through prolonged engagement, persistent observation, and triangulation (Guba & Lincoln, 2015). During data generation and analysis, I read the selected textbooks several times (prolonged engagement). I read for the first time to identify the chapters that I had to analyse using the CDA. At this stage I checked and noted the use of humans (both males and females) in text passages (including frequently used pronouns). I also checked and noted visual images and illustrations of humans. In each chapter where I identified the use of humans, I noted the chapter and the page in my notebook that I entitled: *Analysis Book for Gender Representation in selected Science Textbooks*. When I read the same textbook for the second time, I focussed on the chapters and the pages that I had identified in the first phase of reading. During this phase of reading, I applied CDA method to critically produce data that I used to answer the research question on how is gender represented in selected science textbooks. I also sourced evidence from passages of selected textbooks to justify the manner in which I described gender representations. I repeated the analyses of textbooks to ensure that I, as a researcher, am not biased.

I also applied persistent observation, to give careful attention to detail, during the critical analysis of images and illustrations (Wood & Kroger, 2000). Persistent observation assisted me to be cautious that my judgement is not bias. To establish triangulation, I also ensured that in my sample I select textbooks from different authors and publishers (Flick, 2018).

3.8.2 Confirmability

Confirmability means “data exist in support of every interpretation, and that interpretations have been made in ways consistent with the available data” (Wood & Kroger, 2000, p. 82). I have kept the transcripts of texts that I used during analysis so that they can be made available for reanalysis. Anney (2014) argue that findings should be grounded in the data, so analysis notes and document entries should be kept so that they can be made available for audit trail.

3.8.3 Documentation

Wood and Kroger (2000) mention that records of documents, and the way the discourse analyst exhibits the basis of his or her arguments, are necessary to convince the reader that analysis was done cautiously. Passages of text, and visual images from selected textbooks that I used during CDA were scanned into the thesis, so that the readers can verify my analysis. I referred to the scanned pages of the selected textbook when describing and interpreting data, to demonstrate that interpretations are grounded in the text.

3.8.4 Orderliness

In subsection 3.7, I provided explicit and detailed criteria that is informed by Machin and Mayr (2012) to exhibit how research was conducted, recorded and reported.

To establish sound conclusion and inferences, I developed themes from data using appropriate category labels (Charmaz, 2006). Fairclough (2003) recommends transdisciplinary process. He argues that transdisciplinary process enables the researcher's judgement to be influenced by other perspectives, disciplines and categories besides CDA during analysis of texts. This broadens the researcher's discernment of social processes, and practices underlying text production. For this reason I was guided by the pyramid below (designed by Charmaz) when coding data (Charmaz, 2006).

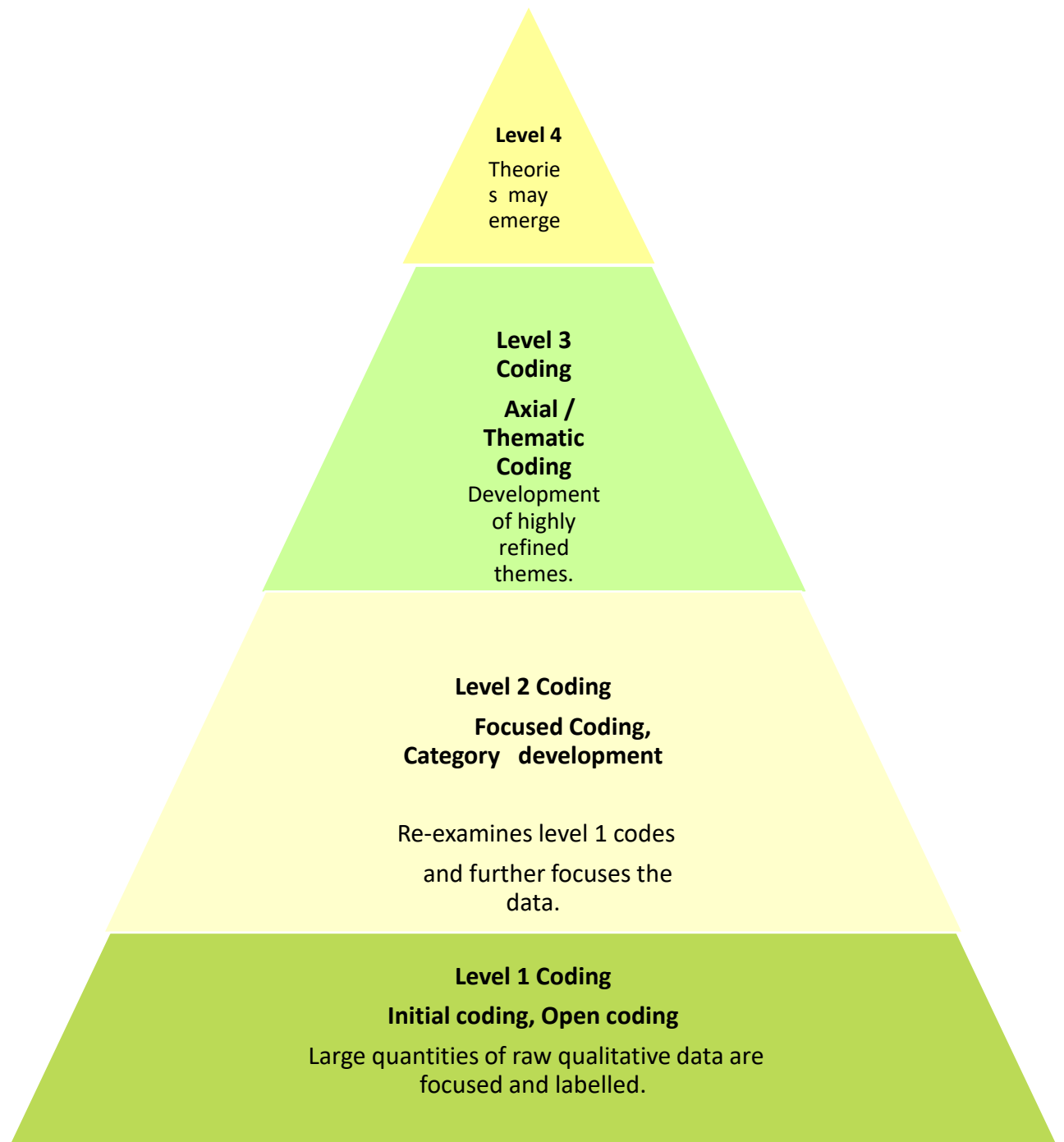


Figure 3.1 Constructing Ground Theory, adapted from Charmaz (2006)

Unlike in quantitative research, there were no preconceived categories or codes available. Codes emerged as I scrutinised data and defined meaning (Charmaz, 2006). However, the entire process of coding, as I analysed data, was guided by my research question to eliminate irrelevancy and redundancy. During initial coding or open coding (as illustrated in figure 3.1)

above, I firstly moved through the data paragraph by paragraph, line by line, and then attached the codes to the line of my written data. Then I moved through the data word by word to give careful attention to meaning and images. In the second level of data coding, I used the initial codes to sort, integrate and organise data as illustrated in figure 3.1 (Charmaz, 2006, 2014). A large amount of data was sifted during this phase. This is termed focused coding. I then compared data to data to develop focused codes and to further refine the data generated. During the third level of coding, I arranged data into categories according to similar properties in such a manner that orderliness, and coherence were achieved (Charmaz, 2014; Machin & Mayr, 2012; Wood & Kroger, 2000). The labels of categories served as a guide for development of themes.

The steps I have outlined in the preceding paragraphs demonstrate that this study was guided by the principles of trustworthiness, and is therefore worth paying attention to. By the end of data analysis, my research question was well answered. Therefore, I used the findings to write a report on how gender is represented in selected science textbooks.

3.9 Conclusion

In this chapter, I presented the details of the methodology that informed the data generation, and analysis processes of this study. I discussed paradigm, approach, design, sampling procedures, data collection methods as well as data analysis procedures, and tools. In the next chapter I discuss data presentation and analysis.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

In the previous chapter, I provided the details of the methodology that I used in this chapter (data presentation and analysis). I mentioned that Critical Discourse Analysis is the method that I used to generate data. I also provided the analytical framework that guided my analysis. In the analytical framework, I provided the explanations of all the criteria that I used to analyse data. Analysis was also informed by constructs that emerged from the literature that I reviewed. The FPDA as a lens for this study also empowered me to be critical during all the phases of analysis process.

In this chapter, I provide results of the analysis of the four science textbooks that formed the sample for this study, in response to the main research question of this study:

- How is gender represented in selected science textbooks?

The names of these textbooks that I analysed are:

- Study and Master Physical Sciences Learner's CAPS textbook for grade twelve,
- Study and Master Life Sciences Learner's CAPS textbook for grade eleven,
- Oxford Successful Natural Sciences Learner's CAPS textbook for grade nine, and
- Oxford Successful Natural Sciences and Technology Learner's CAPS textbook for grade six.

In the analysis of each textbook, I provided the analysis for the textbook cover, as well as the analysis of the content knowledge inside the textbook. Each textbook analysis was divided into sections according to modules (in Physical Sciences textbook) or knowledge strands (for all other textbooks). Analysis of the content knowledge comprised the text and visual images that accompany the text. I selected and presented few images as samples of all others (from the same module in the textbook) that delineated the same concern to avoid redundancy. I also selected few samples of the text passages to represent all other text passages that convey the same message in the module. The reason for this was to avoid monotonous repetition.

In each module or strand analysis, I provided the overview of what the actual analysis entailed, and the table was provided in each case that summarised the analysis. Keys that I used in each table are as follows:

✓ (a tick) stands for a characteristic that is present

x (a cross) stands for a characteristic that is absent

I also provided the textual description of gender representation in each module or strand. I began textual description by providing the figures that I analysed with their textbook pages at the top of the figure and description at the bottom. The textual description of each module or strand of the textbook is organised into two main themes, namely:

- Gender representation as science active in the module or strand
- Gender representation as science passive in the module or strand

The analysis in science active and science passive roles was each further categorised into two, namely:

- Gender representation as science active/passive in the module/strand using visual images.
- Gender representation as science active/passive in the module using text passages.

After describing features of all figures, I concluded the module or strand analysis by providing the interpretation of the findings. At the end of each textbook analysis I provided the concluding discussion for the textbook. After the analysis of all textbooks, I also provided the discussion of the findings. This discussion reveals the summary of how gender is represented in each textbook using graphs.

This analysis began with analysis of Physical Sciences textbook.

4.2 Analysis of the Study and Master Physical Sciences textbook grade 12

During the analysis of the Physical Sciences textbook, I began by providing the analysis of the textbook cover. During analysis of the textbook cover I was evaluating if the textbook displays any gender bias, and masculinic hegemonic practices.

The content knowledge in the Physical Sciences textbook is organised into modules. There are five modules in the textbook, and in all of them I found human representations to analyse. The five modules include Mechanics, Matter and Materials, Waves, Sound and Light, Chemical Change, and Electricity and Magnetism. In each module, I began by providing the overview of the analysis, and then provided the textual description of gender analysis. I concluded the

analysis of each module by providing the interpretation of the findings. CDA constructs from the analytical framework from chapter three, and constructs that emerged from the literature I reviewed that informed the analysis of the Physical Sciences textbook were overlexicalisation, honorifics, foregrounding, backgrounding, salience, high angle, low angle, lexical choice, symbolic power, gaze, potent cultural symbols, rhetoric, language abstraction and stereotypes. Each of these constructs are explained in this chapter where they are used for the first time to remind the reader what they mean.

4.2.1 Analysis of the textbook cover: Study and Master Physical Sciences textbook for grade twelve

Brugelles and Cromer (2009) state that the first contact of the reader with an illustrated textbook is its cover, so its appeal plays a central role in the choice of the textbook. Kress and Van Leeuwen (2006) state that visual language is culturally specific, and is neither transparent nor universally understood. Hence in figure 4.1 below, I was evaluating whose interests (between male and female gender) the textbook cover promotes.

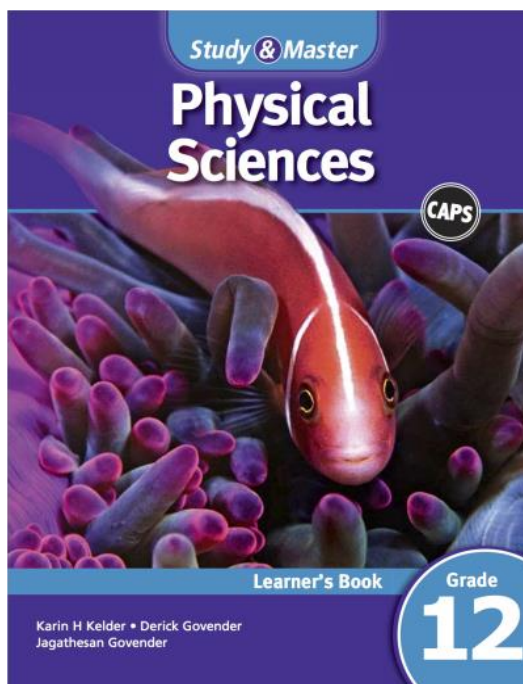


Figure 4.1 Cover for Physical Sciences textbook

The title for the textbook is “Study and Master Physical Sciences CAPS learners’ textbook”. Nothing is controversial about the title of the textbook. Therefore, the title of this textbook is

gender neutral. All other features on the textbook cover did not connote gender bias.

Interpretation for the textbook cover (Physical Sciences)

The textbook cover is gender neutral as it does not include any features that promote one gender while discriminating the other.

4.2.2 Overview of analysis in the introductory part: Study and Master Physical Sciences textbook for grade 12

In the introductory part of the textbook, twenty one human representations appear, and they are all males. They are all depicted as science active. These representations exhibit gender bias against girls because there are no female representations. I did not find human representations that depict gender in science passive roles in the introductory part of the textbook.

Table 4.1 *Gender representation in introductory section of Physical Sciences textbook*

Figure	Page	Male	Female	Image	No image	Science active/passive	Size	Named	Not named
4.2	19-21	✓			x	All active		✓	
4.3	19	✓			x	Active		✓	
4.4	13	✓		✓		Active	small		✓

Keys:

✓ = a characteristic that is present

x = a characteristic that is absent

4.2.3 Textual description of the introductory part in the Physical Sciences textbook

Gender representation as science active in the introductory part in the Physical Sciences textbook

Textbook page no. 19 – 21

1637: René Descartes published *Discours de la méthode*, which contained an outline of the scientific method.

1661: Robert Boyle published *The Sceptical Chymist*, a treatise on the distinction between chemistry and alchemy. It contained some of the earliest modern ideas of atoms, molecules and chemical reactions, and marked the beginning of the history of modern chemistry.

1789: Antoine Lavoisier published *Traité Élémentaire de Chimie*, the first modern chemistry textbook. It was a complete survey of (at that time) modern chemistry, including the first concise definition of the Law of Conservation of Mass, and thus also represented the founding of the discipline of stoichiometry.

1869: Dmitri Mendeleev published the first modern Periodic Table, with the 66 known elements organised by atomic weights. The strength of his table was its ability to accurately predict the properties of as yet unknown elements.

1876: Josias Willard Gibbs published *On the Equilibrium of Heterogeneous Substances*, a compilation of his work on thermodynamics and physical chemistry which laid out the concept of free energy to explain the physical basis of chemical equilibria.

1877: Ludwig Boltzmann established statistical derivations of many important physical and chemical concepts, including entropy, and distributions of molecular velocities in the gas phase.

1883: Svante Arrhenius developed the ion theory to explain conductivity in electrolytes.

1884: Jacobus Henricus van't Hoff publishes *Études de Dynamique chimique*, a seminal study on chemical kinetics.

c. 770: Abu Musa Jabir ibn Hayyan (aka Geber) an Arab/Persian alchemist is considered by many to be the father of chemistry. He developed an early experimental method for chemistry and isolated numerous acids, including hydrochloric acid, nitric acid, citric acid, acetic acid, tartaric acid and aqua regia.

c. 1220: Robert Grosseteste published several Aristotelian commentaries where he laid out an early framework for the scientific method.

c. 1267: Roger Bacon published *Opus Maius*, which among other things, proposed an early form of the scientific method, and contained results of his experiments with gunpowder.

c. 1530: Paracelsus first used the word 'chemistry'.

1597: Andreas Libavius published *Alchemia*, a prototype chemistry textbook.

1605: Sir Francis Bacon published *The Proficiency and Advancement of Learning*, which contained a description of what would later be known as the scientific method.

1615: Jean Beguin published the *Tyrocinium Chymicum*, an early chemistry textbook, and in it draws the first ever chemical equation.

1905: Fritz Haber and Carl Bosch developed the Haber process for making ammonia from its elements, a milestone in industrial chemistry with far-reaching consequences in agriculture.

1907: Leo Hendrik Baekeland invented bakelite, one of the first commercially successful plastics.

1909: S. P. L. Sørensen invented the pH concept and developed methods for measuring acidity.

1935: Wallace Carothers led a team of chemists at DuPont who invented nylon, one of the most commercially successful synthetic polymers in history.

Figure 4.2 Male scientists from the introductory part of the textbook

The pages 19 – 21 shown above are demonstrated in the textbook as historical development of the scientific method. The following features are evident:

Overlexicalisation

Machin and Mayr (2012) describe overlexicalisation as repeating same features in text as a strategy to persuade the readers to accept the ideology implicated.

I note that all scientists that are mentioned are males. Although their names are unfamiliar because most of them are not English, the use of grammatical features like pronoun he, and possessive pronoun his, indicate that these scientists are males. For example, the authors of this textbook state that Abu Musa Jabir ibn Hayyan was considered as a father of chemistry in the year 1770. The authors further state that “He developed an early experimental method for chemistry ...” They also mention Rogen Bacon who in the year 1267 “... published Opus Maius..., contained results of his experiments with his gunpowder.”

Although the descriptions of some of the scientists are not coupled with the use of pronoun ‘he’ or possessive pronoun ‘his’, writers who have conducted research about them (scientists mentioned) reveal that they are males, and they even provide pictures in some instances that show their gender. For example, Paracelsus, who is described as the founder of the word “chemistry” in 1530. Stillman (1920) who conducted a study on the personality and influence of Paracelsus, reveal that this scientist was a male.

Textbook page no. 19

1605: Sir Francis Bacon published *The Proficience and Advancement of Learning*, which contained a description of what would later be known as the scientific method.

Figure 4.3 Male scientist represented to suggest superiority

Honorifics

Machin and Mayr (2012) describe honorifics as the manner in which people may be represented through what they do, such as suggesting superiority or a role that requires a degree of respect. In figure 4.3 above, the scientist who is the founder of scientific method in 1605 is addressed as Sir Francis Bacon. The term Sir is a polite way of addressing a man, especially of the high rank (Rao & Tetreault, 2018).

Textbook page no. 13



ALWAYS smell a substance
by wafting its vapour gently
towards your nose.

Figure 4.4 A boy demonstrates science laboratory rules

Lack of gaze

Mayr and Machin (2012) mention that gaze is established by determining whether or not the person depicted looks at the viewers. They argue that if a person is not looking at the viewers, it is an indication that viewers are not invited into an activity. In this way they are not encouraged to emulate the person depicted.

The figure 4.4 denotes a male holding a test tube with a chemical. He is used as an example in demonstrating the laboratory rules. Therefore, he is depicted as science active. The person is not looking at the viewers. Therefore the person depicted in this visual image does not provide a role model for learners to pursue science. It also excludes girls totally as females because it denotes a male. It can possibly send message that science is not for girls. The chemical in the test tube is blue in colour.

Interpretation or textual processing for introductory part of the textbook

The male scientists that are outlined in the very first pages of the textbook which are meant to orientate learners to the theoretical and practical content, confirm the hegemonic masculinity and gender inequality in the introductory section of this textbook (Park, 2015). Supardi (2016) argues that opening statements are used in language communication to persuasively communicate ideas, and arguments that shape the perspective of the listener's or reader's judgement. They are also used to convince the listener to follow a specific course. He further mentions that introductory statements are important because they are the first impressions that are used to stimulate the attention. Exclusion of female scientists from the onset of this textbook

implies that girls lack science role models.

4.2.4 Overview of analysis of module one: Mechanics (Physical Sciences)

In this section, I provide the summary of the analysis of the module Mechanics in the tabular form. I also provide the textual description below the table which demonstrate the scanned images and text passages from the textbook. I selected and analysed ten figures from Mechanics module. These figures depicted four males and six females. The table 4.2 show that in four males that were represented there were three that were science passive and only one that was depicted science active. In six figures of females that were selected, only one was science active. All other five females that were depicted were science passive.

Table 4.2 *Gender representation in Mechanics module in Physical Sciences textbook*

Figure	Page	Male	Female	Image	No image	Size	Size Active/Passive	Named	Not named
4.5	45	✓		✓		Small	Active		x
4.6	48		✓		x		Active		x
4.7	32		✓	✓		Small	Passive		x
4.8	65	✓		✓		Small	Passive		x
4.9	161		✓	✓		Moderate	Passive		x
4.10	146	✓		✓		Moderate	Passive		x
4.11	163		✓	✓		Small	Passive		x
4.12	66		✓		x		Passive	✓	
4.13	38	✓			x		Passive		x
4.14	33		✓		x		Passive		x

Keys:

✓ = a characteristic that is present,

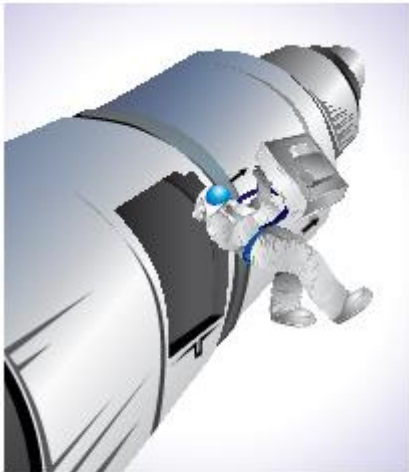
x = a characteristic that is absent

4.2.5 Textual description of gender representation in module one: Mechanics (Physical Sciences)

a) Gender representation as science active using visual images: Mechanics module

I found only one visual image that represented gender in science active role in this module. The figure 4.5 below represents the male gender.

Textbook page no. 45



1.1.5 An astronaut pushes his pack away to allow him to return to the space craft.

Figure 4.5 A male is an astronaut

Pronouns reveal the symbolic power in science active role

Discourse may be used to convey power to represented participants through the manner in which they are portrayed (Connell, 2013).

Although the astronaut is represented by a very small image in figure 4.5, the pronouns his and him reveal that he is a male. An astronaut's career is highly prestigious. This figure connotes that highly prestigious professions are associated with males. In this way the figure 4.5 empowers boys (who use this textbook during science lessons) to pursue astronaut career. Girls may be demotivated to pursue this career because they are not represented.

b) Gender representation as science active in text passages: Mechanics module

Textbook page no. 48

Zanele investigates the motion of a 2 kg trolley along a frictionless horizontal track. She applies a constant horizontal force of 10 N, so that the trolley, which was initially at rest, attains a velocity of $4 \text{ m}\cdot\text{s}^{-1}$. Calculate for how long she applies this force.

Solution

Take the direction in which the trolley moves as positive.

$$\vec{F}_{\text{net}} \Delta t = \Delta \vec{p} = m\vec{v}_f - m\vec{v}_i$$

$$(+10 \text{ N})\Delta t = 2 \text{ kg} (+4 \text{ m}\cdot\text{s}^{-1}) - 2 \text{ kg} (0 \text{ m}\cdot\text{s}^{-1})$$

$$\Delta t = 0,8 \text{ s}$$

Zanele applies the force for 0,8 seconds

Figure 4.6 A woman investigates a motion in a plane

Lack of visual image conceals a female in science active role

A black woman (Zanele) is portrayed as science active, investigating the motion, what causes objects to move. The mass of the trolley investigated is only 2kg, and she applies only 10N force. There is no visual image to expose her like in the case of the man depicted in figure 4.5. She is portrayed applying a force of 10N for 0,8 seconds.

c) Representation of gender as science passive using visual images: Mechanics module

Science passive in this study will refer to anything that a person portrayed engages in, but does not involve scientific activity. The visual images below depict a woman (figure 4.7) and a man (figure 4.8) represented through the use of colourful images.

Textbook page no. 32



Figure 4.7 A woman is jogging

Saliency

Mayr and Machin (2012) state that size can be used to indicate ranking of importance. For example, when persons are depicted in large images, they may be regarded as important, while persons depicted with small images may be the ones who are regarded as unimportant participants. The figure 4.7 depicts a small image of a person. It is not clear whether the person is a female or a male, unless you decide to consider that because the person illustrated has **thoracic** breasts then it must be a female. This picture possibly connotes that females are not important participants in the science textbook that is analysed.

Textbook page no. 65

Example 4

A boy stands on a bridge over a river. He throws a stone vertically upwards. The stone takes 4,2 seconds to hit the water below.

1. If the height of the bridge above the water is 16 m:
 - a) determine the initial velocity of the stone.
 - b) determine the final velocity of the stone.



Figure 4.8 A boy illustrating a motion

Pronouns accompany a visual image to highlight gender

Although figure 4.8 also depicts a boy in a small image, the pronoun 'he' and a noun 'boy' highlights that it is a boy who is used as an illustration.

Textbook page no. 161

A girl pushes a 5 kg box for 5 seconds along a 10 m horizontal surface. She applies a constant force of 20 N on the box.

1. Calculate the work done by the girl on the box.
2. Calculate the power of the girl.

Solution

$$\begin{aligned} 1. \quad W_F &= F\Delta x \cos \theta \\ &= 20 \text{ N} \times 10 \text{ m} \cos 0^\circ \\ &= 200 \text{ J} \end{aligned}$$

The work done by the girl is 200 J.

$$\begin{aligned} 2. \quad P &= \frac{W_F}{\Delta t} \\ &= \frac{200 \text{ J}}{5 \text{ s}} \\ &= 40 \text{ W} \end{aligned}$$

The power of the girl is 40 W.



Figure 4.9 A girl handling a 5kg mass

Focus

The figure 4.9 reveals focus, the CDA construct that is used to determine how attention is drawn to the participant either through exaggeration to highlight his weaknesses or by reducing to conceal, to create certain impressions to the readers (Machin & Mayr, 2012).

A girl is depicted in figure 4.9. She is only moving a 5kg object for five seconds along 10m horizontal surface. The girl's power is 40W. She appears to be pushing very hard, the skirt is twisted, and **her back is bent**. The image is colourful, and the size of the picture is moderate.

Textbook page no. 146



An object is pushed along a surface. Work is done on the object

Figure 4.10 A boy pushing unspecified mass

An image (figure 4.10) depicts a boy. He is described as being able to move the object because of the force, and work he is doing to the object. The mass of an object that is pushed and the force applied by the boy are not mentioned as it was done in the case of a girl pushing a 5kg object with 20N force in figure 4.9. This was possibly done to conceal that he possesses the same strength as the girl. His back is not bent as low as the girl's back (in figure 4.9). This could signal that he has greater physical strength.

Lorber and Martin (2001) observe that although women, in general, are physically smaller than men, cultural and social factors collude to exaggerate this difference so that women, as adults, are not as physically strong as men. This makes women appear to depend on men to execute physically strenuous tasks, and women become construed as weak, this weakness and dependence on men disempowers women.

d) Representation of gender as science passive in text passages: Mechanics module

Textbook page no. 163

3. A mother pushing her child in a stroller, approaches an incline that makes an angle of 15° with the horizontal, and is 20 m long, as shown in the diagram alongside. The mass of the child and the stroller is 25 kg. A constant frictional force of 35 N acts on the pram while it moves down the incline. The mother applies a force on the pram that acts up the incline so that the pram moves down the incline at a constant speed of $1 \text{ m}\cdot\text{s}^{-1}$.

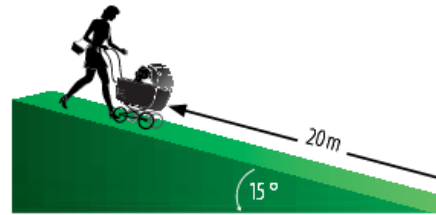


Figure 4.11 A woman depicted alone in caring role

Language abstraction

Language abstraction is an implicit way of representing humans in a manner that enacts gender discrimination (Rubini & Menegatti, 2008). Words are used to cast the portrait as highly appropriate for specific role in order to perpetuate gender bias and to reproduce inequalities. Zittleman and Sadker (2015) reveals various forms of gender bias, one of which is deliberate omissions of men in parenting role.

The figure 4.11 depicts a woman and it is also worth noting that pronouns were adequately used in the accompanying text to reveal the woman's gender, whilst there were no pronouns when a woman was depicted as science active in figure 4.7. This figure portrays the woman alone in parenting role, pushing her child in a stroller. Therefore, this figure is portrayed in a gender biased manner, perpetuating that women are more suitable for caring and nurturing roles than pursuing highly prestigious science professions like an astronaut portrayed as a male in figure 4.5.

Textbook page no. 66

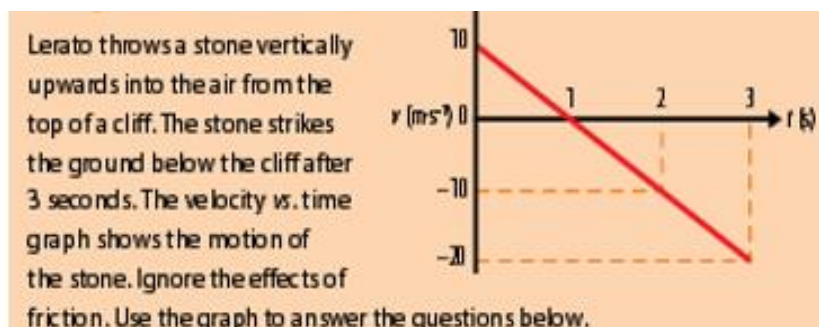


Figure 4.12 A girl illustrating a motion

Lack of pronouns conceals female gender

The figure 4.12 lacks pronouns to give confidence to the status of female gender. Readers who are not of African origin, and who use the textbook, may not know that Lerato is a girl's name. This is subtle form of concealing to suppress. **In this case Lerato is rendered invisible to the reader.**

Textbook page no. 38

1. A car travels at a constant velocity of $31 \text{ m}\cdot\text{s}^{-1}$, when the driver notices a stationary truck on the road in front of him. He applies the brakes to slow down at a constant rate. The driver is alert, and his reaction time is $0,677 \text{ s}$.

Figure 4.13 A man drives carefully

Textbook page no. 33

Example 6

A car of mass 500 kg is traveling at a constant velocity of $30 \text{ m}\cdot\text{s}^{-1}$ when the driver realises that she is exceeding the speed limit. She decides to slow down. She applies her brakes for 4 seconds . If a constant net force of

Figure 4.14 A woman is portrayed as a lawbreaker

Gender discrimination

Feminists such as Baehar (2007) are of the view that, controversial representations, and inadequate reflection of women's needs and interests in the conditions under which they live, is a form of gender discrimination. Mudaly (2006, p.61) firmly holds the view that this can result in "girls' underachievement in schooling system and in education in general".

The figures 4.13 and 4.14 display an act of gender discrimination. In figure 4.14, a woman is represented through controversy, **as a lawbreaker** who exceeds the speed limit. On the contrary, the figure 4.13 stresses that the man is an alert driver who notices obstruction, and applies brakes to slow down.

Interpretation of Module one: Mechanics

In the Mechanics module of the textbook, most of the female representations in the beginning are not coupled with an image of a woman or a girl. Fitzgibbon (2013) argues that the lack of the use of an image with positive gaze, where the person depicted in the image looks at the viewer, reduces the possibility of emotional attachment. Even in the cases where one wants to assume that the image used refers to a female, it becomes difficult, because the image is either too small to detect the gender of the person depicted or the passage where woman is used as an example lacks the use of pronouns that describe a female person e.g. 'she' or 'her'. On the contrary, most representations of male gender are coupled with an image and in the case where there is no image, the use of pronouns, 'he' or 'his', clarify that the person being referred to is a male.

In ten representations of both genders that I selected, four depict males, and six depict women. In six females that are represented, only one is named, while all four male representations are named. Of the four male representations, three have images. On the contrary, in six female representations only three representations have images. One female image is very small and is black. This act of depicting women with very small, black images, marginalises women and girls, and render them invisible in text (Fitzgibbon, 2013).

The chapter is about mechanics, so it orientates learners to aspire to professions like becoming an astronaut, as illustrated by figure 4.5. However, the use of only a man as an example of an astronaut is discriminating against girls. It reinscribes hegemonic patriarchal rules, which support the notion of men pursuing high status professions in science (Chambers, 2005; Schiebinger, 2000). There are examples where both female and male persons are used as drivers of vehicles. However, in the case of the female driver depicted in figure 4.14, she is portrayed as a lawbreaker, who exceeds speed limit. On the contrary, the male driver in figure 4.13 is portrayed as a careful and alert driver. The female driver only applies the brakes to slow down as a result of noticing later that the constant speed she is driving at, is above the recommended speed limit, while the male driver applies brakes because he is an alert driver, who notices an obstruction. This is evidence of what Mayr and Machin (2012) refer to as backgrounding and foregrounding. Males are foregrounded, while female persons are backgrounded through controversy and small, black images that do not draw attention of the readers of the textbook. Machin and Mayr (2012) state that the motive behind backgrounding

the participant, is to insinuate that he or she is subordinate. Therefore, this module promotes the ideology of masculinist science (Carey, Jackson, Antonello, & Rushing, 2016).

It also demonstrates male and female persons in relation to work, force and power, and orientates learners to aspire to careers associated with mechanical engineering (Litzinger, Lattuca, Hadgraft, & Newstetter, 2011). In figure 4.9 a girl is portrayed being able to handle only a 5kg mass. She only exerts a force of 20N over a 10m horizontal surface. On the contrary, in figure 4.10 a boy is also pushing the mass. However, the weight of the mass is not specified. In addition, the boy's back is not bent as low as the girls' back in figure 4.9. This is evidence of depicting women in a controversial manner to weaken. This image possibly connotes that women can't handle a large mass of an object because the girl depicted has only 40W power (Mudaly & Van Wyk, 2015).

The figure 4.11 depicts a woman pushing her baby in a stroller. This connotes that the only power women have enables them to raise children alone. There is no male depicted as a father alongside woman taking care of the child (Srivastava, 2012). Caring roles are associated with motherhood and are confined to domestic settings (McKinney, 2005). Marxist feminists argue that these services are usually rendered as unpaid labour (Mudaly, 2006). De Benedictis and Orgad (2017) argue that the devaluation of caring, productive and reproductive women's roles is exacerbated by print media. They argue that symbolic masking of parenthood, through naturalising motherhood in print media, condones and justifies lack of social, political and economic recognition and reward of motherhood. This is also evidenced by Mudaly and Van Wyk (2015) who state that women are sidelined and marginalised from highly prestigious profession as they are "...seen as passive vessels for transmission of hereditary traits" (Mudaly & Van Wyk, 2015, p. 231). They refer to this act, as rendering women worthless, insignificant, and incapable of becoming physicians. This is another form of prejudice that can subordinate women to caring roles only and not STEM careers. Chikunda and Chikunda (2001) argue that textbook biases where women are portrayed in nurturing and caring roles often than men, channel girls to careers that are an extension of domestic activities than STEM careers. For example, a woman may be employed in a medical surgery for housekeeping services or as a tea lady and not as a surgeon.

In this module, Mechanics, women are represented in a controversial manner to weaken their self-esteem, (possibly), in relation to the careers associated with science, particularly Mechanics.

4.2.6 Overview of analysis in module two: Matter and Materials (Physical Sciences) grade 12

This module is also divided into two sections, one section deals with chemistry, and the other deals with organic molecules. I analysed both of these sections as one module. The textbook has used ten human representations to illustrate science concepts. However, I have displayed only two visual images and one text passage to avoid monotonous repetition. All these figures portray only males as scientists. There are no representations of female gender in this module of the textbook, that's why there is no figure that represents female gender in textual description.

Table 4.3 *Gender representation in Matter and materials module in Physical Sciences textbook*

Figure	Page	Male	Female	Image	No Image	Science Active/passive	Size	Named	Not Named
4.15	75	✓		✓		Active	Large		
4.16	87	✓		✓		Active	Large		x
4.17	132	✓			✓	Active		✓	

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.2.7 Textual description of module two: Matter and Materials (Physical Sciences)

a) Gender representation as science active using visual images in Matter and Materials

Textbook page no. 75



2.1.1 Friedrich Wöhler made the organic compound urea from an inorganic source.

Figure 4.15 Male scientist Wohler

Hegemonic masculinity

Figure 4.15 depicts Friedrich Wohler, a male scientist. The accompanying text states that he made the organic compound urea from inorganic source. This portrayal confirms the evidence of hegemonic masculinity because female scientists are not depicted as founders of important science knowledge as in the case of the male depicted in figure 4.15.

Textbook page no. 87



2.1.9 Person being tested with an intoximeter

Figure 4.16 A male using potent cultural symbol

Potent cultural symbol

Machin and Mayr (2012) describe a potent cultural symbol as an object that carry cultural symbolism. They further clarify the concept of potent cultural symbol by mentioning that the stethoscope signify medical practice.

The image of the person depicted in figure 4.16 is also for the male person. The face, nose and ears are for a male person. The activity is science active. He is using the potent cultural symbol, the scientific instrument to investigate the principles and applications of the alcohol breathalyser. In this module, no female was found using potent cultural symbols to achieve gender balance.

b) Gender representation as science active using visual images in Matter and Materials

Although the module Matter and Materials also contains abundance of representations of males as scientists, I selected only one text passage to display this. All other passages depicted the same concept, males as founders of scientific knowledge.

Textbook page number 132

Did you know?

During World War II, Japan, Germany and Italy controlled nearly all the world's limited supplies of natural rubber. In the United States rubber products were rationed and the government funded research into synthetic rubber compounds. Both James Wright, an American engineer, and Earl Warrick, who worked at Dow Corning Corporation independently invented 'Silly Putty' in 1943. They discovered that when boric acid reacts with silicone oil, a gooey, bouncy material with several unique properties were produced. The putty would bounce when dropped, could stretch further than regular rubber and had a very high melting point. Unfortunately it did not have the properties to replace rubber, so it had no purpose. Samples were sent to scientists around the world but no practical use was found. A toy store owner decided to sell it as a novelty toy for adults. The product was packed in plastic eggs and has been sold in toy stores all over the world ever since.

(Adapted from information in Wikipedia)

Figure 4.17 Wright and Warrick

Exclusion of females maintains masculinist science

The male scientists are used to illustrate scientific concepts and to provide background information on the development of scientific concepts in figure 4.17. The exclusion of female scientists in this module may send message to girls that science is masculinist.

The case study (figure 4.17) relates of the male scientist James Wright. He is described as an engineer. It also mentions that Earl Warrick and James Wright invented Silly Putty independently. In the whole module there were no females that were portrayed as inventors or as scientists such as engineers.

Interpretation of module two: Matter and Materials module

In this module of the textbook, women are totally excluded. This is the module that orientates learners to become chemists in various specific fields. Although the authors of this textbook did not use many images, they mentioned only males as pioneers in chemistry. Therefore, girls who use this textbook as a resource for content knowledge lack role models who are chemists. Sheltzer and Smith (2014) confirm that the prime reason for women attaining fewer Life Sciences' degrees, and fewer of them appointed in STEM fields, is exclusion of them from the so-called male faculties in US. Internationally, Life Sciences (as a tertiary term) is used as an

umbrella term to refer to science degrees or courses., and not the Life Sciences (formerly known as Biology) as a school subject as it indicates in South Africa. Sheltzer and Smith (2014) insist that high achieving, male science faculty members, train fewer women in laboratories compared to the number of women who are trained by other investigators. They further mention that exclusion of gifted women (from predominantly male laboratories), possessing the capacity to make substantial input to the scientific enterprise, contributes to the under-representation of women in the science academy. This seriously hampers the progress of scientific discovery.

4.2.8 Overview of analysis of module three: Waves, Sound and Light (Physical Sciences)

In the module “Waves, Sound and Light” I analysed four figures. The table 4.4 reveals that these figures consist of three male representations and two female representations. The female representations include one image of poor quality, it is small and black, and the woman in this image is portrayed as science passive. The other female representation is in the text passage where she is conducting an investigation with a male, and is therefore science active. Again in this representation the woman is made to look subservient to her male counterpart. She is mentioned after the male has been mentioned. However, they are both portrayed as science active. All male representations are science active and they are a majority. Hence this module exhibits gender inequality.

Table 4.4 *Gender representation in Waves, Sound and Light module in Physical Sciences textbook*

Figure	Page	Male	Female	Image	No Image	Science Active	Size	Named	Not named
4.18	171	✓		✓		Active	Large	✓	
4.19	172	✓		✓		Active	Large		x
4.20	183	✓	✓		x	Active		✓	
4.21	182		✓			Passive	small		

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.2.9 Textual description of module three: Waves, Sound and Light (Physical Sciences)

a) Gender representation as science active: Waves, Sound and Light module

Textbook page no. 171

Christian Andreas Doppler (1803–1853) was an Austrian mathematician and physicist. He published many papers on electricity and magnetism, as well as on optics and astronomical topics. His most famous publication was made in 1842 and titled 'On the Colored Light of Double Stars and Certain Other Stars of the Heavens'. Within this paper he proposed that the observed frequency of light and sound waves is dependent upon how fast the source and observer are moving relative to each other, a phenomenon now referred to as the Doppler Effect. A few years later his theory for sound waves was proved correct by experiments conducted with musicians on railway trains playing instruments and other trained musicians writing down the apparent note as the train approached them and receded from them.



Figure 4.18 Austrian physicist Doppler

Textbook page No. 172



1. Your teacher will attach a string to the end of a tuning fork. The tuning fork is set into vibration and then whirled in a circular motion. As the tuning fork whirls it moves towards you for half of its revolution and then away from you for the other half of its revolution.
2. Note how the pitch of the sound changes as the tuning fork moves around the circle.
3. Record your observations.

Figure 4.19 A male investigates Doppler effect

Although in the figures 4.18 and 4.19 above I noted gaze and potent cultural symbol, my

analysis will not focus on these CDA constructs as they have been discussed in the preceding modules. However, I have also noted the evidence of stereotype in these figures, and the discussion thereof follows below.

Stereotype of portraying males in scientific roles

Blumberg (2008) and Fiske (2018) describe stereotypes as general ideas that societies hold about specific groups of people, and they are largely used to designate societal members to specific roles. They state that stereotypes promote prejudice which may include exclusion of portrayal of the particular group, which may consequently be marginalised and rendered subservient to the other.

The figure 4.18 depicts a male scientist Doppler. The figure 4.19 depicts a man in science active role. The continuous neglect of portrayal of women as scientists and in scientific roles, is the gender stereotype that perpetuates women subordination in science education.

Textbook page no. 183

Two learners, Francois and Sheena, conduct an experiment to determine the speed of sound. Sheena stands with a tape recorder while Francois rides on his bicycle blowing a hooter which gives off a sound of frequency 460 Hz.

A number of frequency readings are taken while Francois is riding his bike at a steady speed of $10 \text{ m}\cdot\text{s}^{-1}$ and sounding off the hooter. Sheena finds two sets of average frequencies: 447 Hz and 474 Hz.

Figure 4.20 A boy is mentioned first

Overlapping

Machin and Mayr (2012) describe overlapping as "...determining which elements in texts are placed in front of others, giving an impression that they come first".

In figure 4.20 the name of a boy, Francois, is coupled with the possessive pronoun 'his', so he is a male. He is overlapping, mentioned first in the activity. The name of a girl, Sheena, lacks the pronoun to identify her gender. She is also mentioned after Francois (the male). These representations connote that females are subservient to males.

b) Gender representation as science passive: Waves, Sound and Light module

Textbook page no. 182

- e) A stationary police car, at a distance of x_0 from a reference point O, is sounding its siren at a frequency of f_0 . A girl walks in a straight line towards the police car from the point O, passes the car, and then walks away from the car.



Figure 4.21 Representation of a girl illustrating frequency

Backgrounding

Machin and Mayr (2012) explains backgrounding as the tendency of the authors to portray participants in a manner that connotes subordination to their counterparts, which includes portraying the person depicted through a small image to conceal. The use of the small black picture to represent the woman in the figure 4.21 is the evidence of backgrounding.

Interpretation of module three: Waves, Sound and Light (Physical Sciences grade 12)

All male representations in this module are science active. This stereotype is repeated in this Physical Sciences textbook (see the analysis of module three of this textbook). Bruigelles and Cromer (2009) argue that exclusion of girls from science textbooks' portrayals may be the reason for their development of low self - esteem and passivity during science lessons. Only one female is represented as science active (in figure 4.20) and she is not represented by an image. The other woman is science passive and represented with a very small image. The use of a small image in figure 4.21 is an act of backgrounding female gender which renders women invisible in text (Fitzgibbon, 2013), and it signifies subordination of female gender (Chambers, 2015; Van Leeuwen, 2005).

These representations imply that girls lack science role models in this module (Clark Blickenstaff*, 2005). Morgan (2012) proposes that such stereotypes be eradicated from children's reading material to promote global understanding.

4.2.10 Overview of analysis of module four: Chemical Change (Physical Sciences)

The table 4.5 depicts seven figures. In all these representations, males are portrayed in science

active roles and they are named. On the contrary, there is only one representation where a female student is depicted science active in a large colourful image, conducting an experiment. The other two representations portray women as hairdressers and as consumers of science products.

Table 4.5 *Gender representation in the Chemical Change module in the Physical Sciences textbook*

Figure	Page	Male	Female	Image	No Image	Science Active/passive	Size	Named	Not Named
4.22	342	✓		✓		Active	small		✓
4.23	328	✓				Active	Medium	✓	
4.24	236		✓	✓		Active	Large		x
4.25	254	✓	✓		✓	Active		✓	
4.26	364	✓		x		Active		✓	
4.27	249		✓	✓		Passive	Large		x
4.28	197		✓	✓		Passive	Large		x

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.2.11 Textual description of module four: Chemical Change (Physical Sciences)

Visual images and texts that I analysed in this module reveal how this module perpetuates power imbalance which result to gender inequality. Although power imbalance and gender inequality are inextricably intertwined, I have used them separately in this analysis to show that they are not synonymous. Figures analysed below demonstrate how unequal distribution of power leads to gender inequality.

a) Gender representation as science active using visual images: Chemical Change module**Textbook page no. 342**

4.3.7 The chemist Søren Sørensen developed the pH scale.

Figure 4.22 Male scientist Sorensen

Textbook page no. 328

4.4.1 Michael Faraday

One of the pioneers of electrochemistry was Michael Faraday

Figure 4.23 Male scientist Faraday

Textbook page no. 236

4.3.6 Titration is a traditional method used to determine concentration.

Figure 4.24 A woman is science active

Low angle mandates power (figures 4.22 – 4.24)

Van Leeuwen (2005) and Kress and van Leeuwen (2006) identify the vertical angle of the camera as another semiotic tool that is used by social structures to empower or disempower. They state that photographs taken from low angle make the represented participant to look large and closer to the viewers. They continue to mention that photographs taken from high angle may result in decreased size of the represented participant and resulting in a participant being further away from the viewers (also known as interactive participants). They further mention that the represented participants seen from high angle are rendered powerless, making the viewers as the interactive participants exercise symbolic power to the represented participant (in the image). They conclude by stating that the represented participants depicted from low angle exercise symbolic power over viewers as the interactive participants.

A woman in figure 4.24 is portrayed at a low angle, making her image large and closer to the viewers. This signals that the woman depicted is in the position of power than the viewers. Therefore, woman in the image exercises power to learners as interactive participants, attracting the attention of girls to the activity that is demonstrated. She is portrayed applying scientific knowledge that has been discovered by others. The accompanying text mentions that she applies titration, a traditional method to determine concentration. Males in figures 4.22 and 4.23 were also photographed from low angle, bringing them closer to the viewers. In this way the image empowers boys as viewers to be attracted to represented participants as scientists.

Male scientists are portrayed at the higher level of achievement, as producers of scientific knowledge. Sorensen in figure 4.22 is described as the founder of the pH scale, while Faraday in figure 4.23 is described as the pioneer of electrochemistry. These portrayals can disempower, weaken and render women subservient to men in the world of science, because the image of a woman only empowers girls to be attentive science students who only apply scientific knowledge that was discovered by others. On the contrary the portrayals of male scientists in figure 4.22 and 4.23 empower boys beyond classroom, to emulate these scientists who are the possessors of scientific inventions and discoveries.

b) Gender representation as science active in text passages: Chemical Change module

In the analysis of text passage below, power imbalance is also noted resulting in gender inequality. As power imbalance has been discussed in the preceding visuals, the subsequent analysis will focus on gender inequality.

Textbook page no. 254

John and Caroline each prepare hydrogen gas by adding dilute sulfuric acid to zinc granules in a test tube. In both cases the temperature increases and gas is liberated at the same rate. However, when John adds a few pieces of copper to his reaction mixture, the reaction in his test tube proceeds noticeably faster.

- a) What role does the copper play in this case?
- b) Explain how the copper has the observed effect on the reaction.
- c) Name three other methods that Caroline can use to increase the rate of reaction in her test tube.

Figure 4.25 Males experimenting with new idea

Gender inequality

Downey, Titley, and Toynbee (2014) mention that ideologies in texts are capable of producing a social world that is characterised by social inequality as a result of unequal distribution of authority. Van Dijk (2016) who is a linguist confirms this statement, elaborating that ruling classes exercise their power to disseminate gender inequality through texts.

In figure 4.25 the male (John) and the female (Caroline) work individually to conduct a scientific investigation. John takes the initiative to discover new knowledge. Caroline is not portrayed as being proactive, but instead she is depicted as being in need of ideas from the reader, "...name three other methods that Caroline can use to increase the rate of reaction...". Overlapping is notable in the manner in which John is portrayed, he is mentioned first. Mentioning the male before the female, and portraying the male taking the initiative to discover new scientific knowledge while portraying the woman lacking creativity, signals gender inequality. This text maintains the ideology that males have innate ability to discover new scientific information. It also maintains that the ideology of patriarchal values in science that science is not for females.

Textbook page no. 364

Fritz Haber first developed the process early in the 20th century, and the first commercial plant was built in 1913. In 1918 he received the Nobel Prize for chemistry for his work. His initial ammonia yield was only 0,26%. He

Figure 4.26 Male is awarded a Nobel Prize

Lexical choice

The figure 4.26 shows the linguistic feature known as lexical choice. Machin and Mayr (2012) state that lexical choice refers to the authors choice to use a specific term to convey authority to certain persons, or to claim that they are specialists of knowledge. Frits Haber is portrayed as science active in figure 4.26, and mentioned in an elevated position, receiving Nobel Prize for chemistry. *As a Nobel Prize winner, he is an authority of a branch of chemistry.*

b) Gender representation as science passive in visual images: Chemical Change module**Textbook page no. 249**

4.3.10 Hair relaxer being applied.

Figure 4.27 Women in salon using science product

Determinism

Determinism is a linguistic term that refers to how aspects of texts inevitably shapes the readers' thoughts, decisions or actions in response to how text is portrayed (Machin & Mayr, 2012).

The figure 4.27 depict women in the topic 'the chemistry of hair products'. They are applying the hair relaxer possibly at a salon or at home. This figure exclusively used women to exhibit application of hair relaxer. Sadker and Sadker (2010) identifies sexism as one form of gender bias. They mention an example where representations in textbooks channel girls and women to occupations such as cosmetology. The figure 4.27 can demotivate women from pursuing STEM careers and channel them to salon as hairdressers.

Textbook page no. 197



4.1.7 An antacid tablet relieves heartburn.

Figure 4.28 Woman as a consumer of science product

Focus

Focus is noted as a linguistic feature in this visual image. In figure 4.28 the image of the face of the woman is depicted. The image is large. The attention is drawn to a woman as a consumer of science product, the tablet. She is portrayed as science passive because she not involved in analysing the chemistry of tablets.

Interpretation of Chemical Change module

In this module, only male scientists have been used in the production of scientific knowledge. The females are portrayed as examples when explaining scientific concepts in a number of different topics. The figure 4.28 portrays the woman as a consumer of products of science, not

a producer of scientific knowledge. The figure 4.27 depicts women in a hair salon. The image is large and clear, and is used to explain the chemistry of hair. This image might send the message to girls that they study science to become hairdressers (Zittleman & Sadker, 2015). The only image that portrays women in the scientific activity in a non – controversial manner in this module is figure 4.24. However, the woman is not named and is portrayed as a student. Hence, it is not enough to use it to inspire girls to pursue science (**in my view**). In the same module, males are portrayed as scientists (figure 4.22 and figure 4.23). Therefore, these portrayals can promote the ideology of gender aligned power during science lessons. Connel (2013) mention that gender is one factor (among others) that is used by societies to mandate power. Mirembe and Davies (2001) elaborate that messages of the official curriculum promote male domination and power imbalances. Downey, Titley, and Toynbee (2014) elaborate that messages in texts are used by social structures to legitimate power. The visual images portrayed above (figures 4.22, 4.23 and 4.24) depict representations of a female and males at different levels of power, females with little power only to apply scientific knowledge during science lessons, males with greater power, invited to emulate scientists beyond classroom environment.

When girls do not see women scientists in science textbooks they might lose enthusiasm for science subjects (D'Souza, 2015). This can result in poor academic performance of girls (Mburu & Nyagah, 2012). Wong (2016) mentions that girls who see science as masculine usually perform poorly than others (girls who don't see science as masculine).

In figure 4.25 the boy and the girl are used as examples of learners conducting a scientific investigation. The girl is portrayed as a passive thinker because she does not attempt to advance the investigation to discover something new. This scenario reinforces the ideology of masculinist science because males are foregrounded, while females are backgrounded.

4.2.12 Overview of analysis of module five: Electricity and magnetism (Physical Sciences) grade 12

In the module “Electricity and Magnetism”, there is only one figure that I analysed. This is the only image available in this module. The table 4.6 depicts two males that are represented. Women are not represented in the module “Electricity and Magnetism”.

Table 4.6 *Gender representation in the Electricity and Magnetism module*

Figure	Page	Male	Female	Image	No Image	Science Active/Passive	Size	Named	Not Named
4.29	293	✓		✓		Active	Medium	✓	
		✓		✓		Active	Large	✓	

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent


4.2.13 Textual description of module five: Electricity and Magnetism (Physical Sciences)

Representation of gender as science active (text and image): Electricity and Magnetism module grade 12

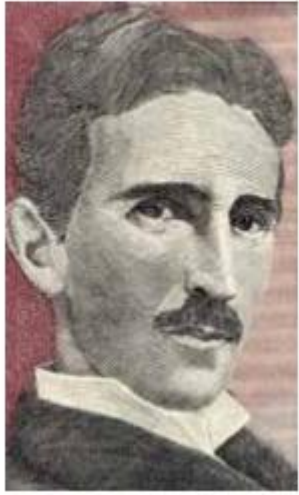
Textbook page no. 293

Case study AC vs. DC – The great debate

In the early years of electricity generation (in the 1880s), most of the power stations in the United States were generating power in the form of direct current (DC), while most of the countries in Europe were using alternating current (AC). Thomas Edison (1847–1931) was a famous inventor who had over a thousand inventions to his name, one of them being the light bulb. Edison was also a very successful businessman and owned numerous power stations which were generating DC power. For obvious reasons he was totally against AC power, stressing the dangers of electrocution by AC. To prove his point, Edison in a much publicised event, electrocuted a large elephant using AC. Nikola Tesla (1856–1943), a brilliant physicist, and who once worked for Edison, however proposed the use of AC as the main source of power in the United States.



Thomas Alva Edison (1847–1931)



Nikola Tesla (1856–1943)

Figure 4.29 Males in Electricity and magnetism

Rhetoric

Rhetoric is a linguistic noun that is used in discourse to refer to the art of writing or speaking that is intended to persuade readers or listeners into specific ideology through emphasis. It may also involve exaggeration and stating facts in an insincere manner (Van Dijk, 2016). Van Dijk elaborates that rhetoric is used to reproduce inequalities through ideological messages to legitimate power.

In the image 4.29 above, two male scientists are represented. They are both portrayed as science

active. Words were carefully selected to describe Edison as the famous inventor, successful businessman and owner of numerous power stations. Tesla is described as a brilliant physicist and the promoter of alternating current in United States. This is evidence of using rhetoric to emphasize to learners who use this textbook that science is for males. This is the last module of the textbook that I analysed. Possibly the passage was meant to reinforce the ideology of masculinist science. It is being insincere to girls to use exaggeration to portray male scientists in this manner while there is not a single female who has been described the same way in the whole textbook.

This legitimates the power of males as scientists over females. This confirms the findings of Blumberg (2008) who conducted a study on stereotypes in American textbooks. He discovered that in almost all portrayals, males were depicted in the positions of power more frequently than women. Women were also portrayed as incapable or shrewd mothers.

Interpretation of module five: Electricity and Magnetism (Physical Sciences)

In the module “Electricity and Magnetism”, women scientists are not represented at all. Girls lack science role models in this module. The module perpetuates gender inequality, discrimination and sex- role stereotypes of scientists as males (Donnelly & Twenge, 2017). Baker (2007) mentions that the masculinity of science is one of the principal motives behind girls’ withdrawal during lessons, and their avoidance of pursuing science subjects. Schiebinger (2000) further mentions that the image of scientist is universally perceived as masculine. Ellis (2017) state that girls use factors such as difficult and hard to describe science. These factors are associated with cultural stereotype of masculinity (Murnen, Greenfield, Younger, & Boyd, 2016).

The text passages and the images of male scientists above, display knowledge presentation in manner that imposes hegemony on learners. Gramsci (2009) argues that hegemony is the way in which the ruling classes in the society, maintain their own interests and convince all members of the society to accept such interests as interests for all. This module, similar to the others, contains discoveries of male scientists only. They are portrayed as producers of important science knowledge. As knowledge producers, they are positioned as powerful players in the discipline of science. This module empowers only the male gender in the classroom, which ultimately becomes the dominant. This is possibly the reason for male domination in science related careers and professions. Eddy, Brownell, and Wenderoth (2014) maintain that the numerical dominance of boys in science is one characteristic that reinforces that science is

masculine. This textbook provides ideas to girls (during science lessons) that are uncharacteristic of their own lives, and they are compelled to accept wrong identities, that science is not for them (D'Souza, 2015). This is what Fairclough (2013) calls symbolic violence, where the interests of one social class are promoted while the interests of the other are negated. Symbolic violence unconsciously shapes a world for boys that is different to that of girls. It is also evidence of continuing assaults that make girls to lose self-esteem, causing them to unconsciously shut down their creative thinking abilities (Fairclough, 2003). This ultimately impacts negatively on their science academic performance, and sometimes results even in learners' withdrawal from school (Osborne & Walker, 2006).

4.2.14 Concluding discussion: Study and Master Physical Sciences CAPS textbook for grade 12

In the Physical Sciences textbook, none of the portrayed scientists are female. Marginalisation of female scientists in this textbook is a form of what Fitzgibbon (2013) terms discourse modernity. Exclusion of female scientists is possibly meant to perpetuate a political ideology that science is masculine. Considering that this textbook is for grade twelve learners, this could contribute to girl's doubts about their pursuit of careers in science related fields at the tertiary level. This signals that women may continue to be underrepresented in STEM fields. Below is the table that shows the names and the gender of scientists that were included in this textbook. Some of the scientists that are portrayed in the table were excluded from texts because analysis revealed that they possessed same features that were already discussed.

Table 4.7 *Scientists portrayed in Physical Sciences textbook*

Name of the scientist	Country	Gender
Friedrich Wohler	German	Male
Charles Goodyear	American	Male
James Wright	American	Male
Earl Warrick	United States	Male
Adolf von Baeyer	German	Male
Hendrik Baekeland	Belgium	Male
Eduard Simon	German	Male
Bonastre	France	Male
A. Doppler	Austria	Male
Le Chatelier	France	Male
Arrhenius	Sweden	Male
Bronsted	Denmark	Male
T M Lowry	England	Male
Soren Sorensen	Denmark	Male
Thomas Edison	United States	Male
Nikola Tesla	Europe	Male
Albert Einstein	Germany	Male
Michael Faraday	United Kingdom - London	Male
Fritz Haber	Germany	Male

The next textbook that was analysed was the Study and Master Life Sciences for grade eleven. It is used by Life Sciences learners in the FET band.

4.3 Analysis of the Study and Master Life Sciences textbook for grade 11

The analysis of the Life Sciences textbook included the analysis of the textbook cover, and the content knowledge inside the textbook. In the analysis of the textbook cover, I sought to determine whether textbook cover is gender neutral or not. In the second part of the analysis,

which is the textual description of the content and visual images inside the textbook, I divided the textbook according to the knowledge strands that are studied in each term. In each strand, I provided the table that summarises how gender is represented, i.e. which gender is named, portrayed by images, whether the images are colourful or in black and white, and the influence of the size of the image of each gender. This followed by textual description, where I provided the scan of the text or image from the textbook with textbook page mentioned for reader's reanalysis, as well as short description of what appears in the scan. Constructs that I used to describe the appearances of text and visual images include potent cultural symbol, foregrounding, focus, gender bias, stereotypes, subservient, pronouns, backgrounding, iconography, gaze, and salience.

I concluded the analysis of each strand by providing the interpretation of what the description implies or maintains, i.e. whether the manner in which gender is represented is inclusive, neutral, discriminative or marginalises one gender while elevating the other.

4.3.1 Analysis of the textbook cover for Life Sciences

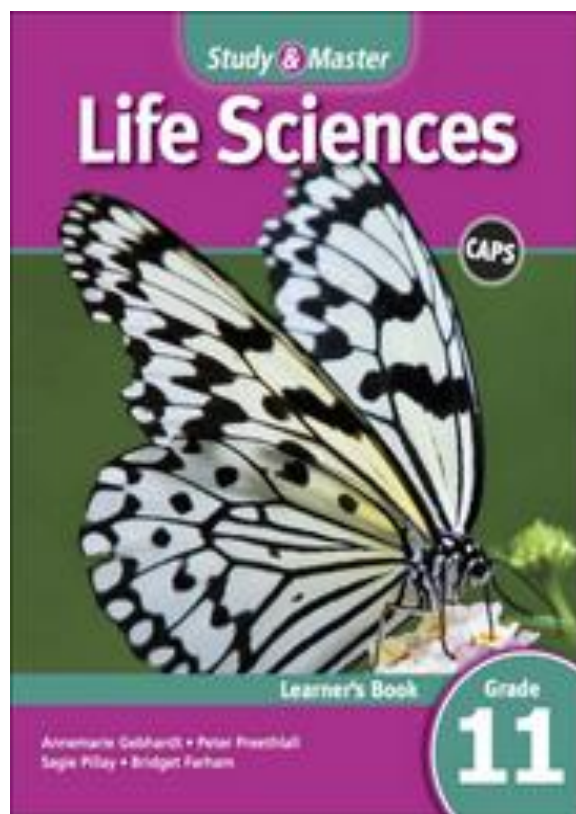


Figure 4.30 Cover for Life Sciences textbook

Analysis of the textbook cover

The title of the textbook is “Study and Master Life Sciences textbook” for grade eleven. There is nothing controversial about the title of this textbook. The picture of the butterfly on the cover page of the textbook is relevant because one of the strands in the textbook deals with “Biodiversity of Plants and Animals”. Therefore, the cover of the textbook is gender neutral.

Interpretation of the textbook cover for Life Sciences

The textbook cover does not promote masculinity because there are no features that promote one gender while negating the other.

Analysis of the introductory part: Study and Master Life Sciences textbook for grade 11

The introductory part of the Life Sciences textbook did not have human representations. For this reason, no analysis was done in this section because analysis in each section was guided by the research question which explored gender representations only.

4.3.2 Overview of the analysis of strand one: Diversity, Continuity and Change (Life Sciences)

In the strand “Diversity, Continuity and Change”, more females were represented in the text than males. The table 4.8 shows the analysis of three female representations and three male representations in six scanned text passages and visual images. Only women are portrayed as science active. More males are depicted as sick, taken care of by women. All males are portrayed in science passive roles. Although the images and texts depicted in the analysis of this module were carefully selected to minimise repetition, there were no representations of males in science active roles in the textbook (in this module). Image of persons in the clinic depicted as HIV patients was omitted because humans were too small. Hence it was difficult to distinguish gender.

Table 4.8 *Gender representation in the Diversity, Continuity and Change in the Life Sciences textbook*

Figure	Page	Male	Female	Image	No Image	Scientific Activity	Size	Named	Not Named
4.31	16		✓	✓		Active	Large		x
4.32	43		✓	✓		Active	Medium		x
4.33	43	✓	✓	✓		Passive	Medium		x
4.34	63	✓		✓		Passive	Large		x
4.35	67	✓			x	Passive		✓	
4.36	83		✓	✓		Passive	Large		x

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.3.3 Textual description of strand one: Diversity, Continuity, and Change (Life Sciences)

a) Gender representation as science active using visual images: Diversity, Continuity, and Change strand

Textbook page no.16



Figure 4.31 Woman using potent cultural symbol

Potent cultural symbol

In figure 4.31, a woman is portrayed as science active, using potent cultural symbol, microscope. This figure can encourage girls to pursue science.

Textbook page no. 43

The most famous of these pandemics was the Spanish Flu pandemic of 1918. The virus affected every corner of the world and killed between 50 million and 100 million people. It was caused by the A/H1N1 virus.



Figure 4.32 Woman in nursing role

Foregrounding

A woman is depicted as a nurse in figure 4.32. It is not clear whether the patient is a male or female. The figure 4.32 foregrounds women in nursing role, possibly to diplomatically motivate girls to aspire the nursing profession. This figure can maintain the ideology that nursing profession is a feminine career.

b) Representation of gender as science passive using visual images: Diversity, Continuity, and Change (Life Sciences)

Late blight of potato

This disease is caused by the organism *Phytophthora infestans*. About 150 years ago the potato crop of much of Europe, including Ireland, was destroyed by this organism. *Phytophthora infestans* was an introduced pathogen on a non-native crop. The ravages of this disease led to around one million deaths and 1,5 million emigrations from Ireland alone.

This organism is spread by two different types of spores: zoospores, which attack the tuber, and sporangia, which infect the aerial parts of the plant. These spores become dormant on the potato tubers and can be very widely dispersed by wind and rain. They begin to germinate when conditions are damp and relatively cool. These conditions are easily produced under the leafy canopy of a growing potato field.



Figure 1.1.43 A memorial to the Irish famine in Dublin, Ireland

Figure 4.33 Males with late blight of potato

Focus

Irish men are depicted as sick and poor in figure 4.33. Again attention is drawn to males as sick. This might not encourage boys to pursue Life Sciences as a subject. The accompanying text mentions that people in Ireland were killed by this disease. However, the image depicts only males as sick.

Textbook page no. 83

Figure 4.34 Women brewing beer

Gender Bias

One form of gender bias is portraying women alone in activities that confine them in domestic settings (Sadker and Sadker, 2010).

In figure 4.34 women are depicted in domestic settings preparing traditional beer, and they are pensioners. The persons are not science active, but the activity is used in explaining the concept of alcoholic fermentation in science. This figure repeats the stereotype of portraying women in prejudiced manner, it does not channel women and girls to STEM careers. For example, the women portrayed are not in the science laboratory exploring how pyruvic acid is changed to alcohol during the brewing of beer.

c) Gender representation as science passive in Diversity, Continuity and Change in texts**Textbook page number 67**

Activity 26 The immune system and disease (Specific Aim 1) 

Find out the name of the bacterium that causes whooping cough (pertussis). Busi contracted whooping cough. His symptoms over a 20-day period are charted below. Use the chart to describe the symptoms of whooping cough.

Figure 4.35 A Male with whooping cough

Reinforcing the stereotype of men as victims of sickness

A male, Busi is used as an example of a very sick person, with whooping cough in figure 4.35. The noun Busi is also used to refer to girls. His gender is revealed by possessive pronoun 'his'. He is portrayed science passive. This module repeatedly portrays males as victims of sickness.

Interpretation of strand one: Diversity, Continuity, and Change

In strand one, “Diversity, Continuity and Change” of the Life Sciences textbook all male representations are science passive. Two images portray women as science active. The figure 4.31 depicts a woman viewing (possibly slides of) the microscope. Positioning of a woman as science active in the first pages of the strand “Diversity, Continuity and Change”, can attract girls’ attention. Boys lack science role models in this strand because men are only portrayed as sick patients and science passive. This confirms Keller’s opinion that masculinity of science is more applicable to Physics than to Biology (renamed Life Sciences in South Africa) (Keller, 2003). Ceci and Williams (2007) who conducted a study titled “*Why aren’t more women in science*”, discovered that students (who were participants of the study) perceived Physics as masculine, while Biology was perceived as gender neutral.

4.3.4 Overview of analysis of strand two: Life Processes in Plants and Animals (Life Sciences)

In the strand “Life Processes in Plants and Animals”, figures 4.36 and 4.37 depict males and females. Hence the table 4.9 shows three female and two male representations in three figures. More women than men are represented in the strand “Life Processes in Plants and Animals”. However, a woman scientist that is mentioned is not named and is not illustrated by an image. Another representation shows a woman as subservient to the man in scientific activity that is depicted, while the other depict woman with psychological disorder. There is only one clear male person depicted as science active and in control. The other male representation shows the body and the face is hidden.

Table 4.9 *Gender representation in the Life Processes in Plants and Animals strand in the Life Sciences textbook*

Figure	Page	Male	Female	Image	No image	Science active/passive	Size	Named	Not named
4.36	141	✓	✓	✓		Active	Large		x
4.37	175		✓		x	Active			x
4.38	183	✓	✓	✓		Passive	Large		x

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.3.5 Textual description of strand two: Life Processes in Plants and Animals (Life Sciences)

a) Gender representation as science active using visual images: Life Processes in Plants and Animals

Textbook page no. 141



Figure 4.36 Male and female depicted science active

The science active female depicted as subservient to a male

The male and female are depicted in figure 4.36. The male is science active carrying the conical flask with a chemical, possibly the copper sulphate as it is blue in colour. The female looks like an assistant watching the male person or waiting to help when needed. Portrayal of a male and a female working co-operatively in scientific investigations creates space for gender inclusivity in this module. However, Feminists oppose the tendency of science textbooks to portray women in science active roles only to fit the patriarchal view (Schiebinger, 2000). It is the male who is holding the conical flask and not the female. Therefore, a woman in figure 4.36 is again portrayed as a male subordinate.

b) Gender representation as science active using text passages: Life Processes in Plants and Animals (Life Sciences)

Textbook page no. 175

» Activity 8 An investigation into digestion (Specific Aim 2)

A scientist conducted an investigation on digestion, involving gastric juice. She compared the time taken for 50 g of different cooked egg samples to form chyme in the stomach, with the time taken for the same sample to form chyme in a test tube containing gastric juice. The test tube was maintained at 37 °C.

Figure 4.37 Not naming a female scientist is a gender bias

Pronoun reveal gender of the person that was not named

In figure 4.37 the passage mentions the scientist but only the use of the pronoun 'she' in the next sentence enables the reader to conclude that the authors were referring to a female person. The female person is science active. Also, not naming the female scientist is a gender bias that is used as a strategy of rendering women invisible in the discourse (Fitzgibbon, 2013).

b) Gender representation as science passive: Life Processes in Plants and Animals (Life Sciences)

Textbook page no. 183



Figure 4.38 A woman with anorexia versus an obese man

Determinism

A woman is depicted with psychological eating disorder, anorexia nervosa in figure 4.38. The person who is obese cannot be identified because the image does not show the head. However, the structure of the chest appears to be that of a man. This figure can channel learners to think that only women involve themselves in excessive self-starvation that is a result of perceiving oneself as overweight even though the person is thin. Obesity may be the result of over eating. However, a man is concealed possibly to draw attention to the woman as an object of shame.

Interpretation of strand two: Life Processes in Plants and Animals (Life Sciences)

In the strand “Life Processes in Plants and Animals” girls may have science role models because there is one female scientist mentioned. However, this representation shows gender discrimination against women because the scientist is not named and her representation is not coupled by an image in figure 4.37. The image in figure 4.37 depicts a male and a female wearing white laboratory coats. The man is carrying a conical flask with chemicals and a woman is observing what he is doing. This figure casts women as passive observers in their world of science. Radical feminist activists regard this as an act of subordinating women (Chambers, 2005).

4.3.6 Overview of analysis of strand three: Environmental studies (Life Sciences)

The strand “Environmental Studies” portrays five representations of male and female gender.

This strand portrays gender equality in science active roles. It also shows females dominating in science passive roles. The table 4.10 summarises gender representations in the strand “Environmental Studies”.

Table 4.10 *Gender representation in the Environmental Studies strand in Life Sciences textbook*

Figure	Page	Male	Female	Image	No Image	Science active	Size	Named	Not Named
4.39	217	✓		✓		Active	Medium		x
4.40	265		✓	✓		Active	Medium		x
4.41	241		✓	✓		Passive	Large		x
4.42	323		✓	✓		Passive	Large		x

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.3.7 Textual description of strand three: Environmental Studies (Life Sciences)

a) Gender representation as science active using visual images: Environmental Studies

Textbook page no. 217

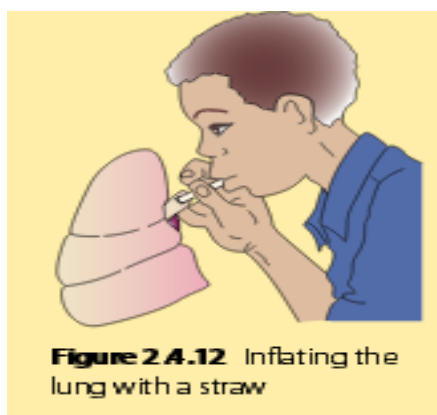


Figure 4.39 A boy experimenting with lungs

Iconography

The figure 4.39 denotes a boy in science active role, using a straw to inflate lungs. This image connotes that boys have science role models in this module. Therefore, it can motivate boys to pursue Biology related courses at the tertiary level.

Textbook page no. 265



Figure 4.40 Woman portrayed viewing microscopic slides

Gaze

A woman is depicted as science active in figure 4.40, picking the substance to be viewed under the microscope with the tweezers or forceps. The woman depicted is working independently to view what looks like microscopic slides. Although the person depicted in figure 4.40 does not look at the viewer (gaze), this image can motivate girls to pursue microbiology and other related fields.

b) Representation of gender as science passive using visual images: Environmental Studies (Life Sciences)

Textbook page no. 241

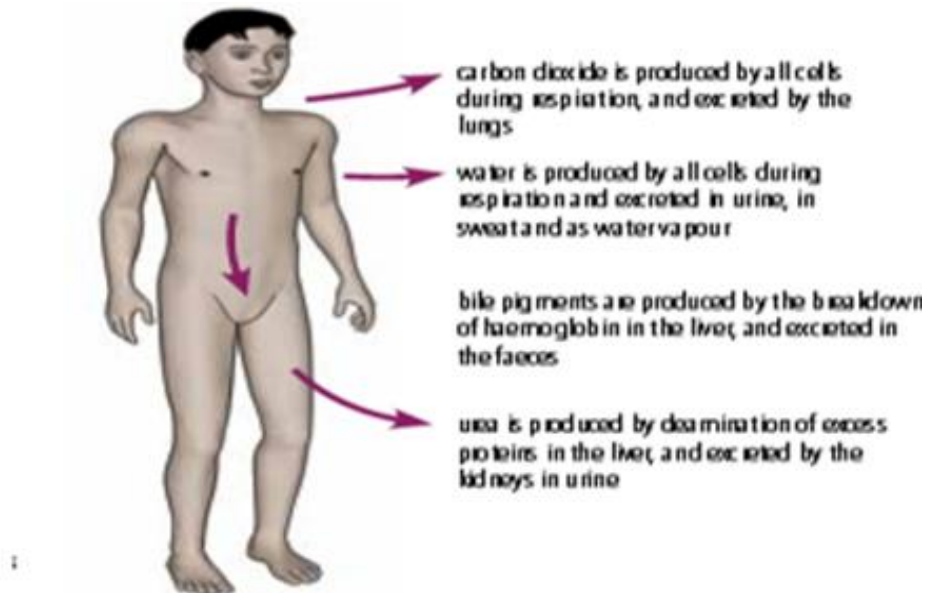


Figure 4.41 Female's body used as a teaching aid

Saliency

The linguistic feature that is evident in figure 4.41 is saliency. While other images of women in this strand are moderate in size, in the figure 4.41 the female's body is exhibited in full, and the size of the image is large. Machin and Mayr (2012) state that size can be used to draw attention. The body of a woman is shown naked (the pubic area does not have penis or scrotum). The woman is depicted as science passive. The woman's body is used as a teaching aid in the topic 'excretion'.

Textbook page no. 323



Figure 3.2.7 Conflict causes starvation and poverty

Figure 4.42 Sex role stereotype of women in caring role

Sex role stereotype

The figure 4.42 depicts women (another woman is behind the other) caring for children alone. This image reinforces a stereotype of women in nurturing role, possibly channelling them to science fields that are an extension of domestic settings. The tendency of print media to portray women as most apt for domestic duties is regarded as strategy to perpetuate hegemonic masculinity (Lung & Ball, 2015).

Interpretation of strand three: Environmental Studies

In the “Environmental Studies” strand, human portrayals in science active roles show the evidence of gender equality. Although there are only two figures that I identified in science active roles, both depicted a male and a female. However, in science passive roles only women are depicted and they are either foregrounded in nurturing roles (which are generally classified as domestic chores) or depicted naked. Marxist feminists oppose the foregrounding of women in domestic chores. They state that these services are usually rendered as unpaid labour, and

this reinforces Capitalistic motives of exploiting women (Mudaly, 2006). Feminist activists also contend with the portrayal of women's bodies naked in print media (Schiebinger, 2000). They propose that if a woman's body is used as a model in studying science, it should be exhibited with a man's body to achieve gender equality (de la Peña, 2012). Therefore, showing only a female's body naked as a teaching aid in figure 4.41 is an act of discrimination against women.

4.3.8 Concluding discussion: Study and Master Life Sciences CAPS textbook

In the Life Sciences textbook "Study and Master Life Sciences textbook for grade eleven", women are portrayed as science active in a number of activities. Furthermore, only female scientists are depicted. This signals that girls have science roles models in this textbook, and it can motivate them to pursue Biology courses at the tertiary level. However, other female portrayals depict women caring either for men or children. It is also notable that more men than women are depicted as being sick. None of the males are depicted in caring roles. Mudaly and Van Wyk (2015) reveal that globally, there is a remarkable increase of women who enrol in health sector, particularly in medicine. However, they argue that medicine profession is still masculine as women are '...under-represented in prestigious, high income specialities...' (Mudaly & Van Wyk, 2015, p. 230).

This is possibly the reason why more girls than boys choose Life Sciences as the subject, and later pursue nursing careers instead of other more prestigious science fields which are male dominated such as engineering and chemistry. Kelly (1985) views Biology (as a university course) as female predominated, because the findings of her study in USA revealed that only thirty to forty percent of male learners enrolled for Biology, while in Physics classes male learners constituted seventy to eighty percent compared to girls.

Scientists that were involved in the knowledge production of the textbook "*Study and Master Life Sciences for grade eleven*" were not mentioned. The next textbook that I analysed was the Natural Sciences textbook.

4.4 Analysis of the Oxford Successful Natural Sciences textbook for grade 9

Analysis of the Natural Sciences textbook also began with the analysis of the textbook cover. This was then followed by textual description which included analysis of visual images and textual content simultaneously.

4.4.1 Analysis of the textbook cover for Natural Sciences

During the analysis of the textbook cover for Natural Sciences textbook I sought to determine whether the textbook cover was gender inclusive or not. I also searched for evidence of dissemination of hegemonic values.

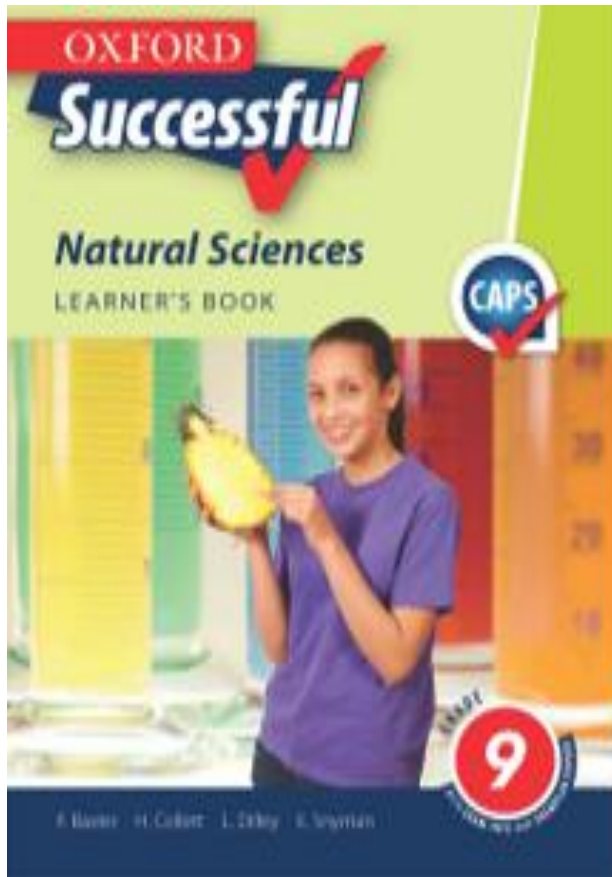


Figure 4.43 Cover for Natural Sciences textbook

Analysis of cover of the textbook

The title of the textbook is “Oxford Successful Natural Sciences Learner’s book”. There is nothing that is gender biased in this title. The textbook cover depicts a girl. This is evidence of foregrounding the female gender because the image depicts a female only.

Interpretation

Possibly the girls may be attracted by the cover because there is only an image of a girl. Therefore, this portrayal lacks gender inclusivity. Boys’ exclusion from the textbook cover which is meant to attract attention of all learners connote that they are marginalised and if they

use this textbook as a learning resource, they might believe that Natural Sciences is not for them.

4.4.2 Overview of analysis of text and visual images in Natural Sciences textbook

In the analysis of Natural Sciences textbook, I also organised the analysis according to knowledge strands. The textbook has four strands, namely, Life and Living (strand one), Matter and Materials (strand two), Energy and Change (strand three), and Planet Earth and Beyond (strand four). The constructs that informed the analysis of Natural Sciences textbook are foregrounding, focus, gender fairness, lack of gaze, positive gaze, potent cultural symbol, hegemonic masculinity, suppression and gender bias.

4.4.3 Overview of the analysis of strand one: Life and Living (Natural Sciences)

The analysis in the “Life and Living” strand depicts three figures of human representations. See the table below. In these figures, one depicts two male scientists. They are depicted as science active in this module. The other figures depict men and women as science passive. Details on the analysis of figures follow after the table.

Table 4.11 *Gender representation in the Life and Living strand in the Natural Sciences textbook*

Figure	Page	Male	Female	Image	No Image	Science active/passive	Size	Named	Not named
4.44	18	✓			x	Active		✓	
		✓			x	Active		✓	
4.45	28	✓	✓	✓		Passive			x
4.46	40/41	✓	✓	✓		Passive	Large		x

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.4.4 Textual description of Life and Living strand in the Natural Sciences textbook

a) Gender representation as science active: Life and Living strand

Textbook page no. 18

History of the discovery of microscopes

Four hundred years ago, no-one knew that micro-organisms existed because they are too small to see. That all changed when **microscopes** were invented. Towards the end of the 16th century (about 1590–1606), the first simple microscope was introduced by some Dutch spectacle-makers. A microscope is an instrument that **magnifies** objects that are normally too small to see. Anton van Leeuwenhoek (1632–1723), a cloth merchant, discovered bacteria in the tartar of teeth, as well as microscopic animals in water.

Light microscopes

A light microscope focuses light onto the object to be viewed to illuminate it. In 1665, Robert Hooke looked at a thin slice of cork, using a light microscope that he had designed. He saw patterns in the cork that looked like tiny compartments, which he called cells. Modern microscopes are similar except that they can magnify by up to 2 000 times.

Figure 4.44 Male scientists Leeuwenhoek and Hooke

Foregrounding

Two male scientists are mentioned in figure 4.44. One was Anton Leeuwenhoek, who investigated bacterial cells, the other was Robert Hooke who used light microscope to discover cork cells. Western males are foregrounded as inventors of science knowledge.

b) Gender representation as science passive using visual images: Life and Living strand

Textbook page no. 28



Figure 4 People with anorexia



Figure 5 Drinking too much alcohol can result in liver disease.

Figure 4.45 Representation of a male and a female with a disease

Focus

A linguistic feature evident in figure 4.45 is focus. Attention is drawn to the woman as very sick, possibly to exaggerate her weakness. On the contrary, the symptoms of sickness on the man alongside her are concealed. The man is not portrayed with symptoms of the disease and is not naked. The body of the male person is not shown in the genital area as in the case of a woman alongside him, who is depicted wearing the underwear only. This is controversial manner of portraying woman possibly to weaken her image or her status.

Textbook page no. 40 and 41

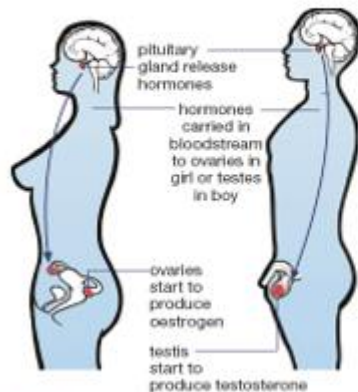


Figure 1 Hormones from the pituitary gland trigger production of sex hormones.

Textbook page no. 40 and 41

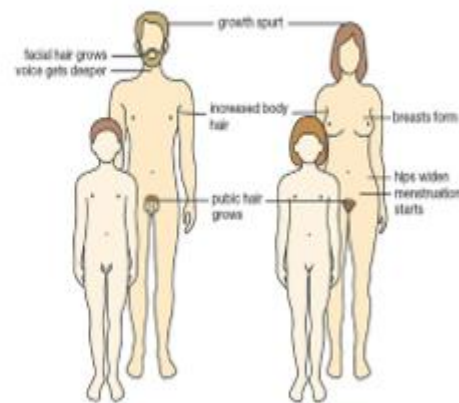


Figure 2 Hormones from the pituitary gland trigger production of sex hormones.

Figure 4.46 Males and females as teaching aids

Gender fairness

Figure 4.46 depict the bodies of both genders naked as illustration in teaching hormones. This figure shows gender equality. Although the bodies depicted are naked, they represent both genders, i.e. male and female. Hence this representation is fair.

Interpretation of strand one: Life and Living (Natural Sciences)

The figure 4.44 represents two male scientists. There are no female scientists represented in this module. This is evidence of gender discrimination against girls (Bian, Leslie, & Cimpian, 2017; Mayr, 2008). Again girls lack science role models in this module. In figure 4.45, while the authors initially appeared to possess a gender neutral approach by stating that both females/ girls and males/ boys can be victims of anorexia nervosa, the man is depicted drinking alcohol (in the same page) which could lead to cirrhosis. The authors did not use an image of a person who is very sick as a result of drinking too much alcohol like in the case of the image of the woman with anorexia. Depicting the body of a woman with an underwear only in figure 4.45 does not show respect to woman's body. The body of a man is depicted in manner that shows respect because the man is not shown naked wearing the underwear only. Feminist activists protest against depicting women's bodies in print media in a manner that suggests violation of women's rights (Price & Shildrick, 2017). Radical feminists argue that images of women's

bodies must be portrayed in a manner that shows respect towards the status of women (Price & Shildrick, 2017). They further state that psychological damage is inevitable for the persons whose bodies are depicted naked in advertisement programmes in media (Daly, 2016).

4.4.5 Overview of analysis of strand two: Matter and materials (Natural Sciences) grade 9

In the strand “Matter and Materials”, I scanned and analysed five figures comprising of text passages and visual images. My analysis reveals that both males and females are portrayed as scientists in this strand. However, portrayals of female scientists are characterised by one or more of the following features, namely, they are not named, depicted in black and white photographs, and they lack surnames. Only one male scientist is portrayed. His portrayal is fair because he is portrayed in a colourful picture, with full name and surname mentioned. Read the full description of these figures in the sub – section 4.4.6.

Table 4.12 *Gender representations in the Matter and Materials module in the Natural Sciences textbook grade 9*

Figure	Page	Male	Female	Image	No image	Science Active/passive	Size	Named	Not Named
4.47	85	✓		✓		Active	Large	✓	
4.48	97		✓			Active	Large		x
4.49	100		✓	✓		Active	Small		x
4.50	75	✓		✓		Passive	Large		x
			✓	✓		Active	Large		x
4.51	93	✓			x	Active		✓	

Keys:

- ✓ = a characteristic that is present,
- x = a characteristic that is absent

4.4.6 Textual description in Matter and Materials module (Natural Sciences)

a) Representation of gender as science active using visual images : Matter and Materials module

Textbook page no. 85



Figure 4.47 Representation of a male as mining engineer

Gaze in male representation

The male mining engineer in figure 4.47 is looking at the viewers. Hence learners are invited into the activity and to emulate the scientist depicted. However, it is boys who will possibly be interested in the image depicted because they are of the same gender as the person depicted (Budden, 2007; Cottrell, 2011; Mburu & Nyagah, 2012).

Textbook page no.97



Figure 4.48 A female scientist as the chemical engineer

Lack of positive gaze indicates gender discrimination

The female scientist depicted in figure 4.48 (chemical engineer) is not looking at the viewers. When the participant is not looking at the viewers, it is an indication that viewers are not invited into the activity, and they are not expected to emulate the person depicted (Machin & Mayr, 2012). Hence the image depicted is possibly meant for teaching only, and not to encourage learners to pursue chemical engineering. This is an act of discrimination because the male in figure 4.47 is portrayed in positive gaze.

Textbook page no. 100

Careers



A PHARMACIST TELLS US ABOUT ANTACID

Josie is a pharmacist who studied at Rhodes University. The Pharmacy Degree is a four-year course. We asked her if she could tell us about antacid. "An antacid is any chemical that is used to treat acid indigestion. The antacid neutralises stomach acid, which is diluted hydrochloric acid. Calcium carbonate is a common ingredient of antacids."

Figure 1 Josie the pharmacist

Figure 4.49 Female scientist as pharmacist is backgrounded

Backgrounding

The use of black and white photograph to depict the female scientist in figures 4.49 (also in figure 4.48) is evidence of backgrounding. The chemical handled by the chemical engineer in 4.48 is not clearly visible because of lack of colour. Also the scientist depicted in figure 4.49 does not have a surname, and this is another strategy of backgrounding. The image of the woman scientist is very small. This may render women invisible and powerless participants in text.

Textbook page no. 75

than they use up, store this extra food as fat. They can become large excess of fat in its tissues. Obese people are more likely other health problems.



Figure 7 Obesity is dangerous for a person's health.

Figure 4.50 A woman scientist is not named

Potent cultural symbol

The body of the male person is also shown half naked in figure 4.50. It does not reveal the genital area, and the man is wearing a pair of shorts (and not an underwear as in figure 4.45, where a woman is depicted with the underwear only). The woman is observed to be a surgeon because she is using the stethoscope (the scientific potent cultural symbol) to diagnose possibly the man's heartbeat who is obese. However, not naming the woman as a scientist is a form of marginalisation. This image can send message to girls that in reality there are no female surgeons (especially in areas of the country where there are no females who practise as doctors), possibly the one depicted is only used as an example.

b) Gender representation as science active using text passage: Matter and Materials (Natural sciences)

Textbook page no. 93

CASE STUDY Neutralising stings

It was Friday the 13th and Vincent had had an unlucky day. He got two insect stings. First he was stung by a wasp, so he put some vinegar on the sting. Later he was stung by a bee, so he got out the bicarbonate of soda and mixed it with some water. The lucky part of the story is that Vincent was an attentive chemistry student, so he knew how to neutralise the stings.




Figure 1 Would you know what to do if this bee stung you?

Figure 4.51 A male described as attentive chemistry student

Hegemonic masculinity

The male in Figure 4.51, is described as an attentive chemistry student. Vincent is a male's name. The pronoun he confirms that Vincent is a male. Portraying Vincent as an attentive chemistry student legitimates hegemonic masculinity. There is no text passage or visual image that has portrayed women as attentive participants during science learning in this module. This image empowers males as suitable students for science learning.

Interpretation of strand two: Matter and Materials

In strand three, "Matter and Materials", there is equal representation of males and females in terms of numbers. There are three males and three females that are depicted. All the women that are depicted are scientists. In the case of men, only two of them are depicted as scientists (see figures 4.47 and 4.51). Figure 4.50 depicts a man who is posing as a patient. However, there is evidence of gender discrimination against women in this module. In these three representations of women scientists, women are marginalised and sidelined through portrayal in either small, or black and white pictures. A female scientist depicted in figure 4.50 is not named. Furthermore, she is depicted using stethoscope to diagnose (possibly) the heartbeat of the obese man. In the whole textbook there is not even one image that portrays the man taking care of women. Figure 4.50 perpetuates the view that women study science in order to take

care of men. In figure 4.48, a female scientist is depicted in a large picture as a chemical engineer but she is not named and is portrayed in a black and white picture. This is another evidence of sabotaging female gender. Figure 4.49 describes the profile of a female scientist (mentioning her name, the degree she studied, and where she studied), but neither her surname nor her country of origin is mentioned. On the contrary, the male scientist in figure 4.47 is depicted in a positive gaze, with a large colourful picture and with full name and surname. This is another way of foregrounding the male as important participant in this module (Machin & Mayr, 2012). Hence this strand also promotes patriarchy in concealed ways.

4.4.7 Overview of analysis of strand three: Energy and Change (Natural Sciences)

In strand three, Energy and Change, I have analysed five figures as displayed in the table 4.13. However, some of these figures show the faces of more than one person. Hence three females and three males are represented in the table below. The analysis reveals equal representations of males and females in terms of numbers, but girls are represented in a manner that promotes inferiority, while boys are represented in manner that introduces superiority and control.

Table 4.13 *Gender representations in the Energy and Change strand in the Natural Sciences textbook*

Figure	Page	Male	Female	Image	No Image	Science active/passive	Size	Named	Not Named
4.52	112		✓	✓		Passive	Large		x
	112	✓		✓		Passive	large		x
4.53	114	✓		✓		Passive	Large		x
4.54	114		✓	✓		Passive	Large		x
4.55	117	✓			x	Passive			x
4.56	166		✓		x	Passive			x

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.4.8 Textual description of strand three using visual images: Energy and Change (Natural Sciences)

a) Gender representation as science passive using visual images: Energy and Change module

Textbook page no. 112 Textbook page no. 112

Textbook page no. 115



Figure 2 The girl exerts a force that changes the shape of the ball.



Figure 4 The goalkeeper exerts force on the ball to stop it moving.



A girl illustrating gravitational force

Figure 4.52 Boys and girls exerting forces

Although all these representations (of the girls and the boy) in figure 4.52 are science passive, they are used to illustrate the scientific concept of forces. The linguistic feature that is evident in figure 4.52 is suppression.

Suppression

Mayr and Machin (2012) state that suppression occurs when terms that are expected to be in the text are absent. A boy in figure 4.52 is mentioned by sport title, goalkeeper. The girl alongside him is suppressed because she is not mentioned by sport titles and **she is portrayed as lacking sport skills**. This image weakens the self-esteem of women.

Textbook page no. 114



Textbook page no. 114



Figure 4.53 Boys pushing a car Figure 4.54 Girls in frictional and non – contact forces

Gender discrimination through power

Again boys are foregrounded in images that demonstrate that they have more power than girls because pushing a car in figure 4.53 requires greater force than combing hair and rubbing hands in figure 4.54 (Baker, 2016). In this way, figure 4.53 prepares boys' minds to aspire Mechanisms and Mechanics modules. The figure 4.54, where a girl is depicted combing hair, presents the evidence of the repetition of the stereotype, where girls are depicted in print media in activities associated with cosmetology (Murnen et al., 2016).

a) Gender representation as science passive in text passages: Energy and Change module

Textbook page no. 117

- 1.1 Bongani has a mass of 45 kg. Calculate his weight on Earth.
- 1.2 Imagine that Bongani goes to the planet Zogg where the acceleration due to gravity is 5 m/s^2 . Calculate his weight on Zogg.
- 2.1 Back on Earth, Bongani hangs his school bag onto a spring balance. The reading is 60 N. What is the mass of Bongani's school bag?
- 2.2 What would the weight of Bongani's school bag be on Zogg?

Figure 4.55 A boy portrayed as adventurous, travelling to another planet

Textbook page no. 166**Question 4**

- 4.1 When Ms Jonas travels on business from East London to Johannesburg, her weight changes from 570 N to 550 N. Explain why this is so. (3)
- 4.2 What happens to Ms Jonas' mass when she travels? (1)

Figure 4.56 A woman travels from East London to Johannesburg, confined to local settings

Gender bias

Bongani (boy's name) in figure 4.55 is portrayed as science passive. His weight decreases as a result of travelling to another planet. This is a strategy of foregrounding a boy as adventurous. The woman in figure 4.56 is science passive. She is backgrounded as a local traveller and not adventurous as the boy in figure 4.55. This is gender bias that marginalises women in science.

Interpretation of strand three: Energy and Change

Although figure 4.52 depicts both girls and boys as science passive, boys are channelled to sports by depicting them in sport clothing and sport fields, while women are cast playing in settings that are not sport fields. Portrayals of men and women in strand three display gender equality in terms of numbers. However, girls are marginalised into activities that repeat the stereotype of portraying women in activities that restrict them to local and domestic settings. Figure 4.55 portrays a male in risk taking activity, travelling to another planet. On the contrary, figure 4.56 portrays a female as a local traveller. Schiebinger (2000) regard the act of portraying women in activities associated with local settings, and men venturing out of local settings, as gender discrimination that maintains patriarchal science education. This does not motivate girls (in my view) to pursue careers associated with travelling outside the planet (Dubbelt, Rispen, & Demerouti, 2016). Instead, it can introduce inferiority to girls (D'Souza, 2015), possibly making them to believe that venturing out of the planet is for boys (in my view).

4.4.9 Overview of analysis in Planet Earth and Beyond (Natural Sciences)

In strand four, "Planet Earth and Beyond", I found only one figure that relates to gender representation (as displayed in the table 4.14 below). Figure 4.57 mentions a woman, and she is portrayed as a scientist. However, this woman is portrayed as needy of others, e.g. as a

scientist who becomes lonely if working far away from home. This sounds as if loneliness interferes with the execution of her duties.

Table 4.14 *Gender representation in Planet Earth and Beyond strand in the Natural Sciences textbook*

Figure	Page	Male	Female	Image	No Image	Science active/passive	Size	Named	Not Named
4.57	184		✓		x	Active		✓	

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.4.10 Textual description of strand four, Planet Earth and Beyond strand in Natural Sciences textbook

a) Representation of gender as science active: in Planet Earth, and Beyond strand

Textbook page no. 179

Careers

Nozi Mzamo is an exploration geologist at Baken diamond mine in Northern Cape, where she works in a team searching for places where it would be economic to mine for diamonds. She works onsite for part of the day and then captures the data on her computer back in the office.

Nozi did her BSc at Fort Hare University and her Honours year at Nelson Mandela Metropolitan University. Nozi says her job is never boring because there are new challenges every day. But she does sometimes get lonely because she is a long way from home.

Source: Adapted from 'Uncovering Earth's booty' by Sarah-Jane Bosch, Career Times, Cape Times 7-01-02

Figure 4.57 A female scientist is described as lonely

Irony

Irony is used in grammar to praise and criticise at the same time in order to disempower or

weaken the person mentioned. The intention is negative rather positive. Stanel (2006) mentions that when irony is used in statements, the underlying meaning is the opposite of the surface meaning.

In figure 4.57 a female scientist Nozi Mzamo is mentioned to encourage learners to pursue geology. She is a black person. However, describing her as getting lonely because she works away from home is evidence of verbal irony. She is portrayed as unfit for her job because of the stigma of loneliness at work. Irony has been used to **cast female scientist as socially dependant, in need of companionship at work**. The intention of the passage is probably to discriminate women who have attained science degrees, and to discourage girl learners who use this textbook as a learning resource from pursuing science degrees. It is also ironical that the text passage in figure 4.51 mentions Vincent, a male as an attentive chemistry student, while the female scientist is described as getting lonely at work. Hence, I conclude that this was possibly done intentionally, to empower boys using the passage depicted in figure 4.51, and later disempower girls using the figure 4.57 above.

Interpretation of strand four: Planet Earth and Beyond

This strand promotes marginalisation of women. Mentioning that the geologist (in figure 4.57) gets lonely at work because she is working away from home is a concealed strategy of introducing hegemonic masculinity to learners. Van Dijk (2016) and Fairclough (2013) argue that one of the ways in which ideologies in texts legitimate inequality is through using deceitful strategies (for example verbal irony in figure 4.57), to empower one social group, while cunningly oppressing the other. It looks like it is an assumption that Nozi gets lonely because in the preceding sentence (in figure 4.57) the author states, “Nozi says her job is never boring because there are new challenges every day.” There is a difference between missing home and getting lonely. This is similar to the findings of Bix (2000) of her study at Massachusetts Institute of Technology titled “*Feminism where men predominate*”. Bix (2000) discovered that male employers in US denied jobs to women who were suitably qualified in STEM fields. These male employers assumed that women could not cope mixing house chores and employment, implying that women are only fit to do house chores.

4.4.11 Concluding discussion: Oxford Successful Natural Sciences CAPS textbook for grade 9

In the Natural Sciences textbook, South African scientists are included. One of the female

scientists depicted in figure 4.49 does not have a surname. This incomplete identity is another way of inferiorising women in science, and could influence female learners negatively. None of the male scientists mentioned or portrayed in the textbook lacked a surname. Nozi Mzamo, in figure 4.57 who is described as a female geologist, is also described as getting lonely in her job as a geologist as she is working far away from home. The textbook is not explicit as to how far from home are the jobs of male scientists who were depicted. It also does not allude to male scientists' enjoyment of the job or to their feelings of loneliness. So highlighting loneliness of a female scientist is a gender bias. It has nothing to do with how Nozi carries out her duties at work. Nozi is therefore portrayed as emotionally dependent. This could be the reason why Mburu and Nyagah (2012, p.103) concludes that "...female characters are missing in leadership roles..." The table below provides the names of the scientists that were used in 'Oxford Successful Natural Sciences textbook for grade nine.

Table 4.15 *Scientists portrayed in Natural Sciences textbook*

Name of the scientist	Country	Gender
Robert Hooke	England	Male
Anton van Leeuwenhoek	Netherlands	Male
Buhle Grootboom (mining engineer)	South Africa	Male
Nozi Mzamo (geologist)	South Africa	Female
Josie (pharmacist)	South Africa	Female

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

Figure 4.48 portrayed a female chemical engineer with a very large picture (although it is black and white in colour, not showing even the colour of chemicals she is handling). This figure cannot be included in the table above as the scientist depicted was not named at all. The person also does not look at the viewer, signalling that learners as the viewers are not encouraged to

emulate her. On the contrary, the male scientist in figure 4.47 Buhle Grootboom, looks at the viewer and his image is colourful as the tie he is wearing is showing different colours. Girls might feel they are not invited to emulate Grootboom because they do not identify with him. The manner in which female scientists are portrayed in this textbook seems like what D'Souza (2006) refers to as social phobia in girls. It can negatively impact on girls' personality and their academic achievement in science subjects. The manner in which gender is represented in this textbook can result in girls' attitude of self-disapproval. Girls can resort to believing that they are neither capable nor worthy of pursuing careers in science (D'Souza, 2015; Dubbelt et al., 2016).

The last textbook that I analysed was the Oxford Successful Natural Sciences and Technology textbook for grade six. The details for the analysis are discussed in the section below.

4.5 Analysis of Oxford Successful Natural Sciences and Technology textbook for grade 6

The analysis of the Oxford Successful Natural Sciences and Technology textbook also included analysis of textbook cover and the analysis of content knowledge inside the textbook. The analysis of content knowledge is also organised according to knowledge strands of the textbook. In each analysis of the strand, I provide the overview of the analysis, followed by textual description of the content knowledge and visual images, and lastly the interpretation of the findings. There are four strands in the Oxford Successful Natural Sciences and Technology textbook, namely, Life and Living/Processing (strand one), Matter and Materials (strand two), Energy and Change/Systems and Control (strand three), and Planet Earth and Beyond (strand four). However, in the sections below I have provided the analysis of only three strands because there were no human representations to analyse in strand three. The constructs that I used to analyse this textbook were gender bias, focus, foregrounding, salience, gaze, backgrounding, gender inclusivity, potent cultural symbol, low modality, angle (of the camera), and suppression.

4.5.1 Analysis of the textbook cover for Natural Sciences and Technology Learner's book for grade six

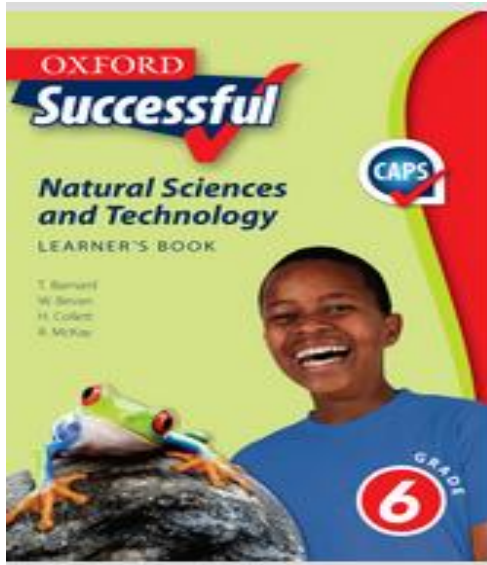


Figure 4.58 Cover for Natural Sciences and Technology grade 6

Analysis of gender in the textbook cover

The cover of the textbook portrays the image of the boy, and has excluded girls. This could enhance boys' interest in the textbook because they will identify with the person on the cover. Girls might feel the textbook is not about them. The cover of the textbook therefore might promote masculinity in science lessons.

4.5.2 Overview of the analysis of strand one: Life and living/ Processing (Natural Sciences and Technology textbook for grade six)

The table 4.16 provides the summary of the figures that I analysed in this strand, Life and Living /Processing in the Natural Sciences textbook for grade six. There are two female representations and two male representations.

Table 4.16 *Gender representation in the Life and Living strand in the Natural Sciences and Technology textbook*

Figure	Page	Male	Female	Image	No Image	Scientific activity	Size	Named	Not Named
4.59	39	✓		✓		Active	Large		x
4.60	26	✓	✓	✓		Passive	Small		x
4.61	14		✓	✓		Passive	Large		x
4.62	25		✓	✓		Passive	Small		x

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.5.3 Textual description of Life and living /Processing strand (Natural Sciences and Technology textbook)

a) Gender representation as science active using visual images: Life and living/Processing strand

Textbook page no. 39



Figure 7 If you take the time and trouble, you can learn a lot from an ecosystem.

Figure 4.59 Boys and girls investigating the ecosystem

Gender fairness

Boys and girls are equally represented in figure 4.59. This image can motivate both boys and girls to learn science. I also identified one linguistic feature in this figure namely, salience. The image (figure 4.59) is very small. However, the boys and girls are clearly identifiable. They are investigating the ecosystem. Hence they are portrayed as science active. This figure can be used to promote gender fairness during science lessons where this textbook is used as the main LTSM.

Gender representation as science passive using visual images: Life and living/Processing strand

Textbook page no. 26



Figure 4.60 An obese man measures his waist

Focus

In figure 4.60 an image of a male person is depicted science passive measuring his waist. A linguistic feature focus has been used. Attention is drawn to the man (with a large image) in the condition of obesity which attracts diseases.

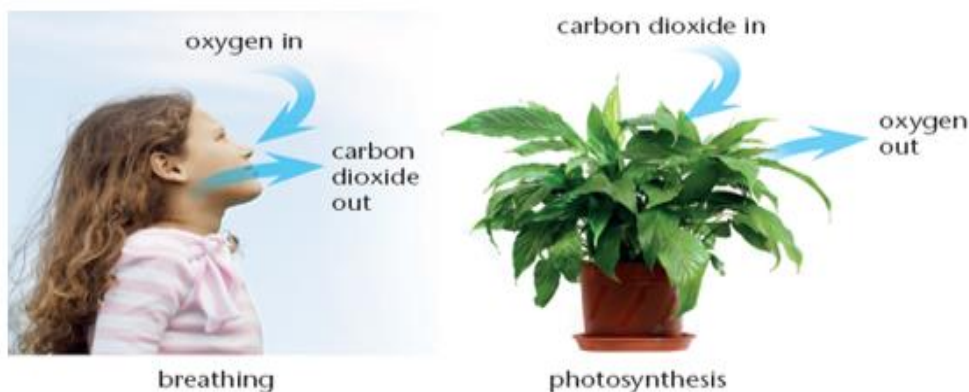
Textbook page no. 14

Figure 4.61 A girl illustrates breathing

Foregrounding

The figure 4.61 depicts a girl as science passive. She is used as an illustration of how the oxygen gas that is released during photosynthesis is used for breathing. This module foregrounds girls by using them repeatedly in science passive roles.

Textbook page no. 25

Case study Natasha's diet

Say hello to Natasha. She is someone like you. Figure 6 shows what Natasha ate yesterday. It is similar to what she eats every day. Do you think she is eating a balanced diet?



Figure 5 Natasha

Figure 4.62 A girl depicted science passive, as a consumer of food

Salience

In figure 4.62 a girl is portrayed in eating role. Salience is notable in this image because she is portrayed in a small image. Women are portrayed in activities associated with food and apron jobs (Bix, 2000). She is neither the producer of the food nor the analyst of the chemistry of food. Hence, she is depicted science passive.

Interpretation of strand one: Life and Living

The “Life and Living / Processing strand” make women more visible. The representations of this strand can motivate girls to aspire science careers. In some instances (such as in figure 4.59) girls are portrayed working jointly with boys conducting scientific investigations. Therefore, the textbook shows gender inclusivity in the representations of humans as science active. I therefore concur with Srivastava (2014), that it is not enough to show only equal numbers of men and women representations in textbooks. One needs to scrutinise which gender is portrayed in science active roles, in order to address gender inequalities and discrimination. In science active representations, neither males nor females are discriminated. The image in figure 4.61 indicates that girls are included as examples in knowledge construction of this textbook. However, it does not portray the participant investigating the processes of photosynthesis or breathing. The manner in which it is presented is not controversial, but does not channel girls into science careers. Natasha in figure 4.62 is not depicted as the designer of the menu or capable of improving her diet. This could imply the possibility of channelling her to become a food scientist, dietician or nutritionist. Instead she is merely depicted as a consumer of food. Bix (2000) mention that women are portrayed in print media in food and apron jobs, and this is possibly the reason for under- representation of women in STEM fields (Clark Blickenstaff*, 2005).

4.5.4 Overview of analysis of strand two: Matter and Materials in the Natural Sciences / Technology textbook

In the strand “Matter and Materials”, I analysed eight figures from the Natural Sciences textbook as illustrated in the table 4.17. Five of the figures depict women and girls as science active in large colourful images. In addition, the handicapped girl is portrayed in science active role. The “Matter and Materials” strand therefore promotes the interests of girls and women.

Table 4.17 Gender representation in the Matter and Materials strand of Natural Sciences and Technology textbook

Figure	Page	Male	Female	Image	No image	Science active/passive	Size	Named	Not Named
4.63	48		✓	✓		Active	Large		x
4.64	50	✓	✓	✓		Active	Large		x
4.65	55		✓	✓		Active	Large		x
4.66	67	✓				Active	Large		x
4.67	75		✓		x	Active	Large	✓	
4.68	61	✓		✓		Passive	Small		x

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.5.5 Textual description of strand two: Matter and Materials (Natural Sciences and Technology)

a) Gender representation as science active using visual images: Matter and materials

Textbook page no. 48



Hold a piece of paper in your hand.
Hold it level with your eyes.
Notice that the paper is very thin.
Paper is made of millions and millions of particles!
A piece of paper is 10 000 particles thick.

Figure 4.63 A girl demonstrating that paper has 10 000 particles

Gaze

The image 4.63 depicts a girl as a science active. She is looking at the viewer. The figure 4.63 invites learners to emulate the girl that is depicted. Again girls may be the ones who are interested in the activity demonstrated because they would associate with the person portrayed. She is following the instructions of the investigation (see instructions of the investigation on the right hand side of the figure 4.63).

Textbook page no. 50



Figure 4.64 Boys and girls representing the state of matter

Backgrounding

Although salience is notable in the figure 4.64, in the first picture a girl is foregrounded through medium size of the image. Boys are backgrounded because they are not easily identifiable in this picture. The figure 4.64 shows both girls and boys as science passive illustrating the scientific investigation in the topic types of matter. However girls, are dominant in terms of numbers depicted in the middle picture. This image renders boys invisible in text, which ultimately empowers women as important participants in this image. This is possibly the reason why girls perform better than boys (academically) during junior years of schooling (Mburu & Nyagah, 2012).

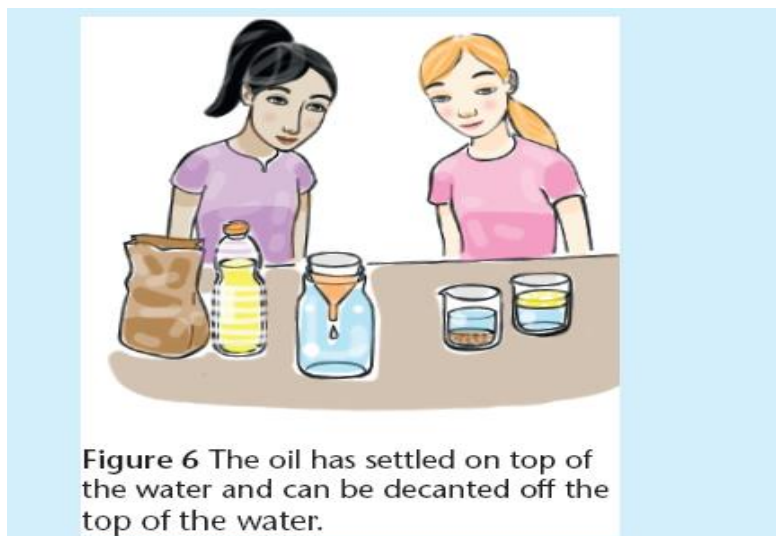
Textbook page no. 55

Figure 4.65 Girls observing mixtures separating

Gender bias

The two girls are portrayed as science active in figure 4.65, observing the results of an investigation. Boys are not represented in this activity, therefore they are backgrounded, rendered as unimportant participants in the activity. Exclusion of boys in this image is a form of gender bias (Sadker & Sadker, 2010) elevating the interests of one gender (female) while negating the interests of the the other (male gender). D'Souza (2015) argues that this could be the reason of students' passivity during science lessons, which may consequently result in them dropping the subject or dropping out from school.

Textbook page no. 67

Figure 4.66 Boys and girls investigating the rate of dissolving

Gender inclusivity

The handicapped girl in figure 4.66 is depicted as science active with other learners, investigating the rate of dissolving. This is another evidence of the authors' effort to make the textbook gender inclusive. This image positively addresses the issue of marginalisation of women. Inclusion of the girl that is physically challenged confirms that the module considers the welfare of the girls who use this textbook for science learning.

Textbook page no. 75

Case study

Edith Stephens Wetland Park – Cape Flats

In the middle of an area of Cape Town called Philippi there is a seasonal wetland. It is called the Edith Stephens Wetland Park. Ms Stephens was a botanist.

She cared about the wetlands on the Cape Flats. She bought a piece of land so that it could be preserved as a wetland. She was not a wealthy woman, but she cared a lot about the environment. The wetland is the home of a plant that has existed for 200 million years. The plant is a small fern called Isoetes (pronounced I-so-eat-tease). Today many people in Philippi benefit from the wetland and use it as place to relax and watch birds. We need to think about the future and act more like Edith Stephens.



Figure 2 Wetlands are also places where people can enjoy nature and be together as families.

Figure 4.67 South African female scientist Stephens

Potent cultural symbol

The woman is foregrounded as the South African scientist who specialised in botany in figure 4.67. Her name is Edith Stephens. The passage stresses that she was not wealthy but she cared for wetlands. **Wetlands are potent cultural symbol. The association of the female scientist with**

a science cultural symbol elevates role of women in science.

b) Gender representation as science passive: Matter and Materials/Processing

Textbook page no. 61



A man collects salt made from sea water.

Figure 4.68 A man represented with low modality

Low modality

Semioticians (such as Van Leeuwen (2005)) state that the small size of the participant in a photograph is a result of low modality. Low modality occurs when the photographer is further away from the person being photographed. He further elaborates that when participants in discourse are represented in a manner that shows low modality in photographs, it is a subtle form of expression that they are not important. He mentions that participants represented with low modality may be unreal to viewers, and so they will be less memorable.

The man is depicted in figure 4.68 collecting salt. He is depicted with a small image and as science passive. His size is small and positioned at the back, possibly because the photographer was not near him when the picture was taken. This portrayal renders men invisible in this module and it backgrounds male gender in this module. This image disempowers male gender as important participants during science lessons (using this textbook). It can not be used to encourage boys to pursue science.

Interpretation of strand two Matter and Materials

The representations of this strand favour girls in numbers. Although figure 4.64 depict a female as science passive in the “Matter and Materials strand”, all other figures with female representaions depict women as science active. Edith Stephens in figure 4.67 is foregrounded as a resourceful scientist. **She is portrayed using her finances to take care of wetlands although she was not wealthy.** This representation can possibly motivate girls to continue with science subjects in the higher grades of schooling.

Males are not completely sidelined by the manner in which they are portrayed in this module. They are mostly portrayed alongside females conducting scientific activities or observing results, e.g in figure 4.65 and figure 4.66. Depicting a man in a caring role, preparing a meal for a family in figure 4.67, is a positive step towards achieving gender equality (Schiebinger, 2000). There is only one image (figure 4.68) where a male is portrayed science passive in a very small photograph. Hence gender representation in the strand Matter and Materials is fair. Miller, Eagly, and Linn (2015, p. 103) state that “...exposure to successful women scientists and mathematicians can weaken gender-STEM stereotypes among young girls...”

4.5.6 Oveview of the analysis of strand four, Planet Earth and Beyond/ Systems and Control

In the strand Planet Earth and Beyond/Systems and Control in the Natural Sciences and Technology textbook, I have provided the analysis of three figures as summarised in the table 4.18 below. In these three representations, women are excluded. Again a South African male scientist is included but his representation lacks a colourful image to attract the reader’s attention.

Table 4.18 *Gender representation in Planet Earth and Beyond/Systems and Control in Natural Sciences and Technology textbook*

Figure	Page	Male	Female	Image	No	Scientific	Size	Named	Not
4.69	130	✓		✓		Active	Medium	✓	
4.70	132	✓		✓		Active	Large	✓	
4.71	133	✓			x	Active		✓	

Keys:

✓ = a characteristic that is present,

x = a characteristic that is absent

4.5.7 Textual description of strand four: Planet Earth and Beyond/Systems and Control

a) Gender representation as science active using visual images: Planet Earth and Beyond /Systems and Control

Textbook page no. 130

In 1609 Galileo Galilei first looked through his small homemade telescope at the stars.



Figure 4.69 Galileo Galilei

Textbook page no. 132

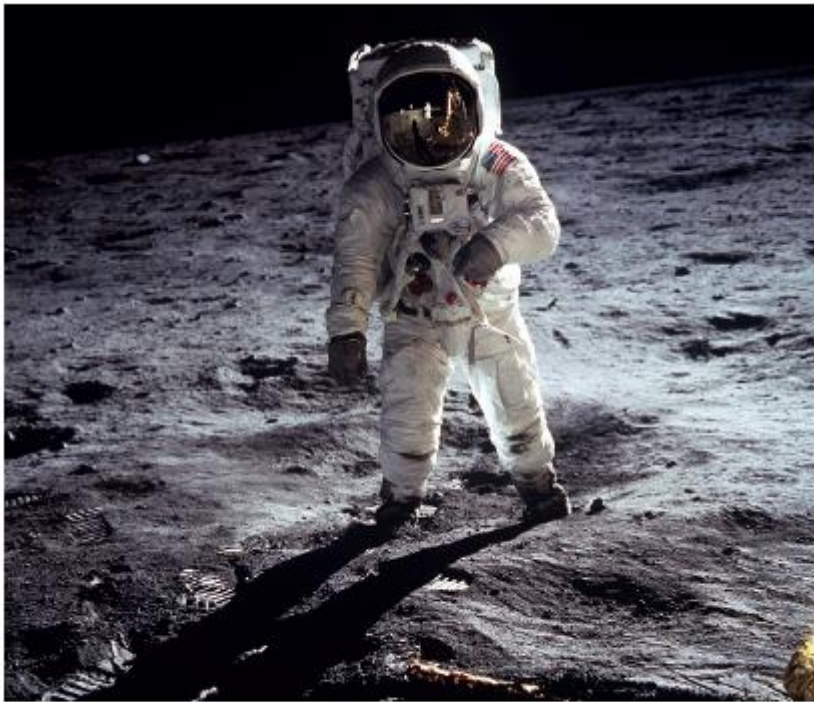


Figure 1 Buzz Aldrin was part of the first crew to land on the Moon.

Figure 4.70 Male Scientist Buzz Aldrin

Power and angle

Kress and van Leeuwen (2006) state that photographs taken from low angle make the represented participant to look large and closer to the viewers. They continue to mention that photographs taken from high angle may result in decreased size of the represented participant and may be further away from the viewers. They mention that represented participants seen from high angle are rendered powerless, making the viewers as the interactive participants to exercise symbolic power to the represented participant (in the image). They conclude by stating that represented participants depicted from low angle exercise symbolic power over viewers as the interactive participants.

The figure 4.69 depicts an Italian male scientist Galileo Galilei. He is depicted from a high angle, resulting in his image being small in size. Therefore figure 4.69 connotes that learners who use this textbook have the power over the image of the person depicted. In other words by virtue of being small, this picture does not have the power to weaken or empower learners in their decision of whether or not they emulate the scientist depicted. Its small size make it easily

ignorable by learners as interactive participants.

In the figure 4.70 an American male astronaut Buzz Aldrin is depicted. Buzz Aldrin is depicted from the low angle making his image large and closer to the viewer. The low angle makes Buzz Aldrin look powerful. Repoussi and Tutiaux-Guillon (2010) mention that textbooks are used as tools of power to disseminate ideologies. The figure 4.70 can possibly empower boys to pursue astronomy. The image also has the power to demotivate girls from pursuing astronomy, they might not associate themselves with the gender of the person depicted.

b) Gender representation as science active using text passage: Planet Earth and Beyond /Systems and Control

Textbook page no. 133

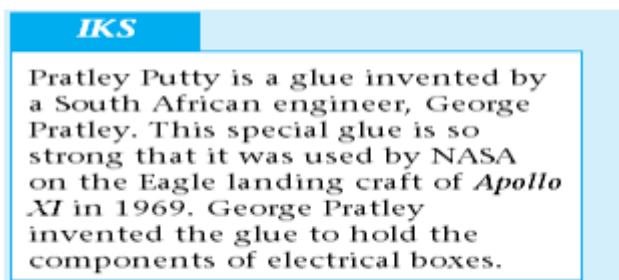


Figure 4.71 Male scientist George Pratley

Suppression

Occurs when terms or features that are expected to be in the text are absent (Machin and Mayr, 2012).

George Pratley in figure 4.71 is a South African male engineer. He invented the glue Pratley Putty, therefore he is portrayed as science active. Pratley Putty was used as early as 1969. He is suppressed, rendered invisible in the text because his portrayal lacks an image.

Interpretation of strand four: Planet Earth and Beyond/Systems and Control

In the strand "Planet Earth and Beyond/Systems and Control", women and girls are not represented. This is evidence of perpetuating a sex role stereotype of depicting males in highly

prestigious professions such as an astronaut (Bian et al., 2017). The visual images of male scientists in strand four “Planet Earth and Beyond” empower boys only to pursue astronomy. Although George Pratley is suppressed because he was not represented by an image in figure 4.71, but by virtue of being a male he was possibly portrayed lacking image to conceal the repeated stereotype of portraying only males as scientists in this module. The manner in which gender is represented in strand four is unfair, discriminating against women and promoting masculinist science education.

4.5.8 Concluding discussion: Oxford Successful Natural Sciences and Technology textbook for grade six

In the Natural Sciences and Technology textbook, only four scientists are portrayed. Three of these scientists are male, one is a female. This textbook also sidelines female scientists, portraying males as the only scientists. The table 4.19 below provides the summary of scientists used in the knowledge production of the textbook.

Table 4.19 *Scientists portrayed in Natural Sciences and Technology textbook*

Name of the scientist	Country	Gender
Galileo Galilei	Italy	Male
Buzz Aldrin	American	Male
George Pratley	South African	Male
Edith Stephens	South African	Female

4.6 Discussion of the findings of the four textbooks that were analysed

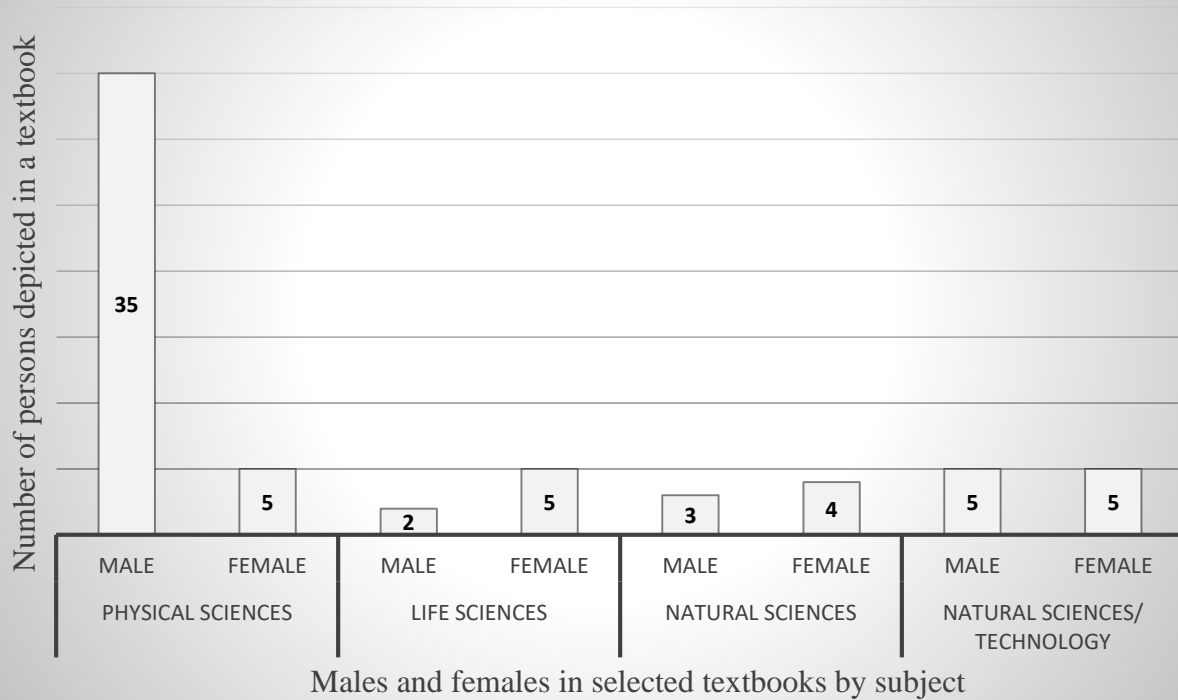
The subsequent paragraphs provide the discussion of the findings of the four textbooks that I analysed. I present the findings that emerged from the CDA constructs (presented in the analytical framework in chapter 3) and constructs that emerged from the literature I reviewed. I also demonstrate how the FPDA as the main theoretical framework for this study informed the interpretation of the findings in each textbook.

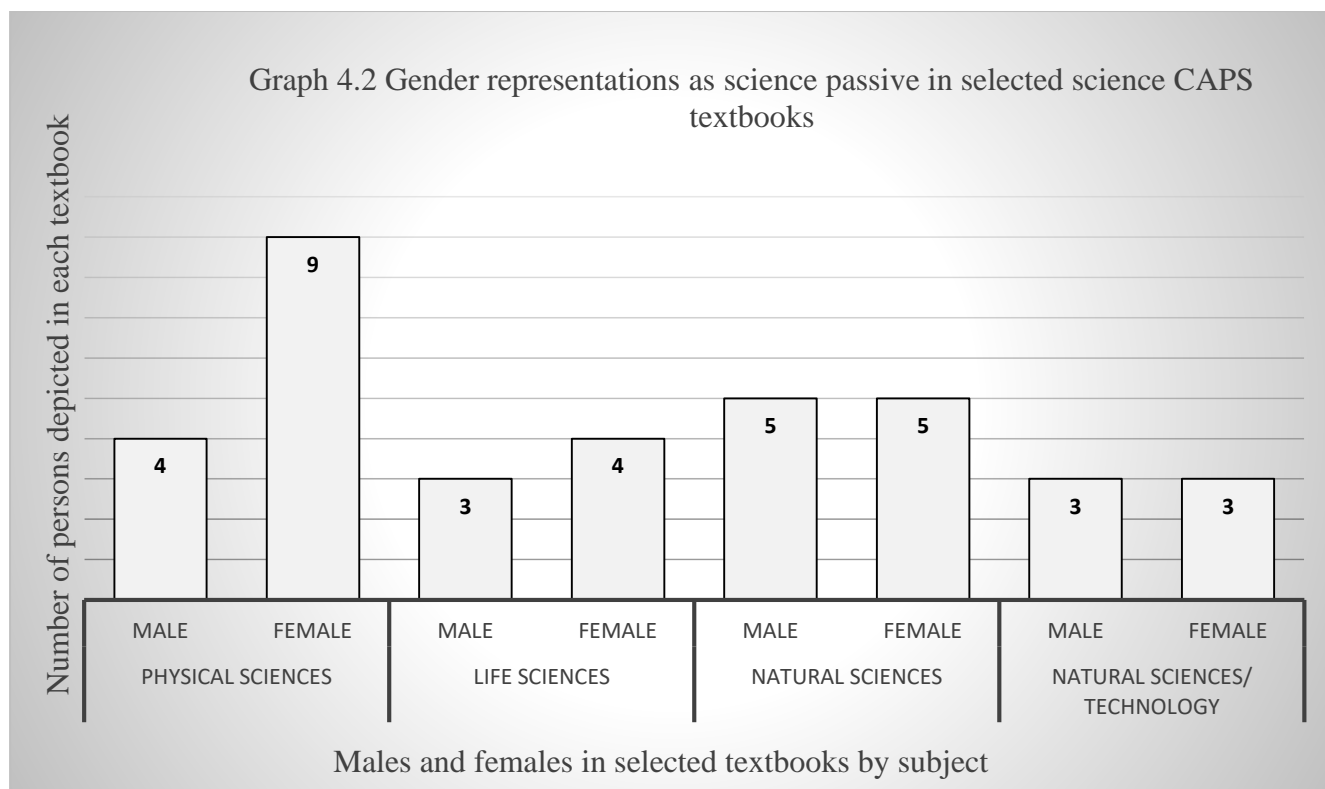
Each textbook analysis consisted of the analysis of the textbook cover and analysis of the content knowledge inside the textbook. During the analysis of the content knowledge of each textbook, I organised the analysis of each textbook according to its modules or strands. The summary of each strand or module analysis was presented in the table, and this was followed by the detailed textual analysis or textual description of the module or strand. The textual description began by providing either the text passage or visual image scanned from the textbook. The CDA constructs and concepts that emerged from the literature I reviewed informed the description of what appeared in the scanned text passages or visual images. Lastly, the interpretation of all the scanned text passages and visual images was provided, and was informed by Feminist Post-Structural Discourse Analysis (FPDA), which is the theoretical framework for this study. In the subsections below I organised and presented the discussion of the findings into themes.

Masculinity versus femininity

In the Physical Sciences textbook, more males than females were portrayed as science active. Females were largely depicted in activities that are science passive. Mburu and Nyagah (2012) state that the criteria that is generally used to judge whether the textbook is masculinist, feminine or gender neutral include the numbers of males and females that are depicted. The graph 4.1 depicts that thirty five males were portrayed as science active in Physical Sciences textbook, and only five females were portrayed as science active. The graph 4.2 depicts that nine females were depicted as science passive in Physical Sciences textbook, and only four males as science passive. Therefore, the Physical Sciences textbook promotes masculinity in science because more men than females are depicted as science active. Although there are more females portrayed as science passive, these roles do not channel girls to pursue STEM courses at the tertiary level (Clark Blickenstaff*, 2005; Mudaly & Van Wyk, 2015). The male domination in Physical Science textbook is possibly the reason for their domination in STEM careers.

Graph 4.1 Gender representations as science active in selected science CAPS textbooks





The Life Sciences textbook had features which appeal to females. However, women were largely portrayed taking care of men, while none of men were depicted taking care of women or children. Mburu and Nyagah (2012) confirm that there is over representation of women performing domestic functions such as cooking, caring for children and housekeeping in textbooks. In fourteen human representations in Life Sciences textbook, women dominated in science active roles. The graph 4.1 depicts that there are five females that are represented as science active, and only three males represented as science active. The graph 4.2 depicts that there are three males that are depicted as science passive, and four females that are represented as science passive. Therefore, the Life Sciences textbook encourages women to pursue Life Sciences as a subject. It promotes femininity, and is possibly the reason why Biology courses are female dominated (Eddy et al., 2014).

The analysis of the Natural Sciences textbooks and Natural Sciences and Technology textbooks, presented the results that exhibited similar representations in numbers of males and females depicted. The graphs 4.1 and 4.2 show equal representations of males and females in both sciences active and science passive roles.

Gender representation according to educational and socioeconomic statuses

In the Physical Sciences textbook, the professional statuses of scientists portrayed were

emphasized. The scientists in this textbook are addressed according titles of the jobs they do or according to their discoveries/inventions. The name of the scientist is preceded by mentioning the scientist's country and the profession, for example, an *American* engineer Charles Goodyear or the *Austrian* physicist Andreas Doppler. This act legitimates the power of male scientists over female scientists. While it is important that their professional statuses as well as their discoveries be acknowledged, failure to mention female scientists with such titles and acknowledgements is evidence of masculinic hegemonic practice that broadcasts the message that only males have produced scientific knowledge. Women who were depicted in the Physical Sciences textbook were only used as examples in practice activities (that learners must use for homework or as exam practices) or as illustrations when explaining scientific concepts.

In the Life Sciences textbook, there are no male scientists that were mentioned. However, men are the ones that were portrayed through visual images in a controversial manner. For example, in figure 4.31, only males were depicted as infected with the late blight of potato. Therefore, this textbook disempowers males, and by so doing it segregates boys (who use this textbook during science lessons) in Life Sciences as a school subject. It is also ironical that when a woman is mentioned in the professional status that can empower/motivate other women readers, such as depicting a woman as a scientist (in figure 4.35) in Life Sciences textbook, there is neither an image nor job description to elevate her. To make matters worse this woman scientist is not even named. On the contrary, when she is portrayed in her weakest point such as having a psychological disorder, she is portrayed in a large colourful image such as in figure 4.36. Most images in Life Sciences textbook denote women in low socioeconomic status such as poor, taking care of children alone, and in nursing roles taking care of men. This perpetuates the notion that women are most suited to caring, nurturing roles, as opposed to creative roles in the production of scientific knowledge (O'Connor, 2015).

In the Natural Sciences textbook for grade nine, males are foregrounded as scientists, who are able to discover new scientific knowledge. Mostly men are portrayed in positions of leadership in their places of work, such as engineers and described as attentive students of chemistry. Most women who are portrayed in leadership roles in science are not named. This marginalises women from the world of science and channels them to careers that are not science related (Bix, 2000). In addition, only boys are portrayed playing sports in sports field, wearing sports clothing in the section explaining scientific concepts related to forces. A woman who is

portrayed bumping the ball is not in the sports field **and is not given the specialist sports skill.**

In the Natural Sciences and Technology textbook, a South African woman scientist is described as caring for wetlands or environments and bought land but it is highlighted that she was not wealthy. The other scientists were male.

Findings that emerged from using CDA constructs and constructs from the literature reviewed

The CDA constructs that were employed during data generation and analysis included overlexicalisation, foregrounding, backgrounding, salience, use of potent cultural symbols, honorifics, iconography, use of pronouns, focus, settings, gaze, low angle, high angle, low modality, language abstraction, rhetoric, determinism and irony. All these CDA constructs are defined fully in sub section 3.7 of the methodology chapter. However, a brief explanation is provided each time they are used for the first time in the paragraphs below to remind the reader what they mean. I also employed the constructs from the literature I reviewed during analysis to describe how gender was represented in each textbook. The constructs that emerged from the reviewed literature that informed the analysis were stereotypes, gender inclusivity, gender bias, hegemonic masculinity, and symbolic power.

The pronouns and the nouns were identified in text passages and they were used to determine the gender of the person used to illustrate the activity. For example, the proper noun such as Zanele in figure 4.6 indicated that the person who was used in an illustration was the girl because Zanele is a girl's name. The possessive pronoun such as 'his' in figure 4.5, enabled me to determine that the gender of the person depicted as an astronaut was for a male. The images that depicted males were mostly coupled with pronouns he or his, and it was therefore easy to detect that the person depicted was a male. For example, in figure 4.4, an astronaut is not clearly visible whether it is a male or a female. The use of the possessive pronoun 'his', indicates that the person depicted as an astronaut is a male. Most of the images that depicted women were very small (salience) and lacked the pronouns 'she' or 'her' to conclude that the person depicted was a female. However, iconography, a linguistic feature which answers the question "what does the image denote or connote?" (Machin & Mayr, 2012, p.121), enabled me to identify female features such breasts in figure 4.7. This enabled me to conclude that the gender of the person depicted was for a female (Machin & Mayr, 2012).

In the introductory part of the Physical Sciences textbook overlexicalisation was evident. The

figure 4.2 displayed a total of twenty-one male scientists, and there were no female scientists. I argue that this act of repetition of the portrayal of men as the only scientists in the very first pages of the textbook, can discourage girls who use this textbook during science lessons, and ultimately contribute to their withdrawal or dropping out from science subjects (Miller, Eagly & Linn, 2015). Mburu and Nyagah (2012) state that depriving girl readers of adult role models (in textbooks) to identify with and emulate, contribute to the negative effects on their self – image, aspirations and motivation.

The text passages that were analysed also revealed the evidence of backgrounding, where a person depicted was either described in a controversial manner to weaken or not named. For example, in figure 4.14, a woman is presented as a reckless driver of the vehicle by exceeding the speed limit. This is evidence of backgrounding. On the contrary, a man is foregrounded by mentioning him as a careful and alert driver who applies his breaks when he notices obstruction in front of him (Machin & Mayr, 2012).

The Life Sciences textbook portrayed women using potent cultural symbols (in figure 4.31 and figure 4.40) such as a microscope in scientific investigations. In the Natural Sciences textbook there was evidence of suppression. For example, in figure 4.52 girls are suppressed because they were depicted alongside boys playing sports. Boys were addressed using sport titles such goalkeeper. However, girls were not addressed with sport titles (Machin & Mayr, 2012).

The use of honorifics (addressing a person in a manner that indicates a degree of respect) was also identified in Physical Sciences textbook. For example, in figure 4.3, a male scientist is addressed as Sir Francis Bacon. In all the four textbooks, honorifics was never used to address women scientists.

Positive gaze, which indicates that viewers are invited to emulate the person depicted, was identified in figure 4.22 from the Physical Sciences textbook which depicted a male scientist Sorensen. It was also identified in figure 4.47 from the Natural Sciences textbook which depicted a mining engineer who was a male. All the visual images that represented females either as science active (e.g. in figure 4.24 from Physical Sciences textbook) or as scientists (e.g. in figure 4.48 and figure 4.49 from the Natural Sciences textbook) lacked positive gaze. Instead these women were depicted looking at chemicals they were holding. I argue that this act implies that girls lack science role models. The images of female scientists depicted do not encourage girls to emulate them (Machin & Mayr, 2012).

In Natural Sciences and Technology textbook Galileo Galilei in figure 4.69 was portrayed from high angle and so his image was small in size. I interpreted this image as empowering learners to ignore the person represented. So possibly it cannot be regarded as the strategy for sidelining girls. However, Buzz Aldrin in figure 4.70 is portrayed from low angle and therefore his image is large and closer to the viewers. I mentioned that this empowered Buzz Aldrin as the represented participant to influence the viewers to emulate him, possibly boys as they would associate with the gender of the person depicted. A female (for example in figure 4.24) was portrayed from low angle as a student applying the scientific knowledge discovered by others. On the contrary, the males were also portrayed from low angle as scientists who are the inventors and producers of science knowledge, for example in figures 4.22 and figures 4.23. I argued that this act weakens the image of women and render them powerless in their world of science because there no female scientists that were portrayed in the same manner.

I also noted symbolic power, where both males and females were portrayed science active in a module. However, females would either be portrayed as lacking innate ability to be proactive to advance the investigation or mentioned after the males have been mentioned. I argue that these acts legitimate the power of males over females, and are subtle strategies of maintaining the patriarchal values in science education. Rhetoric empowered me to identify the insincerity of the Physical Sciences textbook that selected words to exclusively describe males as brilliant physicists, famous inventors, successful businessmen, etc. in figure 4.29 to endorse that science is for males. No females were described with similar attributes in the whole textbook. Language abstraction made me notice that discourse was cunningly used to portray women as highly appropriate candidates for parenting and nurturing roles, and not science. Irony revealed the deceitful strategy of the Natural Sciences textbook that begins by foregrounding a female as a geologist and in the same passage highlights that she is lonely as she works far away from home. Furthermore, Vincent was described as attentive chemistry student who applies scientific knowledge to solve problems beyond classroom context.

The implication of these findings is that Physical Sciences textbooks continue to be masculinist (Baker, 2016) and to disseminate the patriarchal ideology (De Wet, 2011). Furthermore, science textbooks continue to broadcast stereotypes of males as producers of science knowledge. Unless these stereotypes are confronted and addressed, the Life Sciences (formerly known as Biology in South Africa) courses will continue to be female dominated, and Physical Sciences male dominated. If the stereotypes in Physical Sciences textbook are not challenged

and removed, STEM courses might continue to be male dominated. The Natural Sciences, and Natural Sciences and Technology textbooks depicted few female scientists. However, they did not provide enough motivation for girls to pursue STEM careers because they were depicted in a controversial manner. These textbooks are only used in the elementary stages of learning. Hence, it is possible that learners would have forgotten their positive representations by the time they have to choose between Physical Sciences and Biology courses at the tertiary level (Mburu & Nyagah, 2012) .

4.8 Conclusion

In this chapter, I analysed the findings that developed from the data analysis of selected science textbooks. The two main themes that were used to organise analysis in each module or strand of the textbook were:

- Gender representations as science active
- Gender representations as science passive

Analysis of the content knowledge in the Physical Sciences textbook revealed gender biases in favour of men. In science passive activities women representations dominated. Gender representations in Physical Sciences textbook, included visual images that confirmed discrimination against women. In certain instances, women were depicted in very small black images and they were marginalised into activities that imply that they are either capable of handling lightweight objects or depicted alone in nurturing roles. In the Life Sciences textbook, women representations dominate both in science active and science passive roles. In addition, more men than women are depicted as sick. The Natural Sciences textbook shows gender equality (in terms of numbers) both in science active and science passive roles. However, there is evidence of sidelining and sabotaging of women because the women scientists depicted are either not named or lack surnames. In addition, one-woman scientist is described as lonely as a result of working way from home. The Natural Sciences and Technology textbook also disseminates stereotypes of males as scientists because there were only males who were depicted as scientists. In the next chapter I present the summary of the findings of the study, limitations and suggestions for further studies.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, LIMITATIONS AND RECOMMENDATIONS

5.1 Introduction

In the previous chapter, I provided the results of data generation and analysis for this study. I analysed four science textbooks that formed the sample for this study. The names of the textbooks were analysed were Study and Master Physical Sciences for grade twelve, Study and Master Life Sciences for grade eleven, Oxford Successful Natural Sciences for grade nine, and Natural Sciences and Technology textbook for grade six. I employed constructs that I explained in chapter three as the framework that guide the analysis, as well as constructs that emerged from the literature I reviewed to scrutinise textual knowledge and visual images. In this chapter I present the summary of the findings, limitations of this study, recommendations and conclusion.

5.1.1 Summary of the findings

In response to the research question for the study, “how is gender represented in selected science textbooks?”, I employed CDA constructs as well constructs that I derived from the literature I reviewed to generate data to answer the question. Both the textbook covers and knowledge content inside the textbooks were carefully scrutinized in order to provide a thorough analysis. Analysis of language and visuals revealed the evidence of marginalisation, gender biases, sex role stereotypes of scientists as males, and gender discrimination against women in concealed ways.

The Physical Sciences textbook portrayed only male scientists as producers of scientific knowledge. Females were only represented as examples in assessment activities. Females were portrayed in a contradictory manner that weakens the self - esteem of women. This can possibly discourage girls and women from pursuing science careers. For example, women were portrayed in non -scientific activities, pushing babies in trolleys, as hairdressers in salons, etc. Although men were also portrayed in non-scientific activities, it was not in a demeaning manner. Wherever women were portrayed in scientific activities, they were implicated as unfit for science. For example, they were portrayed as possessing little physical power. In addition, they were handling light weight objects in activities that are associated with force and power. On the contrary, men were portrayed handling exceedingly heavy objects.

Although the Life Sciences textbook did not clearly portray male scientists, I managed to uncover that all scientists that were used to name biological structures were males. Only one woman scientist was used in practice activities. However, it was in a demeaning manner because she was not named and her country of origin was not mentioned. Men were portrayed as victims of sickness. Women were portrayed taking care of sick men, possibly implying that women learn science in order to take care of men. In certain instances, women were depicted in poverty, and taking care of children alone.

In the Natural Sciences textbook both male and female scientists were portrayed. However, women scientists were portrayed in a manner that undermines their professional statuses. For example, they were not named, lacked surnames and described as becoming lonely as a result of working away from home. Men were used as examples of being adventurous, travelling to another planet, while women were depicted as dependent and in examples of only travelling locally. Women were also portrayed in sport activities either as lacking sport clothing or playing in domestic settings rather than sport fields. In contrast men were portrayed in proper sporting clothing, playing sports in sport fields, and addressed by sport titles such as a goalkeeper.

The Natural Sciences and Technology textbook presented fair gender representations. There were equal representations both in science active and science passive roles, and some of the figures portrayed both girls and boys working co-operatively in science investigations.

5.2 Limitations of the study

This qualitative study was conducted on the sample of only four textbooks, each representing a grade different from others. Therefore, it cannot be used for generalisability because the sample is too small to represent all South African textbooks. Only CDA was used as the method of data generation. The CDA is criticised because “it is decides for others what is true” (Pennycook, 2001, p. 47). Hence, I ensured that every argument is accompanied by either scanned text or visual image, for readers’ reanalysis and to demonstrate that the analysis was trustworthy. In the next section I provide the implication of the study.

5.3 Implication of the study

Theoretical implication

FPDA as a lens for this study empowered me to expose discriminatory practices against women in discourse. It is therefore one of the effective strategies that empowers women with tools they

can use to resist male domination (Flores, Gómez, Roa, & Whitson, 2018). Since FPDA is a bricolage of Feminist, Post – Structuralist, and Discourse Analysis lenses, it was adequate in scrutinising the texts and visuals from all angles. Through Post – Structuralist lens (which seeks to investigate the systems involved in text production) I managed to challenge texts in order to expose gender imbalances. Liberal feminist lens, enabled me to detect that women scientists, particularly in the Physical Sciences textbook, are denied their right to be represented. Not even one-woman scientist was portrayed in the Physical Sciences textbook. Radical feminist lens empowered me to justify my interpretations and assumptions on gender discrimination and marginalisation in textbooks that I analysed. Marxist feminist lens empowered me to expose hegemonic practices that were concealed in textbooks that I studied. For example, the Physical Sciences textbook depicted only a male as an example of an astronaut, a highly prestigious profession. The female scientist in the Life Sciences textbook was rendered invisible. Her portrayal was not accompanied by a colourful image. It also enabled me to challenge visual images that reinforced portrayal of only women in nurturing roles, and activities associated with domesticity such as figure 4.11. On the contrary, men were cast venturing out of the planet, e.g. in figure 4.55. The implication is that science curriculum continues to be permeated with patriarchy in subtle ways.

Methodological implication

In this section I provide the arguments on why I regard the paradigm, approach, research design and data collection strategies that I used in this study as effective in uncovering the truth that answered the research question.

Croucher and Cronn-Mills (2014) argue that critical paradigm aims to challenge reproduction of inequalities and dominant discourses in educational research. They argue that education serves the interests of those who have power, usually rich white males. Using the critical paradigm in the analysis of four textbooks empowered me to be critical in order to uncover that the selected Physical Sciences textbook portrayed male gender in manner that maintains patriarchy in science education. This became evident when female scientists were totally excluded as inventors and producers of scientific knowledge (discoveries). For example, a male scientist Sorensen in figure 4.22 was portrayed as the founder of the pH scale, and Faraday in figure 4.23 was portrayed as the pioneer of electrochemistry. In the entire Physical Sciences textbook female scientists were never mentioned. The findings of the study such as figure 4.29 (which described Edison as the famous businessman who invented the light bulb, and Tesla as

the successful brilliant physicist) confirm that the science textbooks that were studied serve the interests of rich males.

This study adopted qualitative approach which seeks to understand the underlying reasons and opinions behind the manner in which reality is portrayed. I adopted Critical Discourse Analysis as one of the methods of qualitative research. Critical Discourse Analysis constructs such as rhetoric revealed that one of the strategies used by social structures to enact power to males in science education is use of words to cunningly elevate only male scientists as successful and brilliant.

To achieve rigour in research confirmability was applied through scanning into the thesis the texts and visual images that had data so that readers could confirm the findings. Persistent observation as the principle of trustworthiness assisted me to gain rich data during analysis of visual images. For example, CDA constructs such as low angle and high angle of the photographs, emerged as a result of persistent observation. This empowered me to look for the reason for the positioning of some of the participants at the back in the photograph (resulting in the represented participant to appear small in size). I also challenged photographs that were positioned in front and made the represented participant to appear large. These findings imply that science continues to be masculinist because it is the male scientists that were portrayed from low angle making them more memorable to learners as interactive participants.

5.4 Suggestions for future research

This study focussed on construction of gender identities in textbooks. I propose that future studies incorporate race and class when exploring gender to enhance the findings by considering all factors that influence human representations in textbooks. Furthermore, a quantitative study can be pursued to maximise the chances of using the findings of the study for generalisability. To enhance the findings to the CDA, interviews can be incorporated, so that the researcher can get the opinions of possibly the learners and teachers.

5.5 Recommendations

Authors should make both male and female scientists visible in texts in unprejudiced manner to make science textbooks gender balanced (Srivastava, 2012). Furthermore, gender inclusivity should be considered when producing science textbooks. This can be achieved by increasing numbers of images depicting boys and girls conducting experiments and investigations.

Textbooks should portray males and females as producers of scientific knowledge and as

possessors of scientific inventions (Mudaly & van Wyk, 2015). This can help to address masculinist science that is presented in patriarchal view. Furthermore, science textbooks should be evaluated and revised regularly in order to remove one sided portrayals with obvious prejudices (Blumberg, 2015).

I also propose that authors of science textbooks depict equal numbers of men alongside women in nurturing roles, caring for children and elderly (Mburu & Nyagah, 2012; Srivastava, 2012). This will help address the stereotypes of portraying women alone in activities associated with domestic settings (Sadler, Sonnert, Hazari, & Tai, 2012). Authors of science textbooks should refrain from portraying women in controversial manner (Srivastava, 2012). This can help provide enough science role models for girls. In this way the number of women who pursue STEM careers can be possibly increased (Baker, 2016).

5.6 Conclusion

In this chapter I presented the summary of the main findings.

The findings of this study revealed that, despite the commitment of the policies of education such as National Education Policy Act of 1997, and legislation such as South African Schools Act of 1996, to address gender inequalities and promote the advancement of the status of women, a lot still needs to be done to achieve this commitment in the science education provisioning. For example, the science textbook that is used in junior years of schooling (Oxford Successful Natural Sciences and Technology for grade six) exhibited a certain level of inclusivity. Male and female scientists, including the South African scientist, were portrayed as the producers of scientific knowledge. In addition, girls were largely depicted with boys conducting scientific investigations. This is possibly one of the reasons that girls' academic performance equals to and is sometimes better than that of boys during primary school years. However, a textbook that is used during Senior Phase of schooling, and guides girls and boys on whether or not they pursue science subjects, particularly Physical Sciences in FET band, was found to be biased. The Natural Sciences textbook depicted female scientists that either lacked autobiography or surnames. On the contrary, the male scientist was portrayed with full name and surname, with a positive gaze. I cannot regard this textbook to be promoting masculinity because there were representations of female scientists. However, it was discriminating against women. Such representations of female scientists in textbooks do not encourage girls to pursue Physical Sciences in the FET band of schooling. This is possibly the reason why there are few girls who pursue Physical Sciences as a school subject. In addition,

Physical Sciences textbook displayed marginalisation against women scientists because they were excluded as the producers of scientific knowledge.

These findings imply that Physical Sciences textbook continues to be rooted in patriarchal ideology (De Wet, 2011; Volovitz et al., 2004). This is evidence of what Gramsci calls hegemony, where one group (in the society) that is dominant oppresses the other which ultimately becomes subservient (Gramsci, 2009; Lung & Ball, 2015). These representations elevate males into the position of power while demoting female scientists.

Therefore, I recommend that textbooks be regularly reviewed and revised (Lung & Ball, 2015). This will enable constant removal of prejudiced and controversial gender representations (Pingel, 2010) from science textbooks, and possibly increase the numbers of women who participate in STEM fields (Mbeki, 2001; Stout et al., 2011).

I also discussed implication, limitations and recommendations for future research.

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Appendix A: Turnitin Report

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Exploring gender representations in selected ... *By Penelope Ndlovu*

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Appendix B: Ethical Clearance Certificate



11 May 2018

Mrs Penelope Princess Zandile Ndlovu (217078714)
School of Education
Edgewood Campus

Dear Mrs Ndlovu,

Protocol reference number: HSS/0391/018M

Project Title: Exploring gender representations in selected Science textbooks

Approval Notification – No Risk / Exempt Application

In response to your application received 07 May 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)

/ms

Cc Supervisor: Dr Ronicka Mudaly
Cc Academic Leader Research: Dr SB Khoza
Cc School Administrator: Ms Tyzer Khumalo

Humanities & Social Sciences Research Ethics Committee

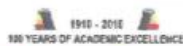
Professor Shenuka Singh (Chair)

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