



GENDER REPRESENTATIONS IN PHYSICAL SCIENCES  
TEXTBOOKS: STUDENT TEACHERS' PEDAGOGICAL  
RESPONSES

By

Penelope Princess Zandile Ndlovu

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**SUPERVISORS: PROFESSOR SHAKILA SINGH**

**PROFESSOR SURIAMURTHEE MAISTRY**

**SUPERVISOR'S PERMISSION TO SUBMIT**

**Statement by supervisor**

As the candidate's supervisors, we agree to the submission of this thesis.



23 January 2024

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Supervisor's signature

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Date



22 January 2024

Supervisor's signature

Date



22 January 2024

Student's signature

Date

## **DECLARATION**

I, Penelope Princess Zandile Ndlovu, declare that this thesis is my work. Additionally, I hereby proclaim that this work has not been presented for academic evaluation at any other institution of higher learning, and I have conscientiously indicated and duly recognised all the references utilised in the process.

## **DEDICATION**

I extend my gratitude to God the Almighty for providing me with the strength and intellectual capacity to complete this thesis in the name of Jesus Christ.

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## **ABSTRACT**

This research aimed to analyse the representations of gender in Physical Sciences textbooks and explore student teachers' pedagogical plans for mitigating biased messages found in texts designed for science teaching and learning. The study adopted tenets of the critical paradigm and drew on theories of the Social Construction of Gender, Feminist Post Structuralist Discourse Analysis, and Critical Theory as the main analytical lenses.

The data was produced and analysed in two phases. Firstly, gender representations in the selected Physical Sciences textbooks were analysed using critical discourse analysis. The findings show that the textbooks are gendered masculine and promote Western ideals, which implies inadequate decolonisation of the science curriculum. The text framing depicted men in roles that are prone to conveying a message of male supremacy and female inferiority. This was seen through the overrepresentation of men as producers of scientific knowledge. The studied textbooks did not acknowledge the contributions of female scientists. Conversely, the inventions of male scientists were consistently highlighted and used as an introduction to the majority of topics covered in these textbooks.

Secondly, student teachers from one University were sampled to explore their pedagogical responses to gender representations in chosen Physical Sciences textbooks and what factors influence these interpretations. I employed qualitative methods through a blended approach, including face-to-face interviews and telephonic interviews through WhatsApp voice messaging. I utilised thematic analysis to analyse and interpret data and identify key themes for presenting the findings.

The research found that student teachers identified ways in which the content of studied textbooks promotes traditional masculine norms and negative societal stereotypes that undermine and devalue women, which could lead to girls dropping out of the Physical Sciences stream. The omission of women's input in the development of scientific knowledge in specific textbooks was regarded as a type of gender-based discrimination against women. The engagements with the student teachers indicate that they can be helpful agents of curriculum decolonisation and degendering, as was evident in their delineations of self-efficacy to disrupt gender norms and stereotypes from Physical Sciences textbooks. They proposed strategies to disrupt gender norms and negative stereotypes in science textbooks. By challenging deeply ingrained masculine norms disseminated through Physical Sciences textbooks, there is a

possibility of enhancing the presence and participation of women in career fields related to science, technology, engineering, and mathematics (STEM).

**Keywords:** gender, STEM, textbooks, student teachers

# TABLE OF CONTENTS

|   |           |
|---|-----------|
| DECLARATION.....  | iii       |
| DEDICATION.....   | iv        |
| ACKNOWLEDGEMENTS .....  | v         |
| ABSTRACT.....   | vi        |
| TABLE OF CONTENTS .....                                       | viii      |
| LIST OF TABLES .....  | xv        |
| LIST OF FIGURES .....   | xvi       |
| LIST OF APPENDICES .....                                      | xvii      |
| ACRONYMS.....   | xviii     |
| <b>Chapter 1 .....</b>  | <b>1</b>  |
| <b>1.1 Introduction.....</b>                                  | <b>1</b>  |
| <b>1.2 The South African education context.....</b>           | <b>2</b>  |
| <b>1.3 Rationale for the study .....</b>                      | <b>4</b>  |
| <b>1.4 Problem statement .....</b>                            | <b>8</b>  |
| <b>1.5 Positionality of the Researcher .....</b>              | <b>9</b>  |
| <b>1.6 Purpose of the study.....</b>                          | <b>11</b> |
| <b>1.7 Significance of the study .....</b>                    | <b>13</b> |
| <b>1.8 Critical questions of the study.....</b>               | <b>14</b> |
| <b>1.9 Objectives.....</b>                                    | <b>14</b> |
| <b>1.10 Overview of research design and methodology .....</b> | <b>15</b> |
| <b>1.10.1 Research design .....</b>                           | <b>15</b> |
| <b>1.10.2 Paradigm.....</b>                                   | <b>15</b> |
| <b>1.10.3 Sampling .....</b>                                  | <b>16</b> |
| <b>1.10.4 Data generation .....</b>                           | <b>16</b> |
| <b>1.10.5 Data analysis.....</b>                              | <b>17</b> |
| <b>1.10.6 Establishing Trustworthiness in The Study.....</b>  | <b>18</b> |
| <b>1.11 Ethical Considerations.....</b>                       | <b>19</b> |
| <b>1.12 The Structure of the Thesis .....</b>                 | <b>20</b> |
| <b>1.13 Conclusion .....</b>                                  | <b>21</b> |
| <b>Chapter 2: Literature Review .....</b>                     | <b>23</b> |
| <b>2.1 Introduction.....</b>                                  | <b>23</b> |
| <b>2.2 Functions of textbooks .....</b>                       | <b>23</b> |
| <b>2.3 Textbooks as tools for socialisation .....</b>         | <b>26</b> |

|   |  |           |
|---|--|-----------|
| 2.4   | The significance of textbooks in shaping the curriculum .....  | 26        |
| 2.4.1   | Textbooks as a component of formal (intended) curriculum .....   | 26        |
| 2.4.2   | Textbooks as a vehicle for transmitting the hidden curriculum .....  | 28        |
| 2.5   | Political and ideological role of textbooks.....   | 29        |
| 2.6   | The History of Textbook Evaluation and Research.....   | 31        |
| 2.7   | People's misconceptions of gender.....   | 32        |
| 2.8   | Representation of gender in textbooks.....   | 34        |
| 2.8.1   | Gender differences in occupational Roles.....  | 36        |
| 2.8.2   | Gender representation in STEM-related fields.....  | 38        |
| 2.8.3   | The role of curriculum and textbooks in promoting stereotypes .....  | 40        |
| 2.9   | Reviewing the intricate correlations between social class, gender, and racial identity. ....               | 42        |
| 2.10  | International strategies that were adopted to deal with gender discrimination and gender inequalities..... | 44        |
| 2.10.1  | UNESCO.....  | 44        |
| 2.10.2  | The United Nation’s Education for All (EFA).....   | 45        |
| 2.10.3  | The Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW).....                | 47        |
| 2.11  | The impact of gender in science textbooks on learners’ conception of science .....                         | 48        |
| 2.12  | The implication of the literature review .....   | 49        |
| 2.13  | Conclusion .....   | 50        |
| <b>Chapter 3: Theoretical Framework .....</b> |  | <b>51</b> |
| 3.1   | Introduction.....  | 51        |
| 3.2   | Theoretical Underpinning.....  | 51        |
| 3.2.1   | Critical Theory: Definition.....   | 52        |
| 3.2.2   | Origin of the Critical Theory .....  | 52        |
| 3.2.3   | Critical Theory as an Effective Tool to Challenge Hegemonic Practices.....                                 | 53        |
| 3.2.4   | Summary of the strengths of the Critical theory.....   | 54        |
| 3.2.5   | Limitations of the Critical Theory in critiquing textbooks .....   | 54        |
| 3.3   | The Social Construction of Gender .....  | 55        |
| 3.3.1   | Origin and development of social construction of gender .....  | 55        |
| 3.3.2   | The socialisation of women and men into gendered jobs .....  | 56        |
| 3.3.3   | Summary of the Strengths of the Social Construction of Gender .....  | 58        |
| 3.3.4   | Limitations of the Social Construction of Gender in critiquing textbooks.....                              | 59        |
| 3.4   | Feminist Post-Structural Discourse Analysis (FPDA) .....   | 59        |
| 3.4.1   | Summary of the Strengths of the FPDA .....   | 60        |
| 3.4.2   | Limitations of the FPDA in critiquing textbooks .....  | 60        |

|   |            |
|---|------------|
| 3.5 The Significance of the Theoretical Framework to the Study .....              | 61         |
| 3.6 Conclusion .....  | 63         |
| <b>Chapter 4: Methodology.....</b>  | <b>64</b>  |
| 4.1 Introduction.....   | 64         |
| 4.2 Qualitative Approach .....  | 64         |
| 4.3 Paradigm.....   | 67         |
| 4.3.1 Critical Research Paradigm .....  | 67         |
| 4.3.2 Ontology of the critical paradigm.....                                      | 68         |
| 4.3.3 Epistemology of the Critical Paradigm .....                                 | 69         |
| 4.4 Location of the study .....   | 70         |
| 4.5 Context of the study .....  | 70         |
| 4.6 Phase 1.....  | 71         |
| 4.6.1 Sampling of Textbooks .....   | 71         |
| 4.6.2 Data generation methods: CDA.....   | 72         |
| 4.7 Data analysis, procedures and tools .....                                     | 79         |
| 4.7.1 Analysis of selected Physical Sciences textbooks using CDA .....            | 79         |
| 4.8 Phase 2.....  | 83         |
| 4.8.1 Recruiting and sampling of participants for interviews .....                | 83         |
| 4.8.2 Data generation methods for phase 2: Why Interviews?.....                   | 86         |
| Face-to-face and Remote Interviews as Data Generation Method for this study ..... | 86         |
| 4.8.3 Data Analysis for phase 2: Analysis of interview transcripts.....           | 95         |
| 4.8.4 Thematic Analysis of Interview Data .....                                   | 96         |
| 4.9 Rigour in research.....   | 100        |
| 4.9.1 Credibility .....   | 101        |
| 4.9.2 Transferability.....  | 102        |
| 4.9.3 Confirmability .....  | 103        |
| 4.9.4 Dependability.....  | 103        |
| 4.9.4 Dependability.....  | 103        |
| a) Audit trail .....  | 103        |
| b) Stepwise replication.....  | 103        |
| c) Code-recode strategy .....   | 104        |
| d) Peer examination .....   | 104        |
| 4.10 Ethical considerations.....  | 104        |
| 4.11 Conclusion .....   | 105        |
| <b>Chapter 5: Analysis of selected textbooks.....</b>                             | <b>107</b> |
| 5.1. Introduction.....  | 107        |

|  |     |
|--|-----|
| <b>5.2 Gender inequality being disseminated through textbooks</b> .....                          | 107 |
| <b>5.2.1 Representation of men and women scientists</b> .....                                    | 108 |
| <b>5.2.2 Representation in Science Active and Science Passive roles- texts and visuals</b> ..... | 113 |
| <b>5.2.3 Visuals are disproportionately male-oriented.</b> .....                                 | 115 |
| <b>5.3 Physical Sciences textbooks index differentiated gender roles.</b> .....                  | 116 |
| a) <b>Lexical choices</b> .....  | 116 |
| b) <b>Claim-counterclaim</b> .....   | 118 |
| c) <b>Foregrounding and backgrounding</b> .....  | 119 |
| d) <b>Reiteration</b> .....  | 119 |
| <b>5.4. Marginalisation of women scientists</b> .....  | 120 |
| <b>5.4.1 Silences about women’s scientific contribution to knowledge</b> .....                   | 121 |
| <b>5.4.2 Women scientists marginalised through not naming.</b> .....                             | 122 |
| <b>5.4.3 Biased visual representations of men and women.</b> .....                               | 124 |
| <b>The angle of the camera.</b> .....  | 124 |
| <b>Gaze</b> .....  | 126 |
| <b>5.5 Stereotypes that perpetuate gender power imbalance.</b> .....                             | 128 |
| <b>5.5.1 Stereotypes of women as weak</b> .....  | 128 |
| <b>Hyperbole</b> .....   | 128 |
| <b>Presupposition</b> .....  | 131 |
| <b>The indexical and iconic sign</b> .....   | 133 |
| <b>Potent cultural symbol</b> .....  | 134 |
| <b>5.5.2 Subservient positioning of women</b> .....  | 136 |
| a) <b>Overlapping</b> .....  | 136 |
| b) <b>Functionalisation</b> .....  | 137 |
| c) <b>Agent-patient relationship</b> .....   | 139 |
| <b>5.5.3 Stereotype of Men as Creative and Independent Analytical Thinkers</b> .....             | 140 |
| a) <b>Functionalisation and generic pronouns</b> .....   | 140 |
| b) <b>Specification</b> .....  | 142 |
| c) <b>Collectivisation</b> .....   | 144 |
| <b>5.6 Gendered Entrepreneurship Discourse in Physical Sciences textbooks</b> .....              | 145 |
| <b>Overlexicalisation</b> .....  | 145 |
| <b>5.7 Physical Sciences Textbooks index racism and classism</b> .....                           | 148 |
| <b>5.8 Conclusion</b> .....  | 151 |
| <b>Chapter 6: Analysis of interview data</b> .....   | 153 |
| <b>6.1 Introduction</b> .....  | 153 |
| <b>6.2 Student Teachers’ understandings of gender</b> .....                                      | 153 |

|  |     |
|--|-----|
| 6.2.1 Dynamism of Gender Roles.....  | 156 |
| 6.2.2 Gender and women’s career choices and opportunities.....                                     | 157 |
| 6.2.3 Student Teachers’ Understanding of How Gendered Stereotypes Affect Girls' Efficacy<br>.....  | 159 |
| 6.3 Student teachers’ concern about gender biases in selected textbooks.....                       | 162 |
| 6.3.1 Recognition of biases that promote masculinity in science. ....                              | 162 |
| 6.3.2 Omission of women’s inventions in textbooks - an epistemological omission .....              | 166 |
| 6.3.3 Influence of stereotypical discourse in texts .....  | 170 |
| 6.4 Student Teachers’ sense of efficacy to mediate media assaults.....                             | 172 |
| 6.5 Potential of Learning from Gender-sensitive Mentors.....                                       | 176 |
| 6.6 Possible strategies to address gender issues in existing science textbooks. ....               | 181 |
| a) Teaching methods that promote gender equality.....  | 181 |
| b) Raising awareness among students about the partiality within texts.....                         | 182 |
| c) Enhancing girls’ self-efficacy to grasp scientific knowledge .....                              | 183 |
| d) Incorporation of pedagogic strategies that enhance cooperative learning among learners<br>..... | 185 |
| e) Integration of gender-inclusive images, graphics, and written resources.....                    | 185 |
| f) Give priority to girls without overlooking the needs of boys.....                               | 186 |
| 6.7 The Conclusion.....  | 187 |
| Chapter 7: Discussion of the findings.....   | 189 |
| 7.1 Introduction.....  | 189 |
| 7.2 Gender inequality being disseminated through textbooks .....                                   | 189 |
| 7.3 Physical Sciences textbooks index differentiated gender roles. ....                            | 193 |
| 7.4 Marginalisation of Women Scientists.....   | 195 |
| 7.4.1 Silences about women’s scientific contribution to knowledge .....                            | 196 |
| 7.4.2 Not naming marginalises women scientists.....  | 198 |
| 7.4.3 Biased visual representations of men and women.....  | 200 |
| 7.5 Stereotypes that perpetuate gender power imbalance.....  | 202 |
| 7.5.1 Stereotypes of women as weak.....  | 202 |
| 7.5.2 Stereotypes that perpetuate the notion of women in low-paying jobs.....                      | 203 |
| 7.5.3 Stereotype of women in domestic settings.....  | 204 |
| 7.5.4 Stereotype that Physical Sciences is not an option for girls. ....                           | 206 |
| 7.5.5 Subservient positioning of women .....   | 208 |
| 7.5.6 Stereotype of men as creative and independent analytical thinkers .....                      | 209 |
| 7.6 Gendered Entrepreneurship Discourse in Physical Sciences Textbooks .....                       | 211 |
| 7.7 Physical Sciences Textbooks index racism and classism .....                                    | 212 |

|   |            |
|---|------------|
| 7.8 Student Teachers' understandings of gender .....  | 215        |
| 7.9 Student Teachers' sense of efficacy to mediate media assaults.....  | 217        |
| 7.10 Possible strategies to address gender issues in existing science textbooks .....   | 221        |
| a) Employ teaching methods that promote gender equality .....   | 222        |
| b) Raising awareness among students about the partiality within texts .....   | 222        |
| c) Enhancing girls' Self-Efficacy .....   | 223        |
| d) Incorporation of pedagogic strategies that enhance cooperation.....  | 224        |
| e) Integration of gender-inclusive graphics and text materials.....   | 224        |
| f) Give priority to girls without overlooking the needs of boys.....  | 225        |
| 7.11 Conclusion .....   | 225        |
| <b>Chapter 8: Summary of the findings and conclusion .....</b>  | <b>227</b> |
| <b>8.1 The Introduction .....</b>   | <b>227</b> |
| <b>8.2 Overview of chapters .....</b>   | <b>227</b> |
| <b>8.3 Responding to the Research Questions. ....</b>   | <b>232</b> |
| 8.3.1 Research question 1 .....   | 232        |
| 8.3.2 Research Question 2.....  | 233        |
| a) Uneven and inordinate bestowal of power.....   | 234        |
| b) Physical Sciences continue to be gendered masculine. ....  | 237        |
| c) Inadequate severing of the curriculum from colonial and Apartheid roots .....  | 238        |
| 8.3.3 Research Question 3.....  | 239        |
| <b>8.3.4 What informs student teachers' interpretations to gender representations in selected Physical Sciences textbooks?.....</b> | <b>243</b> |
| a) Understanding the Societal roots of hierarchical segregation .....   | 243        |
| b) Strategic approaches of student teachers facilitate transformative methods proposed by FPDA and Critical Theory.....             | 244        |
| <b>8.4 Research's significance, worth and contributions to knowledge. ....</b>  | <b>246</b> |
| <b>8.5 Reflections on the Study .....</b>   | <b>247</b> |
| 8.5.1 Methodological Reflections on the Study .....   | 247        |
| 8.5.2 Reflections on the study from a personal and professional standpoint.....   | 248        |
| <b>8.6 Limitations of the study .....</b>   | <b>250</b> |
| <b>8.7 Implications of the study .....</b>  | <b>250</b> |
| 8.7.1 Implication to the teaching practice: Physical Sciences teachers exposing hidden curriculum .....                             | 250        |
| 8.7.2 Implication to Education Policies .....   | 251        |
| <b>8.8 Recommendations for future science textbook research.....</b>  | <b>251</b> |
| <b>8.9 Conclusion .....</b>   | <b>252</b> |
| <b>References .....</b>   | <b>255</b> |

|   |     |
|---|-----|
| <b>APPENDICES</b> .....   | 285 |
| <b>1. APPENDIX 1: Ethical Clearance</b> .....                       | 285 |
| <b>APPENDIX 2: Amendment to Ethical Clearance Certificate</b> ..... | 286 |
| <b>APPENDIX 3: Turnitin Report</b> .....                            | 288 |
| <b>APPENDIX 4: Letter from the editor</b> .....                     | 293 |
| <b>APPENDIX 5: Letter for recruiting participants</b> .....         | 294 |
| <b>APPENDIX 6: Participants' Consent (Edit as required)</b> .....   | 295 |
| <b>APPENDIX 7: Sample of interview transcripts</b> .....            | 297 |
| <b>1. Interview transcripts of Elelo</b> .....                      | 297 |
| <b>2. Interview Transcript of Wane</b> .....                        | 301 |

## **LIST OF TABLES**

|  |     |
|--|-----|
| Table 4.1 Textbooks that were analysed .....                                   | 73  |
| Table 4.2 Framework Guiding Textbook Analysis .....                            | 82  |
| Table 4.3 Information on Participants .....                                    | 87  |
| Table 4.4: Information on face-to-face individual interview appointments ..... | 93  |
| Table 4.5: Details of participants' interview using WhatsApp voice notes ..... | 95  |
| Table 5.1: Men/women as producers of scientific knowledge in Textbook A.....   | 110 |
| Table 5.2 Men/women as producers of scientific knowledge in Textbook B .....   | 111 |
| Table 5.3 Men/women as producers of scientific knowledge in textbook C .....   | 113 |
| Table 5.4 Men and women in science active and science passive roles .....      | 115 |
| Table 5.5 Depicting all scientists as Western Whites.....                      | 150 |

## LIST OF FIGURES

|  |     |
|--|-----|
| Figure 2.1: Impact of practices in textbook design.....                          | 23  |
| Figure 5.1: A woman is depicted science-active .....                             | 123 |
| Figure 5.2: Science active woman depicted as a student .....                     | 123 |
| Figure 5.3: A woman scientist is not named.....                                  | 124 |
| Figure 5.4: A man physicist founder of Kelvin scale .....                        | 125 |
| Figure 5.5: A woman physicist .....  | 125 |
| Figure 5.6: A man chemist .....  | 125 |
| Figure 5.7: A woman chemist, Paulze .....  | 127 |
| Figure 5.8: A woman’s radiograph taken from the back .....                       | 128 |
| Figure 5.9: A woman photographed from the back .....                             | 128 |
| Figure 5.10: A woman and a man exemplifying gender equality.....                 | 129 |
| Figure 5.11: A girl pushing a box .....  | 130 |
| Figure 5.12: A boy pushing a box.....  | 130 |
| Figure 5.13: A boy pushing 2 x 25kg box .....                                    | 131 |
| Figure 5.14: Women in the river.....   | 132 |
| Figure 5.15: Lisa jogging.....   | 132 |
| Figure 5.16: Women in Salon .....  | 135 |
| Figure 5.17: A mother pushing a child .....                                      | 134 |
| Figure 5.18: Students observing a demonstration of skills in the laboratory..... | 136 |
| Figure 5.19: A woman scientist portrayed as a student .....                      | 137 |
| Figure 5.20: A man Meteorologist.....  | 139 |
| Figure 5.21: Students observing a demonstration of skills in the laboratory..... | 141 |
| Figure 5.22: An astronaut is a man .....   | 142 |
| Figure 5.23: A man paediatrician.....  | 143 |
| Figure 5.24: Friedrich Wohler .....  | 144 |
| Figure 5.25: Faraday .....   | 144 |
| Figure 5.26: Dmitri Mendeleev.....   | 144 |
| Figure 5.27: Galilei .....   | 144 |
| Figure 5.28: Sir Isaac Newton .....  | 144 |
| Figure 5.29: Science Entrepreneurs .....   | 147 |
| Figure 5.30: Real-life situations – Mirriam Makeba and Newton.....               | 148 |

## **LIST OF APPENDICES**

|   |     |
|---|-----|
| APPENDIX 1: Ethical Clearance Certificate.....              | 275 |
| APPENDIX 2: Amendment to Ethical Clearance Certificate..... | 276 |
| APPENDIX 3: Turnitin report.....                            | 277 |
| APPENDIX 4: Letter from the editor.....                     | 282 |
| APPENDIX 5: Letter for Recruiting Participants.....         | 283 |
| APPENDIX 6: Participants' Consent.....                      | 284 |
| APPENDIX 7: Samples of Interview Transcripts.....           | 286 |

## **ACRONYMS**

|        |   |
|--------|---|
| DBE    | -Department of Basic Education  |
| CAPS   | - Curriculum Assessment Policy Statements   |
| CDA    | - Critical Discourse Analysis   |
| FET    | - Further Education and Training  |
| GET    | - General Education and Training  |
| PFDA   | - Post –Structuralist Feminist Discourse Analysis                                   |
| LTSM   | -Learner Teacher Support Material   |
| NSERC  | - Natural Sciences and Engineering Research Council of Canada                       |
| SACE   | - South African Council of Educators  |
| SACMEQ | - The Southern and Eastern Africa Consortium for Monitoring<br>Educational Quality. |
| SASA   | - South African Schools Act   |
| STEM   | - Science, Technology, Engineering, and Mathematics                                 |
| STs    | -Student Teachers   |
| HEIs   | -Higher Education Institutions  |
| UNESCO | -United Nations Educational Scientific and Cultural Organisation.                   |
| USA    | - United States of America  |
| US     | -United States  |
| DA     | -Discourse Analysis   |

# **Chapter 1**

## **1.1 Introduction**

Social structures can use textbooks as the mechanisms to sustain political ideologies in the community. The contention made by Apple and Christian-Smith (2017) suggests that texts have the potential to insidiously spread and perpetuate ideologies, thereby exerting influence discreetly and unobtrusively on individuals. Educational policies guide authors and publishers to produce textbooks that sustain particular political philosophies (Pingel, 2010). Text creators can potentially use texts to express and instil ideologies that readers may not be aware of. In this chapter, I provide the setting of the study, the background of education in the South African context, the rationale for the study, the problem statement, the positionality of the researcher, the purpose of the study and the significance of the study. I also outline the study's critical objectives and questions. Finally, I present the overview of the research design, ethical considerations, structure of the thesis and conclusion.

### **The setting of the study**

This inquiry examines gender representations in selected Physical Sciences textbooks to explore ideological messages in science texts and to demonstrate their probable impact on boys and girls as lifelong learners of science education. I recruited student teachers as participants in the study to explore their pedagogical responses to gender representations in selected texts. Pedagogical responses in this inquiry refer to planned activities and modes of implementation in classrooms (Blackstone et al., 2007) to enhance teaching and learning (Nkambule & Mbhiza, 2022). In the opinion of Nkambule and Mbhiza (2022), to promote pedagogical responsiveness, it is crucial for teachers or educators to meticulously plan lesson activities that can transform education and combat inequitable access to knowledge. Walton and Osman (2022) also emphasise that the essence of pedagogical responsiveness is defined by its wide-ranging inclusivity and unwavering dedication to the holistic development and well-being of students. They maintain that an act of being pedagogically responsive invariably leads to a heightened sense of learner efficacy and significant transformation. Hence, in this study, student teachers' pedagogical responses to gender representations refer to approaches or strategies student teachers could devise and implement in science classrooms to reduce the effects of biased messages from selected texts, thereby maximising equitable access to knowledge.

Teachers' faith in their capability to attain the desired outcomes for their students has been termed teacher efficacy (Tejeda-Delgado, 2009). The theory of self-efficacy, developed by Bandura (1977) and Bandura, Freeman and Lightsey (1999), suggests that individuals who establish objectives and incentivise themselves to reach specific performance benchmarks will enhance their self-confidence. They further state that these individuals will resolutely remain motivated and propelled to persistently strive and persevere until they successfully attain the objectives they have set for themselves. Consequently, during student-teacher interviews, I asked whether they had created a sense of efficacy to break gender norms and stereotypical messages that Physical Sciences textbooks could present. Additionally, I expected them to recommend teaching strategies and techniques that science teachers can implement to diminish the effects of one-sided messages from science texts. I deemed their strategies as enhancing the potential for science texts to be inviting to all learners as they learn science.

To show the influence of the government's earlier policies on the composition of textbooks, I initially present a concise chronicle of the South African education system in the background section of this study. This study analysed gender relations as depicted in selected educational texts, thereby demonstrating the significance of the connection between the content found in science textbooks and the guidelines of the government and its educational plans. This chapter also outlines how the post-1994 South African government implemented various policies and regulations to improve gender inequalities in education. These policies and regulations are discussed in this study as they play a crucial role in the textbooks employed as part of the school curriculum.

## **1.2 The South African education context**

In their research, Hay and Monnapula-Mapesela (2009) drew attention to the fact that the South African educational curriculum before 1994 intensified social inequities and the traditional gender roles of women in society. Before this, the Bantu Education Act of 1952 vigorously furthered various educational disparities, particularly concerning gender inequality (Healy-Clancy, 2017). Schools and schooling were deeply entrenched in oppressive patriarchal ideology (Akala, 2018; Coetzee, 2001; Roberts, 2010).

The intersections of race, class, and gender have negative implications for girls and women. Hoveid et al. (2019) state that class, power, sexuality, and health are significant factors that researchers need to consider when conducting educational studies. According to West and

Zimmerman (2009), gender, race, and class operate simultaneously. Ultimately, "...patriarchy, racism, and class oppression are seen as interpretations of gender differences that the society has created" (p.114). Engelbrecht (2006) highlights the idea that Apartheid was the driving force behind the biased and discriminatory nature of South African school curricula. Several researchers who focused on gender discrimination in South African education provisioning, such as De Wet (2011), Healy-Clancy (2017), and Maringe and Prew (2015), found that women of all races faced marginalisation and discrimination until 1994 when South African government enacted policies to promote gender equality. Apartheid ensured that girls were schooled for homemaking to assume subordinate roles in the social order as women, while it ensured that boys learnt to assume managerial duties and be assertive in society's economic, communal and political spectrums (Keddie, 2012; Simpson, 2004)).

This form of education purported that even when women secured employment, they would remain subordinate to men, with no possibility of advancing to leadership positions. Other women (who constituted a large percentage) were also restricted to non-productive housework and were alienated by employers from wage work (Naidoo & Kongolo, 2004). Stichter and Parpart (2019) noted that this meant that there were no opportunities for these women to acquire capital. In rural areas, women were usually assigned agricultural jobs, home chores, and childcare (Espinoza et al., 2019).

Upon the election of South Africa's first democratic regime in 1994, its late and former president, Nelson Mandela, declared in his inaugural statement that the liberation of the nation hinged on freeing women from all forms of oppression (Mandela, 2013). Strategies were introduced to confront racial and gender discrimination. The Constitution of the Republic of South Africa was put in place to counterbalance past wrongs, guarantee equity, and promote non-sexism (Moloi & Chetty, 2010). To confront gender discrimination (De Wet, 2011), the South African Schools Act (SASA) of 1996 was brought into effect. The SASA gave educational institutions the power to identify and act against gender imbalances in schools.

The policy of Apartheid was ended in 1999, and the Employment Equity Act of 1998 facilitated the progression of women in the private sector. The aim was to reinforce the humanitarian ideals of the democratic constitution that upholds gender equality. The CAPS for grades R-12 is dedicated to confronting gender inequalities in schools by improving the way and setting in which knowledge and skills are attained (DBE, 2011). The National Education Policy Act 27 of 1996 was also considered. It endeavours to foster gender equality and elevate the position of women (Woolman & Fleisch, 2006).

Although the educational system in South Africa has seen remarkable improvements, leading to an increase in the number of educated women, they remain greatly underrepresented in esteemed science fields. According to Kim Cloete, a journalist for Creamer Media's Engineering News and Mining Weekly, there has been a notable advancement in racial demographics from 2005 to 2016, as outlined in the 2018 article. Despite the rise in the number of African physicists, as Creamer (2018) has noted, it is still disproportionately male-dominated. In addition, there is a noticeable lack of South African women in STEM fields in comparison to their male peers (Creamer, 2018). According to President Thabo Mbeki (2001), South Africans concentrated their efforts on reducing racism whilst paying little attention to gender discrimination. His remarks highlighted that the participation of additional women in science and technology would not only bolster their productivity but also promote the country's economic and social advancement. Furthermore, he proclaims that citizens who are empowered become inventive and contribute to the nation's economic productivity and sustainability.

Within the scope of South Africa, the curriculum, in conjunction with its related materials such as textbooks, has been employed to fulfil the ambitions of the social justice doctrine, which are strongly enshrined in the Constitution. My attention as a researcher has been drawn to find out whether textbooks, as educational assets, could be one of the causes that suppress girls from taking Physical Sciences as a school subject, thus preventing their potential to join prestigious STEM fields. The research also involved the Physical Sciences student teachers to reinforce my CDA results and to explore whether they were aware of the prejudices in selected textbooks. Moreover, I was interested in finding out how student teachers could adeptly mediate the stereotypical messages from specific texts during Physical Sciences teaching and learning in a classroom environment.

### **1.3 Rationale for the study**

Despite numerous attempts to ensure greater inclusivity of girls and women in science-related disciplines, they remain drastically under-represented at a global level. Patterson and Johnson (2017), who conducted the study in a New Jersey suburban high school, established that there is still a significant dearth of women in high school Physical Sciences classes. They state that this denies girls '... the opportunity to develop the STEM-related knowledge and competencies needed to pursue future related educational and career trajectories' (p.80). Drawing upon my experience as an educator of science, I have observed that numerous female learners evince an affinity for the Physical and Life Sciences when they reach the Further Education and Training

phase in tenth grade. Despite this, a large proportion of the female learners enrolled in Physical Sciences classes do not pass the first year of the FET phase, leading to them abandoning this subject and transferring to other streams which are exclusively Life Sciences and do not include any other scientific disciplines. Meanwhile, the boys in these classes tend to persist in Physical Sciences, even if they have failed their tenth-grade year.

As reported by Hom (2014), Life Sciences do not provide chances to engage in exceptionally esteemed STEM professions, such as engineering, medicine, and pharmacy, without also studying Physical Sciences (Hom, 2014). According to Hom (2014), the quantity of US students who exhibited enthusiasm for STEM subjects at high school dropped by 57% before they concluded their high school education. She elaborated that the US was campaigning to increase the number of workers in STEM fields to 8,65 million by 2018. She mentioned that although male learners pursue engineering and technology fields at college, female students prefer science fields like biology and marine biology.

Coetzee has articulated that, in South Africa, the traditionalist approach to gender roles has resulted in women being confined to limited career paths, significantly below the ones that are usually given to men (Coetzee, 2001, p. 302). Agreeing with this perspective, Barnard (2018) observed that in South Africa, women typically tend to pursue vocations such as social work in preference to STEM occupations. She articulated that, even amongst those who initially embark on STEM courses in higher education, many tend to transition to non-science disciplines before graduation. Furthermore, she noted that girls are commonly observed from socio-cultural surroundings to be engaging in activities such as playing with dolls, while boys are habitually seen taking apart and reconstructing the hi-fi system (music system). It is a widely accepted notion that few men are encouraged to develop nurturing tendencies during their formative years, while are encouraged to pursue scientific endeavours. According to Owings (2015), Pontsho Maruping, an executive at South Africa's Technology Innovation Agency (TIA), ardently stated that the participation of women in STEM should be actively encouraged as it adds to the diversity of the workforce, thus productively aiding the country's economic development. She ardently suggested that the government should develop a strategy to advertise female entrepreneurs to inspire upcoming female scientists widely.

Beede et al. (2011) suggested that the disparity between men and women in the STEM workforce is caused, in part, by the lack of female role models and a hostile environment in the STEM fields. According to Creamer's findings from 2018, only 40% of scientists in South

Africa are women. He further recommended the promotion of women's and girls' education in STEM to raise the number of women scientists and researchers ultimately. As a result, this study was implemented to assess the degree to which textbooks, as the principal vehicle for delivering the curriculum (Apple, 1991), advance the development of men and women in STEM fields.

Although there is access to powerful technology which can be used to identify instruction materials, textbooks are still crucial as they offer a handy framework which assists teachers and students in organising teaching and learning (Joyce, 2015). During the opening stages of schooling, textbooks become a paramount real source of education, as kids peruse, study again, and emphasise to comprehend the theories (Chiponda & Wassermann, 2015). Therefore, textbooks are the central and necessary method of proficient propagation of the taught curriculum around the world (Gandhi & Singh, 2018; Joyce, 2015; Teixeira, 2018).

Teachers are likewise responsible for fostering students' critical thinking. Asgharheidari and Tahriri (2015) allude to the notion that one of the teacher's obligations is to create a learning environment that spurs learners to cogitate acutely. They allude to the fact that critical thinking capacitates learners with reflective thinking skills that are focused on what to believe and do. Through their study, which was conducted in Iran, utilising a sample of 30 pre-service teachers, the discoveries indicated that the studied sample of teachers believed it to be their duty to augment learners' critical thought. After much consideration, it was ultimately concluded that those with the requisite cognitive abilities can effectively handle any difficulties they may confront, whether in the academic arena or their day-to-day life (Asgharheidari & Tahriri, 2015, p.390). Besides empowering them with skills to analyse theoretical knowledge critically, Fairclough (2013) mentions that teachers can inspire learners to critique language in texts to identify and conquer biases and stereotypes. In this way, science teachers can help to improve girls' confidence to pursue STEM subjects. According to Engelbrecht (2006), educators must learn techniques for implementing the curriculum that promote positive self-perception and acceptance of others despite prevalent stereotypes.

All these arguments indicate that teachers can be useful means to teach learners how to overcome textbook (including science) prejudices to thrive during science teaching and learning and have better opportunities to participate in STEM-related fields. Breda, Grenet, Monnet, and Van Effenterre (2018) show that the intervention of female and male science teachers as role models has proven to be an effective strategy to increase the number of girls

enrolled in STEM subjects that were previously known to be selectively male-dominated. They further elaborate that exposure to both female and male role models minimizes the predominance of stereotypes aligned with jobs and gender roles in science.

The CAPS is the fundamental curriculum policy document in South Africa. It emphasises the significance of textbooks and that every learner should acquire his or her textbook (DBE, 2011; Motshekga, 2013a). The CAPS document encourages teachers to select the content carefully 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 in rural areas, and these areas are underdeveloped. Learners in these areas do not have access to internet facilities. Therefore, textbooks are the main resources learners rely on for content knowledge, and to prepare for assessment (Motshekga, 2013a). 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 (Annie Chiponda & Wassermann, 2015; DBE, 2011).

Apart from developing the 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, 2006). Biemmi (2015) suggests that the way men and women are depicted in textbooks has a significant impact on children's understanding of gender, which shapes their self-perception, conduct, goals, and anticipations. Apple (1991) regards textbooks as embodiments for propagating cultural politics, thereby categorising society into class, race, gender, and religious groups. He cautions that textual analysts must determine whose culture is taught in textbooks. Careful reading and analysis are, therefore, imperative to illustrate the underlying meaning embedded in texts.

When teachers mediate textbook content to the learners, their biases are bound to be reproduced because a person teaches based on what he/she has learned or influenced him/her. For example, literature has revealed that textbooks that were used to teach before and after 1994 were full of stereotypes of scientists as men (Ndlovu, 2019; Pillay, 2017). In South Africa, the Apartheid policy was used to construct gender biases. Hence the teachers that were taught under such policies were programmed to reproduce such biases that are recurring to the successive generations, not cognisant of their actions. Consequently, universities and schools

have, since 1994, been eager to make the curriculum genderless and non-colonial (Mbhele, Johnson & Mpungose, 2023; Mpungose, 2020).

The reason for including student teachers as participants in this study is that teachers are regarded as the main agents that are used by political and social structures to bring about social change. Cappy (2016) mentions that teachers are also recruited and trained to promote quality learning in classrooms. Education cannot be regarded as a quality if there is a lack of gender equality. Hence, I regard teachers as useful resources to identify and address biases in textbooks and to promote gender equality that the Constitution of South Africa envisages. It is also emphasised by Fairclough (2015), who recommends that teachers should point out biases in print media and equip students on how to resist media assaults.

#### **1.4 Problem statement**

As stated previously, the South African Department of Education has enacted laws and adopted policies since 1994 in an attempt to ensure gender sensitivity in school curricula and textbooks. The Physical Sciences CAPS document promotes the thoughtful selection of content by teachers to support the learning of science, social justice, and societal development. Additionally, the DBE's approval of textbooks based on specific criteria, including gender sensitivity, is an indication of an attempt at including women's contributions in the curriculum. Therefore, in theory, the Physical Sciences textbooks used in this study, which have been approved, should portray women in a gender-sensitive manner.

From my personal experience as a science teacher, I have observed that after grade 10, girls tend to drop Physical Sciences and join classes that have Life Sciences and other general subjects such as History or Business Studies. Hence, the sample included grade 10 textbooks to understand the extent to which gender representation in textbooks might contribute (among other factors) to girls' choice of switching to streams that do not include Physical Sciences in their subject package.

For example, in the school where I teach, a girl obtained five distinctions in her grade 12 results. These distinctions included Physical Sciences and Maths. However, she chose to study law after school. Hence, there is uncertainty as to why a learner would choose a subject package that is so demanding and is known to channel learners to STEM courses after schooling but choose the streams that are opposite to what they had been prepared for.

In my previous study, I explored gender representations in selected science textbooks (Ndlovu, 2019). Through the findings, I came to understand how crucial it is for teachers to be aware of the underlying assumptions in texts so that they can help learners understand how to manage the discouraging messages posed by print media. With this background, I sought to examine how gender is represented in selected Physical Science textbooks and gain insight from student teachers about their pedagogical responses. The purpose was to equip them with the necessary awareness and understanding of their pivotal role in addressing and combating gender discrimination (engaging with learners) as portrayed in Physical Sciences textbooks, ultimately mitigating the ramifications and consequences of such gender biases. While it was not my intention to directly change the behaviour of the participants, immersing themselves in the study was expected to lead to a positive outcome. By doing so, they would gradually enhance their knowledge and acquire the skills to effectively identify and manage media attacks.

Hence, in line with Fairclough's (2013) suggestion, that teachers should work with learners to confront and address biases in texts, I purposed to explore student teachers' pedagogical responses to representations of gender in selected Physical Sciences textbooks and what their interpretations imply for female participation in STEM-related fields.

### **1.5 Positionality of the Researcher**

It is generally accepted that among scholars adhering to the qualitative approach, a researcher must declare their stance candidly. They contend that this brings clarity to the reader, explicating how the researcher concluded the phenomenon being scrutinised (Bourke, 2014; Lindlof & Taylor, 2017; Malterud, 2001). Bourke (2014) suggests that by making their stance known, researchers can be more careful with their preconceived notions and the assumptions they make about the phenomenon being studied. In a nutshell, this gives them the ability to conquer any partiality in the research. Similarly, Cohen, Manion and Morrison (2007, p.7) indicate that "...the social and positional power of the researchers of that knowledge determines what is deemed worthy knowledge". Declaring my position enabled me to be conscious of my subjectivity. Hence, I would frequently reflect on my position to guarantee that my subjectivity did not contaminate the study. Leveraging my subjective perspective as a science teacher facilitated me to develop a more complete awareness of gender representations (Drapeau, 2015; Whitley, 2015).

I took the position of the critical realist, which is in line with the ontology of the critical paradigm. Critical realists posit the existence of autonomous natural and social worlds that are not influenced or observed by humans. Adopting a critical approach provides individuals with the means to confront the status quo and effect significant change. From this vantage point, what is seen is shaped by the individual perspective. Consequently, I could not be impartial to the gender matters I was exploring, as I was emotionally invested in the outcome as I had a personal stake in them. I yearned for the results of the study to bring me personal emancipation in the first instance, in the hopes of attaining restitution for the harm I suffered as a Black South African woman due to the Apartheid regime. As a Black woman, I, too, have been subject to the same patriarchal education as other South African citizens of colour. The segregationist practice in education secured the substandard quality of education in Black schools. For example, at our schools, learners of Biology were not given access to resourced science laboratories, a facility that was available in other former model C schools.

As a woman, I was assigned to a class that did not feature Physical Sciences and Mathematics. In those years, there was no available vocational advising in Black schools. We pursued our studies to acquire gainful employment. Despite the small number of women who chose to take Physical Sciences as an elective, the classroom was soon at capacity. Owing to my relocation to a new secondary school, I was unable to secure a spot in the Physical Sciences class, as it was already full. The science classes were overwhelmingly comprised of men and only male teachers taught science subjects. General classes lacked any enrolment stipulations, as an outcome, our class was overcrowded, and therefore, teachers were unable to provide one-on-one aid to students. Upon completion of my matriculation with grades conducive to university admission, I aspired to become a dietician. To my dismay, I discovered that Physical Sciences is a requisite to gain admittance to the field of dietetics. Subsequently, I shifted my focus to teaching and honed my skills in Biology and Home Economics, as I have a strong fondness for teaching. Due to a lack of financial resources, my parents were unable to pay for my university studies. Furthermore, the bursary that I was granted from the Department of Education was earmarked for teaching. My ambition was to become a university lecturer, to inspire young women to delve into science subjects in and past their schooling.

As a woman, Feminist Post-Structuralist Discourse Analysis (FPDA) empowered me to gain autonomy from the gender prejudice and injustice I have faced since my scientific education began. Nonetheless, I made sure to prevent my pre-existing convictions from impeding my derivation of implicit meaning from language in chosen science textbooks (Scotland, 2012).

Heeding Drapeau's (2015) recommendation, I sought confirmation from my peers in the research cohort as a precaution to counterbalance any subjectivity in my findings. The inclusion of student teachers in the study was also implemented to mitigate any potential personal biases on my part. In other words, their interpretations also verified the analysis and shed light on certain aspects I had overlooked. Lastly, I scanned passages from textbooks that I analysed into the thesis for the reader's reanalysis to confirm the findings (Wood & Kroger, 2000).

### **1.6 Purpose of the study**

Consistent with the viewpoint of Bartlett and Burton (2020) that education studies focus on the process of human growth and knowledge acquisition, I interviewed student teachers to gain insight into their interpretations to gendered Physical Sciences textbooks. I anticipated that through engagement in the study, they would grow and acquire knowledge on how to identify and deal with media assaults. Additionally, Bartlett and Burton (2020) suggest that learning in education necessitates a critical engagement and an interrogative approach as the researcher synthesises knowledge from other disciplines to explore how social factors such as gender, income, ethnicity, and life chances influence teaching and learning. Thus, I used CDA to explore how gender is represented in Physical Sciences textbooks and to understand from student teachers' interpretations how such gender portrayals I had identified using CDA could influence the teaching and learning of Physical Sciences. Examining these factors necessitated an appraisal of political and educational policies. Thus, I have provided an outline of the review of policies that the Department of Education put in place to improve gender equality in education material in section 1.2 of this chapter.

Their viewpoint supports the notion that considering the analytical discourses is necessary for understanding how these factors shape education and learning. Thus, my objective was to apply CDA as an analytical tool to showcase the potential effects of gender portrayals in selected textbooks on the instruction and understanding of Physical Sciences. Moreover, the involvement of student teachers in the study was to acquire unique insights as they are actively engaged in teaching Physical Sciences and utilise textbooks as their main source of content.

Transformative learning, as highlighted by both Leal Filho et al. (2023) and Hoveid et al. (2019), empowers students to engage in critical self-reflection and question their own beliefs. Furthermore, they alluded to the fact that the inclusion of diverse perspectives and individualised approaches from multiple fields when carrying out an educational study is paramount to ensure the sustainable advancement of individuals. Thus, I recruited student

teachers to reflect upon the gender portrayals in science textbooks so that they would be aware of their role in confronting gender prejudice (working with learners) presented by science texts, thereby reducing their effects. I expected that student teachers' insights would supply a spectrum of views on the gender topic, in addition to my appraisal. In keeping with Leal Filho et al. (2023), I anticipated that the student teachers would develop sustainably and potentially alter the science classrooms where they will be employed.

The purpose of the study was, therefore, first to investigate gender representations in selected Physical Sciences textbooks and why it was represented in such ways. Firstly, CDA was to be employed to analyse the selected Physical Sciences textbooks used to teach from grades 10 to 12 in South Africa. The data generated was meant to respond to “research questions 1 and 2” outlined in section 1.8 of this chapter.

Secondly, I engaged student teachers to find out how they would respond to my findings and how they planned to mediate the discouraging messages that texts could present. The interpretations from interviews were meant to respond to objectives and research questions 3 and 4, which sought to understand the “student teachers’ pedagogical responses to gender representations in selected textbooks and what informed their pedagogical responses”. In keeping with Bartlett and Burton (2020), I was eager to demonstrate how student teachers’ engagement in the study would improve their development and education. Bartlett and Burton (2020) advocate for educational research to extend beyond the classroom, emphasising the importance of exploring lifelong learning. I supposed that when student teachers respond to questions during interviews, they would recognise stereotypical messages embedded in texts more subtly. Hoveid et al. (2019) point out that educational research is a pragmatic action that is conducted both in and out of the school environment. These educational studies are conducted to comprehend why events occurred, anticipate what may come to pass in the future, and clarify why matters stand as they are and what has brought them to this point (p.8). Accordingly, research objective two was included to theorise why gender was represented the way it was in selected textbooks.

As I sought to generate data from student teachers, I included questions about the potential effects of the representation of gender in selected textbooks in the interview schedule. I expected that the Social Construction of Gender theories would provide insight into what drove the student teachers' interpretations, which aligned with research objective 4. I correlated the portrayal of gender in the studied textbooks to the portrayal of gender in the textbooks they

had encountered during their educational years. I did this to alert them to the value of counteracting the troubling messages from texts to learners while they were already engaging with learners during practice teaching.

This study engaged student teachers who are enrolled at the selected University in South Africa in the province of Kwa-Zulu Natal. Literature is scarce on student teachers as participants in the analyses of gender representations in Physical Sciences textbooks. The study then seeks to provide new insight and contribute to the ongoing literature about the student teachers' pedagogical responses to gender representations in Physical Sciences textbooks for female participation in STEM-related fields.

### **1.7 Significance of the study**

The findings of this study can help policymakers to set criteria for textbook authors, publishers and editors that consider gender equality. It will also inform the teachers about the importance of devising strategies to address stereotypes and gender inequalities that may be presented with knowledge in Physical Sciences textbooks. Science teachers evaluate the textbook catalogues released by the Department of Basic Education (DBE) annually to select textbooks that schools and sometimes parents buy for Physical Sciences learning. In Physical Sciences, sometimes it may seem impossible to avoid buying a textbook based on, for example, the portrayals of men only as scientists because they are usually used as examples of producers of knowledge in the concept taught. One example is Thomas Edison, who is used in the grade 12 Physical Sciences textbook as the inventor of the light bulb.

It is, therefore, imperative that teachers be made aware that prejudices in textbooks may not disappear immediately, but their stereotypic biases can be confronted and addressed in the classroom during Physical Sciences lesson presentations. Hence, the strategies that student teachers proposed to mediate gender representations in selected textbooks may shed light to other teachers on how to mediate discourse content that may be controversial in the textbooks. In this way, the teachers would bring safe environments for all learners' emotional and mental development during Physical Sciences teaching and learning. Physical Sciences teachers can draw upon the findings of this study to motivate girls to pursue STEM subjects and careers, which can also pave the way for a significant increase in the number of women who participate in STEM careers.

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 the Department of Basic Education (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 criterion that subject advisors consider is gender inclusivity (Pingel, 2010). Hence, the pedagogical responses of student teachers in this study will inform subject advisors about effective strategies that can be used to interpret symbols and language in textbook discourse. The findings can also empower them to justify their reports on why they did or did not approve samples of textbooks evaluated.

The findings of this study can also be useful to the curriculum designers for pre-service teachers to know how to prepare them to be mindful of biases and stereotypes that can be present in Physical sciences textbooks. In this way, pre-service teachers can learn how to find ways to mediate science knowledge in a manner that will attract girls to Physical Sciences classes so that they can pursue highly valued STEM-related careers that were previously male-dominated.

### **1.8 Critical questions of the study**

1. How is gender represented in selected Physical Sciences textbooks?
2. Why is gender represented in the ways it is in selected Physical Sciences textbooks?
3. What are student teachers' pedagogical responses to how gender is represented in selected Physical Sciences textbooks?
4. What informs student teachers' pedagogical responses to gender representations in selected Physical Sciences textbooks?

### **1.9 Objectives**

The objectives of this study are:

1. To analyse how gender is represented in selected Physical Sciences textbooks.
2. To examine the theoretical underpinnings for how gender is depicted in specific physical sciences textbooks.
3. To examine how student teachers adapt their teaching approaches when encountering gender representations within designated Physical Sciences textbooks.
4. To understand the reasons behind the pedagogical responses of student teachers in relation to gender representations found within the specified Physical Sciences instructional materials.

## **1.10 Overview of research design and methodology**

### **1.10.1 Research design**

This study followed the qualitative approach to gain an understanding of how gender is represented in selected science textbooks (Creswell & Poth, 2016). Researchers employ this technique to comprehend the underlying causes, perspectives, and impetuses (Creswell, Hanson, Clark Plano, & Morales, 2007). One of the methods of the 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 the construction of gender by interpreting words and images from selected Physical Sciences textbooks (Cohen, Manion & Morrison, 2013). I analysed how words and visual images are used and the context in which they are used to draw inferences about gender representations in selected science textbooks. This approach was appropriate for my research questions, which sought to understand representations of gender in selected science textbooks and the possible implications of these on learners as lifelong - learners. It also enabled me to understand the student teachers' pedagogical responses to gender representations in selected textbooks and what informed their responses.

### **1.10.2 Paradigm**

The critical paradigm informed the study as a guiding perspective. A research paradigm has been established as a joint system of accepted values and consensus amongst researchers regarding the interpretation and solution of issues (Anand et al., 2020). Opting for the critical paradigm made sense as it is directed towards critiquing and improving society, drawing from insights from all social sciences (Asghar, 2013). It is used to expose the social and cultural mechanisms that uphold subjugation and act as impediments to personal autonomy (Arnold, 2015). It aims to evaluate society's ideology with the aspiration to realise justice. The critical

paradigm seeks to question the perpetuation of disparities and prevailing ideologies in educational research, asserting that schooling serves the interests of those with power. It is the essential framework that detects powers or inclinations that bestow powerlessness on one faction and examines the legality of the dominant (Cohen, Manion & Morrison, 2007).

Applying Critical Discourse Analysis (CDA), I ascertained the inequities that pupils (as readers of selected Physical Sciences textbooks) are subjected to. Following my interviews, I trust that student teachers have developed an awareness of how textbooks can either encourage or impede learners regarding taking on STEM subjects, which will consequently affect their ability to engage in STEM-related fields in the future.

### **1.10.3 Sampling**

Purposive sampling was employed to select textbooks and student teachers as participants in the study. Tongco (2007, p. 147) explains that purposive sampling is a process of choosing participants from the population due to their predetermined qualities. The sample of this study included three textbooks of Physical Sciences that are included in the DBE's catalogue for prescribed textbooks and are used for teaching and learning Physical Sciences in South African schools.

I utilised purposive sampling to recruit ten student teachers for the study. This sample contained four female and six male student teachers from the University of Durban (pseudonym). I explained to recruits that to be eligible; applicants need to be enrolled at the University of Durban. To guarantee the availability of participants from the initiation to the termination of the study, I opted for student teachers in the second year of their academic program. The goal of recruiting ten participants was to find an appropriate quantity to ensure the acquisition of meaningful insights and a diversity of perspectives regarding the phenomenon studied.

### **1.10.4 Data generation**

CDA was employed, first to generate and analyse data from the selected textbooks. The constructs that were employed to analyse data that I collected from the sample are detailed in Table 4.2 in Chapter 4. The Analysis framework was derived from the works of Al Ghazali (2007), Machin and Mayr (2012), and Huckin (1997). Fairclough's (2013) stages of analysis provided the direction for the analysis process. For example, description of text (textual analysis) and processing (textual interpretation) answered research questions 1 and 3, i.e. "How is gender represented in selected Physical Sciences textbooks?" and "What are the student

teachers' pedagogical responses to gender representations in selected Physical Sciences textbooks". Social analysis responded to research questions 2 and 4, "Why is gender represented in the ways they do in selected Physical Sciences textbooks?" and "What informs the student teachers' pedagogical responses to these gender representations in selected Physical Sciences textbooks?". The CDA became an effective tool in revealing how power was conceptualised in terms of the lack of equality between men and women depicted in selected textbooks. Moreover, it was employed to demonstrate how power was perceived as an imbalanced capability to regulate the creation, dissemination, and consumption of texts.

In addition, interviews were engaged to authenticate the CDA findings through a triangulation approach. Denzin and Giardina (2020) assert that in the qualitative methodological approach, "...truth is socially constructed through politics of representation..." (p.6). To be more specific, this method of inquiry ensures that the voices and opinions of the individuals being studied can be meaningfully articulated. Student teachers' responses enabled me to respond to research question 3, which sought to comprehend their pedagogical responses to gender representations in Physical Sciences textbooks. Their interpretations illustrated that they are familiar with the phenomenon as they had been exposed by their teachers to similar textbooks during their schooling and their current lesson preparation and presentation (during practice teaching).

#### **1.10.5 Data analysis**

Before I could analyse the textbooks, I read them to find out if there were any gender representations as I had selected them because they were recommended by the textbook suppliers as textbooks that were commonly used. In alignment with the guidance of Fairclough (2013) and Huckin (1997) which prescribes that the primary phase of CDA should be textual analysis, I initiated the analysis by reading without bias to comprehend the text framing.

At first glance, I took screenshots of the parts concerning human participants to focus on those sections in my later, more in-depth analysis. Then, I engaged in the second stage of reading critically, termed by Huckin (1997) as "revisiting text" to evoke questions and visualise how it could have been worded differently. During textual processing, scrutinising the texts, I drew on CDA constructs in Table 4.2 to uncover how readers would perceive messages and visuals. I examined the ideological assumptions in written texts and visuals to see how each gender is affected in terms of power.

During my social analysis, which Fairclough (2013) identifies as the third process in examining text with CDA, I was informed by the theory of Social Construction of Gender. I was able to conclude who gains from the construction of gender in designated Physical Sciences textbooks. By employing Critical Theory, it was brought to light how the selected Physical Sciences textbooks acted as vehicles for sustaining hegemonic practices continually (Croucher & Cronn-Mills, 2014; Fraser & Jaeggi, 2018; Winkle-Wagner, Lee-Johnson, & Gaskew, 2018). By employing Feminist Post-Structuralist Discourse Analysis (FPDA), I was able to reasonably conclude that the chosen Physical Sciences textbooks actively advanced the idea of patriarchy. By adopting the FPDA framework, I was able to successfully demonstrate how language might have been purposely utilised to maintain and embolden hierarchical power.

Analysis of the interview data was conducted through the use of thematic analysis. It enabled me to identify and systematically arrange datasets to construct meaningful interpretations carefully (Braun & Clarke, 2012). Being driven by the theories that guide the study, I analysed deductively to formulate the codes (Maguire & Delahunt, 2017). The deductive approach became more relevant to me as I analysed the participants' interpretations to answer research question 3, which sought answers to "What are the student teachers' pedagogical responses to gender representations in selected Physical Sciences textbooks?" and research question 4, "What informs the student teachers' pedagogical responses?"

Consequently, in the findings chapter, I pasted the paragraphs, sentences and words from the participants' transcripts to show their interpretations and pedagogical responses to gender representations in Physical Sciences textbooks. Therefore, in this manner, an inductive approach was used, and this made the voices of participants heard as I extracted their interpretations from the transcripts and pasted them into the relevant findings chapter. The researcher implemented six stages of thematic analysis, including becoming acquainted with the data, creating initial codes, identifying preliminary themes, evaluating themes, defining themes, and composing the final report.

#### **1.10.6 Establishing trustworthiness in the Study**

I applied the trustworthiness criteria provided by Lincoln and Guba (1986) to the study to achieve rigour. They included considering factors such as validity, credibility, transferability, dependability, and confirmability.

To achieve credibility, the interviews were audio-taped to ensure that I listened to the respondents' narratives several times to avoid misinterpreting what was communicated. Credibility was also achieved through prolonged engagement, persistent observation, and triangulation (Gandhi & Singh, 2018). Persistent observation was employed during the analysis of texts and visual images during the CDA of textbooks. It enabled me to compare how visual images of women were portrayed differently from those of men. To minimise the influence of the researcher's personal bias, member checks were utilised. It involved providing the participants with the analysed and interpreted data, allowing them to confirm their satisfaction with the interpretation. To increase transferability, I have outlined the research design fully so that future researchers can repeat the study to verify the findings in a different context. To ensure confirmability (Wood & Kroger, 2000), I have kept the interview transcripts (in electronic storage encrypted with a password) that I used during analysis for the audit trail and to ensure they can be made available for reanalysis. To ensure dependability, I directly quoted the participant's interpretations to the thesis in the chapters where they were analysed and discussed to authenticate my analysis. I submitted my analysis to my critical friends and supervisors of the study several times and paid attention to critical comments to increase the dependability of the study, this is termed stepwise replication. I read the transcripts several times, coding data each time I read it. I have found the data dependable because results came out the same every time it was coded; this is termed code-recode strategy.

### **1.11 Ethical Considerations**

The ethical clearance was granted by the Humanities & Social Sciences Research Ethics Committee of the selected University on behalf of the registrar and is attached in the section of appendices. After recruiting the participants to the study through the Physical Sciences lecturer, I provided each recruited person with consent forms. I explained the consent form line by line and stressed that no one was forced to participate. Filling out the consent form was a form of declaration that each recruited person agreed freely to participate in the study (Mohd Arifin, 2018). All participants consented to audio-recorded interviews. Furthermore, I gave each recruited student teacher a letter that explained the purpose of the study and data generation strategies. In the letter, I also clarified that a participant could withdraw from the study at any stage as the participation was voluntary (Cohen, Manion, & Morrison, 2013).

To ensure anonymity and confidentiality, the participants' pseudonyms were used during the thesis write-up. The findings of the study are saved in my OneDrive, which is encrypted with

a password to ensure that they are safe. The hard copies were destroyed. The findings will, therefore, be kept in these password-encrypted electronic devices for five years and then disposed of.

### **1.12 The Structure of the Thesis**

The following is a breakdown of the eight chapters that make up this research project:

**In Chapter One**, the foundation for the study is laid out. I introduced chapter one by outlining the background of South African education to demonstrate how the policies of education before 1994 informed the curriculum. Moreover, Chapter 1 underscored how current South African education policy upholds textbooks as the main LTSM. The purpose, rationale, positionality of the researcher and relevance of the study were also explicitly stated. I have also introduced the research objective and research question. In the final section of chapter one, I presented a concise overview of the study's research design and ethical considerations.

**Chapter Two** discusses the literature that I reviewed to locate the study within the ongoing dialogue and to identify the research gaps. Both local and international literature were reviewed. The main themes that were reviewed in Chapter 2 include understanding of gender, gender representation in STEM, international strategies that were adopted to deal with gender discrimination and gender inequalities, the role of curriculum and textbooks in promoting stereotypes, textbooks as tools for socialisation through curriculum, the impact of gender in science textbooks in learners' conception of science, gender representations in textbooks, intersections of gender, class and race, and strategies used by teachers to deconstruct stereotypical messages in texts. I then indicated the implication of the literature to the study.

**Chapter Three** discusses the theoretical framing of my study. Horkheimers's Critical Theory, as a theoretical foundation for this research, brought to light Capitalistic dynamics embedded within social groups that bestow legitimacy on the subordination of one group whilst elevating the other (Fuchs, 2021; Horkheimer, 1972).

I also drew from Feminist Post-Structuralist Discourse Analysis with ideas of Butler (2011), which astutely demonstrates how women have been inadequately and inaccurately portrayed in discourse, and Baxter (2016), which explored the use of classroom discourse, texts, and other media representations of gender to amplify the voices of women that had previously been neglected, silenced, and excluded in discourse. By employing the framework of the Social Construction of Gender, as posited by West and Zimmerman (2009), a clearer understanding

was attained regarding the genesis of gender roles and their association with prevailing ideas of femininity and masculinity. In Chapter 3, I have explained how the Social Construction of Gender is slightly different from the Social Construction of Gender.

**Chapter 4** discusses the methodology that I employed to generate, present and analyse data. The study was qualitative in nature, located within the Critical paradigm. Purposive sampling was employed to select 3 Physical Sciences textbooks that are used to teach grades 10 to 12 in South African schools. Critical Discourse Analysis was employed to generate data from the selected textbooks. The study also engaged student teachers to get their insights on biases in selected texts and strategies that Physical Sciences teachers could employ to disrupt gender norms and stereotypes that may be prevalent in Physical Sciences textbooks. Face-to-face and telephonic interviews through WhatsApp voice messaging were employed to generate data from student teachers. Thematic analysis informed the analysis of participants' interview transcripts. Delineations of how rigour was achieved by following principles of trustworthiness are detailed in sub-section 4.9 of chapter 4. Ethical considerations are discussed in section 4.9.

Thematic analysis informed the analysis of participants' interview transcripts. I have detailed delineations of how rigour was achieved by following principles of trustworthiness in sub-section 4.9 of chapter 4. In section 4.10, I discuss how I considered ethics.

**Chapter 5** delves into the presentation and examination of the findings generated by utilising CDA. I organised conclusions into themes. In Table 4.2 of Chapter 4, I outlined the framework for analysis. I also outlined the theories of the study, which informed the analysis.

**Chapter 6** presents findings generated from interviews. I coded, categorised, and organised conclusions into themes through thematic analysis. I used the tenets of the Social Construction of Gender, Critical Theory and FPDA to make meaning to the study's analysis.

**Chapter 7** interpreted and discussed the findings I presented in Chapters 5 and 6. I used the themes I established in Chapters 5 and 6 as themes during the discussion of the findings.

In **Chapter 8**, I presented an overview of the chapters, how the study's theoretical framework answered research questions 2 and 4, the research's contribution to knowledge, limitations and implications of the study, and suggestions for future research and synthesis.

### **1.13 Conclusion**

In this chapter, I introduced the study by emphasising the importance of textbooks and then gave an overview of South African education to show how governmental edicts were employed before 1994 to create a foundation for textbook writing. I have also discussed the rationale for the study, which I have linked to the problem statement. I have shown how the study will benefit all the stakeholders involved in textbook production, selection and use for teaching and learning. Thoroughly outlined in this research are critical questions which I correlated to the objectives of the investigation. I also expounded on the research design and approach. Following this, I delivered a concise description of the ethical protocol I adhered to throughout my study and the researcher's positionality. The chapter concluded with an outline of the framework of my thesis and a conclusion to the chapter.

## **Chapter 2: Literature Review**

### **2.1 Introduction**

This chapter synthesises the literature on gender in Physical Sciences textbooks and student teachers' pedagogical responses to gender depictions in textbooks. This review starts with highlighting the functions of textbooks and their role in socialising children. It then discusses the political and ideological role of textbooks. I have also discussed the understanding of gender and then scrutinised previous studies on gender representations in textbooks. It is then followed by analysing the various criteria scholars use to assess whether gender is disproportionately represented, such as differences in occupational gender roles. This review also examines published works that offer perspectives on the historical context of gender representation in STEM-related fields.

Additionally, I assess and combine the global strategies that were conducted to tackle gender disparities in science education. These include the United Nations Education for All (EFA) goals and cooperation among the United Nations Educational, Scientific and Cultural Organization and other non-governmental organisations to promote gender equality in science education. I also analysed and discussed the inclusion of the CEDAW.

I further explore the literature on how textbooks can be used as tools to promote stereotypes through hidden and intended curricula. This chapter ends by analysing the influence of gender in science texts on learners' perception of science and the implications of the literature review for the study. In the next section, I discuss the functions of textbooks.

### **2.2 Functions of textbooks**

Textbooks not only enhance the intellect of learners but also increase their cultural understanding as members of society (Tomalin & Stempleski, 2013). Textbooks are widely seen as catalysts for change in many cultures, as they express culture, values, and accepted social norms (Mirza, 2006). It has been observed that the perception of gender and its impact on the self-perception, conduct, ambitions, and anticipations of individuals are heavily influenced by the depictions of men and women found in educational materials, as stated by Biemmi (2015).

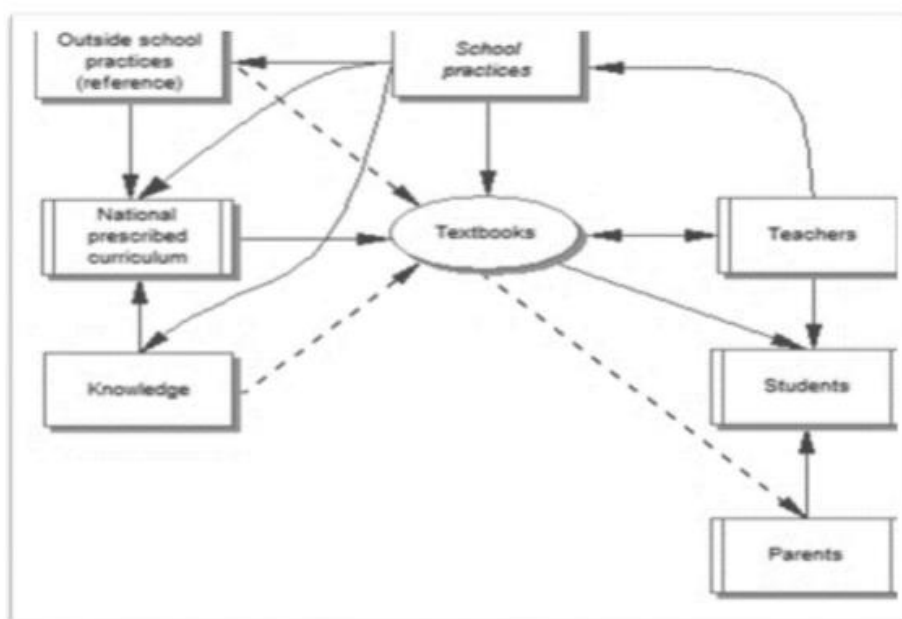
According to Foster (2011), textbooks are widely viewed as physical manifestations of a nation's efforts to promulgate and support conceptions of nationhood and national identity.

UNESCO (2011) contends that textbooks are generally highly valued in nation-states, as they can be utilised to exalt the nation itself and the ruling classes within the nation or to denigrate minority groups. It further states that textbooks communicate political ideologies and justify political trends that the nation follows by permeating them with historical legitimacy. Taking into consideration the fact that textbooks are a key component of teaching, they must be constructed in a way that is sensitive and responsive to the requirements of students (Pingel, 2010).

Repoussi and Tutiaux-Guillon (2010) authoritatively contend that nations leverage textbooks as a means of exercising power and disseminating cultures and ideologies in the process. Furthermore, Pingel (2010) observes that along with conveying social expectations and expectations of interacting with others, unbiased textbooks can be utilised to propagate intercontinental understanding.

According to Bruillard (2011), textbooks have four functions, the first of which is to act as a “referential”. He points out that this implies that the textbook occasionally serves as the main document that gives comprehensive educational content. In his statement, he emphasizes the importance of textbooks in facilitating teaching methods and exercises. He stresses that textbooks have an ideological and cultural purpose, aiding in the processes of socialisation and acculturation. He concludes by noting that textbooks have a documentary function, granting students access to archives and symbols that nurture their critical thinking capacities.

Figure 2.1 below presents Bruillard’s (2011) flow diagram that illustrates the mechanism by which textbooks, in their capacity as the national curriculum, direct the pedagogical process by dictating to teachers what needs to be taught and to learners what needs to be learned.



Keys: Dotted lines represent blurred relationships

Arrows represent determining relationships

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

Keys: Dotted lines represent blurred relationships

Arrows represent determining relationships.

Textbooks play a considerable role in the formation of what learners evolve into beyond the classroom walls. There is a symbiotic correlation between textbooks and teachers. Learners can find all the knowledge areas the Department of Basic Education deems essential in the textbook. Teachers typically transmit this knowledge to students without questioning it.

Arrows demonstrate that teachers must share the textbook knowledge without alteration, regardless of its obscurity. Textbooks might contribute to a vague understanding of the desired identity for students after they finish school. Texts can also fulfil an expressive function in addition to other functions (Bazerman, 2003). According to Bazerman (2003), the reader must unearth how the author has employed text to convey his emotions, for example, through authoritative assertions. It is evident from Cap (2016) that textual communication necessitates the use of language that is intuitive to the receiver, thus demonstrating its vocative nature. He goes on to point out the aesthetic role, where language is used to generate a congenial atmosphere with the reader rather than conveying foreign knowledge.

Besides the functions of textbooks that are illuminated above, texts are used as vehicles to transmit cultural values and norms. In the next section, I discuss the role of textbooks in socialising children.

### **2.3 Textbooks as tools for socialisation**

School curricula, including textbooks, may enforce the reproduction of gender-linked division of labour, resulting in the recreation of an unequal society (Cárcamo et al., 2021). Hence, textbooks play a significant role in distributing the norms required to maintain societal inequality through teaching the hidden curriculum (Kamasak et al., 2019). Inherent to the hidden curriculum are the stereotypes that maintain powerful classes in society (Hansson, 2018). Sriwimon and Zilli (2017) argue that language in discourse manipulates the author's audience, making them believe that the intention is to inform. They continue to mention that the text creators may use the curriculum to obscure reality. The authors can intentionally choose words and signs whose surface meaning differs from the underlying meaning.

### **2.4 The significance of textbooks in shaping the curriculum**

The significance and impact of textbooks within the educational curriculum cannot be overstated. These essential tools serve as the backbone of structured learning, providing students with a wealth of knowledge and information to supplement their classroom studies. Textbooks (Eng et al., 2011) utilise language intricately connected to ideologies, impacting teaching and learning. Lee (2014) recommends that textbook users interpret the hidden curriculum in textbooks to uncover the construction of gender to determine which gender is portrayed in a manner that suggests backgrounding. Therefore, it is imperative to provide a discussion of what the hidden curriculum means and how it is different from the formal school curriculum. The debate about the importance of the hidden curriculum helps us understand how political and social structures use textbooks as the vessels of both the intended and hidden curriculum.

#### **2.4.1 Textbooks as a component of formal (intended) curriculum**

Within the realm of formal curriculum, textbooks play a crucial and intentional role by serving as a prescribed and systematic source of educational material that is meant to direct and organise the learning process in a formal educational setting. Kentli (2009) and Khoza and Fomunyam (2020) view the intended curriculum as comprehensive, conscious, and planned,

usually taking the shape of a succession of lessons with precise objectives. In the course of lessons, learners acquire knowledge and skills to achieve intended outcomes (Department of Education, 2010). Hoadley and Jansen (2009) and Mpungose (2020) hold the opinion that the designated curriculum may be established (by curriculum designers) at multiple levels, such as the national level, provincial regulations, and Annual Teaching Plans (ATPs). ATPs supply comprehensive outlines of the content that teachers must address at each grade level and the allotted duration for each subject. National curriculum prescripts are essential because they “standardise what learners must learn throughout the country” (Hoadley & Jansen, 2009, p. 30). As textbooks contain structured knowledge for the relevant grade and subject (Mpungose, 2020), they form a component of formal school curricula, thus helping to reach the intended curriculum objectives in various countries (Foulds, 2013; Lawrence, 2011). Here in South Africa, the CAPS document (in varied areas) details the topics teachers must consider for a precise grade curriculum, but the content curriculum is outlined in textbooks, and educators ought to utilise several textbooks to guarantee that all content is included (DBE, 2011). The internet is readily available to children in most countries to browse e-books on different websites. However, in small towns and rural areas, textbooks remain the main LTSM because they serve as an essential repository of knowledge that teachers and learners rely on and have proven to produce excellent results, especially in matric final examinations (Motshekga, 2013a).

Nakagawa and Wotipka (2016) mention that textbooks guide teaching and learning because they provide detailed subject matter. Hence, teachers regard them as the primary source of information (Chiponda & Wassermann, 2015). Topics teachers must consider for curriculum planning are summarised in the CAPS document in South African education (Motshekga, 2013b), and most textbook authors have ensured that they include all the curriculum components in their textbooks. The textbook organises all sections and themes of content so that all work taught by teachers in the term is arranged together, which aligns with the CAPS document's requirements (DBE, 2011). Therefore, textbooks are reliable in guiding the teaching and learning processes (Brugelles & Cromer, 2009). Additionally, they enhance the effectiveness of teaching and learning (Motshekga, 2013a) because their illustrations, especially in scientific fields, facilitate comprehension of the learning material. Lee (2014) advocates that despite being vessels of the intended curriculum, textbooks serve as a form of the hidden curriculum, shaping learners' values, attitudes, and social skills. In the next

paragraph, I discuss how, through the hidden curriculum, writers may unconsciously encode language in textbooks with words and images that can shape the beliefs and values of learners.

#### **2.4.2 Textbooks as a vehicle for transmitting the hidden curriculum**

The textbook operates as a platform for the transmission of the implicit educational norms and principles that are integrated into the system, often termed the hidden curriculum. Kentli (2009) and Gunawan et al. (2018) agree that the hidden curriculum includes that which is not openly prescribed for the learners to learn, nevertheless, they learn it. They mention that the hidden curriculum is usually implicit in textbooks, teacher manuals and the social environment provided by the school. It reinforces dominant beliefs, values and norms among learners. Hence, the hidden curriculum is designed such that it is not obvious or conscious to the teachers as well as the learners. However, it may channel learners to unconsciously learn to see the world in a particular way (Neve & Collett, 2018). Therefore, possibly the hidden curriculum in textbooks demonstrated by the roles assigned to men and women (as the reflection of what happens in society) may channel boys to take practical subjects different from those taken by girls.

The findings of the study by Pillay and Maistry (2018) illustrate that the hidden curriculum can exhibit prejudices against particular gender groups. In their analysis of Business Studies textbooks, women were implicitly socialised to believe that men are superior and women are subordinate by mentioning men first. The scholarly discourse presented by Phillips and Clarke (2012) highlights the crucial role of textbooks in shaping children's personal development, serving as a concealed yet powerful means of curriculum that heavily influences their self-image and ultimately affects their academic and career choices. The images in textbooks provide learners with sources of references for career choices (Phillips & Clarke, 2012). Hence, making women invisible in curricula is a form of marginalisation. Ar (2015) recommends textual analysis to determine how the use of language in textbooks impacts society.

It is, therefore, clear that the hidden curriculum in textbooks has power over learners' decisions on whether they remain in STEM-based classes during and after schooling. Consequently, textbooks must be investigated to determine how the hidden curriculum in words, phrases and symbols used unconsciously channel learners in STEM-based classes, specifically Physical Sciences.

## 2.5 Political and ideological role of textbooks

Textbook production has been the subject of much debate, which Apple and Christian-Smith (1991, p.1) refer to as "the politics of the textbook". They are not only limited to being referential material for the classroom. Instead, they are utilised by political systems to propagate their doctrine widely. As suggested by Chiponda and Wassermann (2015) and Apple and Christian-Smith (1991), the manufacturing of textbooks is a delicate political undertaking that concerns the selection of knowledge from a broader scope to be featured in the text. The political debate centres around whose opinion should be taken into consideration and be deemed legitimate.

Apple (2014) proposes that textbooks are not unbiased but rather the consequence of intricate power struggles between different social factions. It is, therefore, the knowledge of those in power that is represented in the official school curriculum. Following Fairclough (2013), syntactical characteristics such as metaphors, prescriptive suppositions, and dialogue can be emblematic. He further suggests that ideology can be subliminally concealed in "unquestioned presuppositions". He, therefore, proposes that appropriate theories be employed to reveal how power is conceptualised in terms of the lack of equality between groups in a society.

According to Chiponda and Wassermann (2015) and Fitzgibbon (2013), those viewed as weak in terms of both social and economic standing are habitually denied recognition and obstructed from having their knowledge featured in textbooks. The distribution of knowledge is significantly involved in the social apportioning of power. Apple (2014) posits that "the power of knowledge has to struggle to exert itself in two dimensions" (p.180). The first is to constrain reality to that which is discernible by constructing it as a "discursive construct" that conceals its arbitrariness and inadequacy. The second dimension lies in having the created truth, formulated through discourse and politics, being acknowledged as valid by those who would not benefit from its acceptance. Hence, the struggle is not only in creating society's norms but also in finding means of circulating them as the truth that becomes acceptable to everyone.

Apple (2014) asserted that textbooks are created, developed, and written by real people with agendas. For example, Taki's (2008) study using the CDA found the Iranian textbooks that were used to teach English as a Second Language (ESL) to represent the discourse of the Western economy and consumer society. He noted that the international textbook depicted humans either at work, classroom or on vacation in the USA.

He mentioned that the studied textbook had a dual agenda, i.e. economic and political. They mentioned that studied textbooks served the economic function by promoting the ideals of neo-liberalism. Accordingly, they held that the studied textbooks were not impartial in the way English skills, knowledge and capabilities were communicated. Instead, they mirrored the discourses of the developed free-market Western economies.

He also concluded that textbook discourses were entrenched in the historical legacy of colonialism, and this implied political function. For example, he shows that the underlying meaning detected through analysis was the promotion of the so-called globalisation in which all countries, companies, and markets are brought into line with certain standards set by corporate America and corporate Europe. They assumed that this would give those corporate powers unfettered access to the world's five billion consumers.

Similarly, Shah and Pathan (2016) also found Iranian textbooks featuring a preponderance of English language content that promoted Western culture. They regarded the discursive construct in studied textbooks as neglecting learners' culture, religion, and traditions to implicitly persuade learners to take their heritage as the universally unacceptable norm. They claimed that Western Capitalism utilises textbooks to market their commodities in non-Western regions. For example, they mentioned that Iranian textbooks featured Western products in glossy pictures. They also noted that Iranian indigenous knowledge was not featured in studied textbooks. They concluded that the authors had a hidden agenda to westernise the learners and entice them to accept Western culture as an acceptable norm.

Multiple scholarly investigations have demonstrated that people of colour, women, and other disadvantaged groups in the United States have repeatedly tried to have their knowledge and histories incorporated into the school curriculum (Apple, 1991; Fitzgibbon, 2013 & Chiponda & Wassermann, 2015). However, it is the cognisance and the chronicles of the influential groups that are included in textbooks. As a result, those with less power are typically subjected to prejudice and excluded. Apple and Christian-Smith (1991) argued that textbooks are heavily centred around the knowledge of those in power, with the less influential being only covered in the context of the dominating groups. Maistry and David (2017) corroborate this standpoint, emphasizing that political systems utilise textbooks to conserve and reinforce their ideologies.

It is suggested that the prevailing social and political situation in South Africa may be depicted in school textbooks that are intended to advance certain agendas. They maintain that textbooks can be used as instruments of propaganda to promote ideals of Capitalism. Shah and Pathan

(2016) contend that Pakistani textbooks were utilised to disseminate the ideology of Western culture and values to Westernise the learners. The overriding message contained in the studied textbooks was secular and liberal, completely ignoring any religious or cultural values of the child. It is stressed that English's purpose in the world is to service foreign policy, protecting and reinforcing the British and American presence in other countries and initiating a demand for Anglo-American products, services and ideas. This task is accomplished by advancing the English language internationally and disseminating textbooks containing English culture, ideology and values. It was alleged that scholarly texts propagate a culture that is almost exclusively American and British. The abundance of such culture in ESL textbooks creates a barrier between the young students and their own culture and values, leading to a generation of people who can better serve those in power. Below, I present and discuss the literature that demonstrates the history of textbook evaluation and research.

## **2.6 The History of textbook evaluation and research**

Morgan (2012) emphatically highlights that textbook research was designed to expunge stereotypes from the reading material children consume to provide them with a more profound knowledge of distant societies. He emphasises that a proper review of textbooks is instrumental in dissipating partiality, misstatements, and hostile messages. According to Smith (2010), after the Second World War, countries which were part of the League of Nations initiated an international programme for the review and comparison of textbooks as an academic pursuit. Furthermore, he highlights that the League of Nations created and implemented tactics for revising and eliminating biased images and confronting contentious matters in educational materials. This initiative also encompassed rectifying representations which illustrated disparities between the genders (Smith, 2010). During the decade of the 1970s, UNESCO initiated an appraisal of reading materials to recognise and ameliorate any sexism and gender stereotyping that was present (Pingel, 2010).

As early as the 1970s, the American Psychological Association and other major textbook companies began to devise directives to produce non-sexist books to ensure equitable representations of both genders within the curriculum, according to Sadker and Sadker (2010). These strategies led to a remarkable achievement in the production of more gender-balanced textbooks. UNESCO (2011) reports that a research programme on the image of women was launched consequent to the "1980 Copenhagen World Conference of the United Nations" for women. Discoveries made from this programme indicated sexism in textbooks that overlooked

the various roles men and women play in society. These conclusions refuted the former analysis of Sadker and Sadker (2010), which demonstrated a higher number of gender-balanced books by 2010.

According to Foster (2011), textbooks are widely viewed as physical manifestations of a nation's efforts to promulgate and support conceptions of nationhood and national identity. UNESCO (2011) contends that textbooks are generally highly valued in nation-states, as they can be utilised to exalt the nation itself and the ruling classes within the nation or to denigrate minority groups. It further states that textbooks communicate political ideologies and justify political trends that the nation follows by permeating them with historical legitimacy. Taking into consideration the fact that textbooks are a key component of teaching, they must be constructed in a way that is sensitive and responsive to the requirements of students (Pingel, 2010).

According to Repoussi and Tutiaux-Guillon (2010), nations consider textbooks as a tool to exercise power, thereby disseminating cultures and ideologies. Repoussi and Tutiaux-Guillon (2010) authoritatively contend that nations leverage textbooks as a means of exercising power and disseminating cultures and ideologies in the process. Furthermore, Pingel (2010) observes that along with conveying social expectations and expectations of interacting with others, unbiased textbooks can be utilised to propagate intercontinental understanding. Morgan (2012) emphatically highlights that textbook research was designed to expunge stereotypes from the reading material children consume to provide them with a more profound knowledge of distant societies. He emphasises that a proper review of textbooks will be instrumental in dissipating partiality, misstatements, and hostile messages.

## **2.7 People's misconceptions of gender**

The distinction between sex and gender is frequently misunderstood. Unfortunately, many people have not grasped that these are different concepts. As stated by Muehlenhard and Peterson (2011), the biological aspect of sex implies that the distinctions between men and women are predetermined and unchangeable. In other words, one's "sex" can be defined by his or her physical anatomy, hormones and chromosomes (Erickson-Schroth & Jacobs, 2017; Muehlenhard & Peterson, 2011). These characteristics are used to establish them as either a boy or girl, male, female or intersex, which involves a mix of male and female characteristics (Erickson-Schroth & Jacobs, 2017). Although related, "gender" and "sex" are not synonymous (Torgimson & Minson, 2005).

Conversely, gender is concerned with conventional societal roles, behaviours and activities that are expected of men and women. In many cultures, gender is seen as a spectrum rather than a dichotomous entity (Connell, 2009). As elucidated by Connell (2009), the construct of gender encompasses the complex and nuanced manner in which human society grapples with the corporeal existence of individuals, precipitating diverse and far-reaching ramifications for our realities and communal destiny. Likewise, as put forth by Muehlenhard and Peterson (2011), gender can encompass a diverse range of behavioural, cultural, and psychological attributes that are frequently associated with one's biological sex. This notion agrees with Torgrimson and Minson (2005) that gender and sex are related but not synonymous.

Societal customs of socialising children are distinctive among cultures. As highlighted by Connell (2009), in Australia, fathers are inclined to guide their sons towards competitive sports to demonstrate physical predominance. Boys are compelled to display courage and toughness. Otherwise, they will be seen as a sissy. Violence is seen as a social tool. Traditionally, boys from lower-income backgrounds are typically recruited into occupations that necessitate the deployment of physical strength, such as law enforcement, military service, private defence, and professional athletics. By contrast, women are usually recruited into professions that aim to rectify the consequences of violence, such as nursing, psychology and social work (Ndlovu, 2019; Pillay & Maistry, 2018).

Connell (2009) proposes that understanding "modern gender" involves acknowledging that it is not a natural characteristic but a result of societal constructs and the hierarchical organization of current societies. These constructs are designed to grant recognition and identity but can also be sources of discrimination and injustice. She persists in emphasising that gender is commonly associated with prejudice, superstition, and untruths. She highlights the reality that male-favouring power structures exist in most societies globally to the disadvantage of women. It follows, then, that gender is comprised of components such as power, sexuality and how individuals are perceived in the professional setting. Connell (2009) proposes that gender be understood as a social structure and not the product of biology alone. Details on how gender is socially constructed are discussed in Chapter 3 of this study.

This background information on how people can define gender or confuse gender and sex alerted me to infuse the question that assesses student teachers' understanding of gender in the interview schedule. During the interviews, I expected the participants to not only

evaluate their knowledge of gender but also to become aware of any misconceptions they may have. The subsequent portion entails an exposition of the literature, empowering me to carve out a unique niche for my research.

## **2.8 Representation of gender in textbooks**

The representation of gender in school instructional material like textbooks has been an ongoing subject of concern. Through the implementation of a combination of qualitative and quantitative methods, Barton and Sakwa (2012) ascertained that textbooks utilised for English Second Language (ESL) instruction in Ugandan secondary schools served to reinforce the existing stereotypes present in society. Per Porecca's framework, the researchers first executed quantitative data analysis, followed by qualitative analysis via CDA. The results yielded the finding that positive women role models are under-represented, and the language of the text is not gender inclusive. They argue that ESL textbooks demonstrate gender bias with a disproportionate level of male representation and a tendency to depict women stereotypically. Generally, the status of women tends to be lower when compared to men, who typically occupy more influential roles and have more varied job opportunities.

Supplementing the conclusions of Barton and Sakwa (2012), Lee and Chin (2021) suggested that the paucity of women representation in texts can have a detrimental effect on girls' development, aspirations and the choices they make regarding their studies and occupations. This view corroborates Cairns and Inglis's (1989) finding, which disagreed with the explanation that the lack of women representation in 9 out of 10 textbooks analysed was due to a shortage of historical documents. Conversely, they claimed that the patriarchal norms of their society influenced authors and publishers.

Applying the content analysis method in combination with socialisation theory, Foroutan (2012) undertook a correlative study in Iran to assess if and to what extent the languages utilised in educational materials are intertwined with gender characteristics displayed in the education system. However, he sought to explore the designs correlated to portraying male and female genders in the books via elements like images, names, pronouns and keywords as per gender. The trend identified in his analysis predominantly favours males over females in most of the conclusions drawn. For instance, a disproportionately large number of images, titles, pronouns and search terms were of the male gender, with the female gender consequently representing a conspicuously lower portion of the total. The research indicated that even though men continue to be the primary gender in language textbooks, the amount of their power changes according

to the language's difficulty. Following extensive analysis, they concluded that social and ideological elements were the predominant causes of the gender representations in favour of men.

As Lee and Chin (2021) noted recently, textbooks are not just for educational purposes but also play a role in creating gender perceptions and expectations among young children. These authors vehemently emphasise the idea that the illustrations in textbooks serve as a vehicle for communicating cultural values and modelling appropriate actions, thus effectively facilitating the early gender role socialisation of little ones. Novosel (2015) used a hidden curriculum as the theory to ascertain how gender representations and depictions were represented in English as Foreign Language (EFL) textbooks. The sample comprised South Africa, Croatia, Russia, and England textbooks. Criteria for analysis included counting occurrences of men versus women; using personal pronouns such as he, his, him, himself, versus she, her, hers, herself; masculine pronouns and the noun 'man' as the generic. The analysis also covered the depiction of genders in occupational roles. The results demonstrated that in all countries (including South Africa) except for England, men outnumbered women in portrayals. These results were similar to the findings of Pillay (2017), who conducted her study in four SADC countries, one of which was South Africa. In all textbooks that she studied, the use of male pronouns also outnumbered female pronouns. Additionally, the authors of all textbooks utilised the term 'man' at least five times, whereas no generic nouns for women were present. In Novosel's (2015) study, the words mother and wife were used more than the words father and husband. Lastly, in the criterion of portraying genders in occupational roles, more men than women were depicted in these roles in South African textbooks, both in Novosel's (2015) and Pillay's (2017) studies.

Ndlovu's (2019) research revealed that the grade 12 Physical Sciences textbook perpetuated the marginalisation of female scientists through its text and visuals. The textbook pages showed 19 scientists as examples of knowledge construction. All these scientists were men, reinforcing the common notion that Physical Sciences is masculine.

Her findings concurred with what had earlier been discovered by D'Souza (2015) as evidence of continuing assaults in media, causing girls to lose self-esteem and ultimately impacting their science academic performance negatively. However, Ndlovu (2019) found that texts and visuals represented women as scientists in the Natural Sciences textbook. However, their presence was limited, as visuals portrayed them in a manner that illustrated them as isolated while working. Where the text cited names, the surnames were omitted or depicted women and

girls in activities that rehash the stereotype of women in activities that restrict them to local and domestic realms. In contrast, boys and men were frequently engaged in risky endeavours, boldly exploring beyond the planet, and treated with respect by using their full names and surnames. The researcher discerned these portrayals as a blatant prejudicial act towards women.

These studies demonstrate that several scholars of gender have conducted considerable research to investigate gender representations in school textbooks. Novosel (2015) studied gender representation in English textbooks, while Pillay (2017) explored gender construction within Business Studies textbooks. Ndlovu (2019) explored science textbooks, including Natural Sciences from the elementary stages of schooling, Life Sciences, and Physical Sciences from the Further Education and Training phase. Ndlovu's (2019) analysis of the textbooks demonstrated that women were marginalised, with them being portrayed in traditional roles or carrying lightweight objects, while the same textbooks represented men going on planetary journeys and producing scientific knowledge. All the studies mentioned above were limited to the researcher's analysis. There was no involvement of any human participants. This review demonstrated a variety of ways in which textbook depictions sidelined women to the margins, such as stereotypes, dissimilarities in occupational gender roles, and disparities in the number of images depicting men and women. Subsequently, the following sections will thoroughly examine the outcomes of reviewing the literature to investigate the portrayal of gender in these categories. The following section discusses gender differences in occupational roles.

### **2.8.1 Gender differences in occupational roles**

Elizabeth Gould (1992) found that society perpetuates occupational sex segregation through subtle forms of socialisation. She highlighted how society assigns specific job responsibilities to men and women for them to identify with. Barbara Wootton (1997) reports that scholars of gender found gender differentiation in occupational roles dated to the early 1900s. Wootton (1997) tells us that in the 1970s, different countries and organisations enacted laws to inhibit sex discrimination in labour force participation to reduce gender stereotyping in employment. Gould (1992) and Wootton (1997) found a gradual increase of women in the labour force between the 1970s and 1980s. Later, Wootton's (1997) study found that women were still overrepresented in clerical and services while most men held positions in craft, operator, and labour. Similarly, Pratto et al. (1997) observed that men largely filled positions that widened

the gender gap. They found that the process of hiring was determined by gender-based stereotypes, which all constituted bias.

Ten years later, Rona, Fear, Hull, and Wessely's (2007) study showed that although the participation of women in the labour force increased drastically, with women permeating the previously male-dominated industry, women had dual roles. They had to look after the homes and go to work. Furthermore, women still experience gender discrimination and sexual harassment in workplaces. As March et al. (2016) contend, the gender roles of masculinity and femininity in Australia not only categorise which jobs are suitable for each gender but also prescribe behavioural expectations for men and women. By contrast, the masculine gender was firmly correlated with employment, while domestic duties were seen as the role of the feminine gender, as noted by March et al. (2016).

As elucidated by Holmes and Schnurr (2006) and Holmes (2009), it is improbable to avoid gender roles in the professional setting. They claim that we all develop gender roles and form gender identities as we engage with colleagues. In their view, one of the gender roles is that of a leader in the workplace, traditionally seen as a role for men more than women in many societies. They claim that despite the progress made in increasing the representation of women professionals in the workplace, most upper-level management positions in many nations remain dominated by men. Holmes (2009) demonstrates that the 2006 New Zealand census indicated that less than 4 per cent of business directors are women. The CEOs of 26 New Zealand government departments were men, while only nine were women. Therefore, examining the upper echelons of the professional realm, it is evident that women tend to align themselves in healthcare, education, and social services. Maistry and Pillay (2014) argue that occupational roles are predominantly gender defined.

Through their exploration of gender representations in recent Business Studies textbooks in South Africa, Maistry and Pillay (2014) found that textbook depictions represented only men in executive positions. They found women often relegated to comparatively low occupations in both status and remuneration. After meticulous analysis, they concluded that when exposing children to media that solely illustrates men as influential figures, there is a strong probability that they will assume that the highest-level positions are entirely off-limits to all but men. With this study emphasizing gender representation in Physical Sciences and encouraging learners to pursue STEM-related fields, the next section will review the literature demonstrating gender representation in STEM-related fields.

### **2.8.2 Gender representation in STEM-related fields**

There's a growing concern that women and those with disabilities continue to be under-represented in Science, Technology, Engineering and Mathematics (STEM) occupations in most parts of the world despite the increase in STEM careers. The study by Haramis (2017) mentioned that although the number of STEM careers in the United States is growing significantly, there is a lack of diversity among STEM majors, particularly regarding women and minority groups. The STEM fields were traditionally considered male-dominated in the United States before the 1980s (Cheryan et al., 2017). The literature suggests that men continue to outnumber women in these fields even today (Clark Blickenstaff, 2005; Cortes & Pan, 2018; Hill, Corbett, & St Rose, 2010). Similarly, Idahosa and Mkhize (2021) found that although the number of human participants in STEM fields has grown enormously in South Africa, it remains skewed towards men. The underrepresentation of women is a notable predicament as the existing gender portrayals in STEM fields serve as a benchmark for students to evaluate potential occupations based on their gender identities (Schiebinger, 2000). It is, therefore, necessary to investigate the curriculum resources (including textbooks) to determine their influence on school girls' and boys' decision to pursue STEM-related courses after schooling, which paves the way for their representation in STEM professions. Striking the balance in gender representations in the STEM fields will increase diversity in the workforce and possibly achieve positive economic growth (Botella et al., 2019).

The studies of Hill et al. (2010) and Cheryan et al. (2017) show that gender differences in interest in science courses become evident before tertiary education. Makarova, Aeschlimann, and Herzog (2016) also observed (in Switzerland) the gender gap in STEM subjects in favour of men. Early research studies reveal the general belief that science disciplines had previously been recruiting exclusively white men, and this had not only deprived the nations of the talents of women of all colour but men of colour as well (Cheryan et al., 2017; Seymour & Hewitt, 1997). Additionally, the scarcity of science undergraduates and graduates was explicitly noted in the US and Malaysia (Daempfle, 2003; Goy et al., 2018; O'Neil & Richards, 2018; Seymour & Hewitt, 1997).

The study of Seymour and Hewitt (1997) in the US and that of Goy et al. (2018) in Malaysia found that before the 1980s, the science disciplines encountered a decline in percentages of students entering Mathematics and Physical Sciences based majors. They state that the enormous decrease was evident in Mathematics and Physical Sciences. The findings revealed

that few women enrolled as students in Mathematics and Physical Sciences majors in both instances. The growing reluctance of women to pursue STEM was interpreted as an indicator of the loss of crucial role models for women in STEM disciplines in the future. These results coincide with what Makarova et al. (2016, p. 1) who mentioned that “Women have a significantly higher dropout rate compared to men, leading to a lower representation of women in the science pipeline”. These studies illuminate that the under-representation of women in STEM, which leads to gender inequities in the workforce could also be caused by the shortage of women Physical Sciences teachers because they serve as role models to girls that “science is for all”. This literature, therefore, applies to this study as it also identifies student teachers as critical resources in STEM education and seeks to involve them as participants to equip them (as future teachers) with practical strategies to mediate discourse content to learners during science teaching and learning to retain and possibly increase girls and boys who show interest in STEM subjects.

Makarova et al. (2016) also illustrate a shift from girl learners who leak from the science pipeline during schooling to an increasing number of girl learners who pursue STEM subjects until they graduate in high school but switch to non-STEM majors when they enter tertiary institutions. These findings are similar to what had also been concluded by Ellis et al. (2016) in the US that most male students persisted in STEM courses until graduation while very few female students remained in the STEM pipeline. What is remarkable about such learners is that, in some cases, they would have passed with distinctions in STEM subjects, including Physical Sciences. Nevertheless, they would decide to pursue non-STEM degrees after schooling, leading to a decline in the number of individuals pursuing advanced STEM degrees after education. Beede et al. (2011) revealed a different perspective on the gender gap in STEM fields. They observe that other women would pursue STEM degrees after schooling but choose non-STEM occupations after graduation despite the high salaries earned in STEM jobs. Their study in the US found that only 24% of women worked in STEM jobs in 2009.

This evidence suggests a systemic bias against women in STEM-related industries, which I found concerning. Why would one persevere up to attaining a STEM qualification with all the sacrifices that accompany those years of education, then decide to either enrol for a non-STEM course at tertiary or pursue the STEM-based course until graduation but look for a job in non-STEM occupations with no training and expertise, and possibly lower salary? Could physical sciences textbooks as a means of curriculum dissemination contribute to the chilly climate during STEM teaching and learning? This study, therefore, sought to find out, from student

teachers' perspective, whether textbooks play a significant role in pushing women out of the science pipeline. In the next section, I review the literature on the role of curriculum and textbooks in promoting stereotypes.

### **2.8.3 The role of curriculum and textbooks in promoting stereotypes**

Globally, several scholars have investigated how texts represent Western culture and stereotypes and how they impact the lives of men and women in society (Baxter, 2018; Dore, 2020). Some textbooks disseminate messages reinforcing male power and control (Pillay & Maistry, 2018). Recent textbook studies still depict men as capable and professional, while women are portrayed as uneducated and non-professional in domestic settings (Hutchinson, 2020; Ndlovu, 2019). Men are depicted as astronauts, doctors, surgeons, pilots, inventors of scientific knowledge, or engineers, while the same textbooks depict women doing less prestigious jobs like housework or nursing. Women do a lot of the work in fields in rural areas, but one hardly sees a woman depicted as a farmer. One way to maintain textbook stereotypes is through language abstraction (Beukeboom & Burgers, 2017; Beukeboom et al., 2014; Menegatti & Rubini, 2017).

Textbooks use words to cast the portrait as appropriate for specific roles in perpetuating gender bias and reproducing inequalities (Menegatti & Rubini, 2017). Menegatti and Rubini (2017) elaborate that the purpose of using stereotypes in texts is to categorise people in society through carefully chosen words. They also mention that texts use language abstraction to make women's representations disappear in implicit forms. The study of Ndlovu (2019) found that authors of studied science textbooks would, for example, cast women alone in a parenting role, pushing a child in a stroller. The same study found that men were depicted in another activity in the same textbook as astronauts. So, in different instances, the omission of the specific gender was done to convey a particular message to the readers in subtle forms. In the first instance, the men were omitted from the parenting role, possibly to connote that women must take care of children. In the second instance in the same textbook, women were omitted as astronauts, possibly to connote that only men should become astronauts. So, through language abstraction, stereotypes of women in parenting roles and men in high-status professions like astronauts are maintained.

Furthermore, researchers have found textbooks to promote the stereotype of masculinist science (Carey et al., 2016). Men are usually portrayed in science textbooks as more capable,

able, heroic, professional, wiser, and adventurous, while women are typically shown as indulging in household chores, doing a second-rate job, or assisting men (Ndlovu, 2019; Pillay, 2017). According to Barton and Sakwa (2012), the English textbooks utilised in Uganda perpetuated gender stereotypes. Using Critical Discourse Analysis, they concluded that the author/s of the studied textbook ignored the ideals of equity and inclusivity that the Ugandan government upholds. Instead, it promoted the gender imbalance that emanated from Uganda's roots in a patriarchal society. They state that the authors of mathematics and science textbooks orientate male learners to science and mathematics. On the other hand, (in the same study), authors of social sciences textbooks demonstrated gender balance in how they portrayed humans as illustrations. These conclusions demonstrate that authors of textbooks studied by Barton and Sakwa (2012) purposed to maintain the stereotype of science as masculine. Their findings explain the argument raised by Makarova et al. (2016) that many girl learners were seen in the US to pursue a non-STEM course after matric graduation despite having passed with A grades in STEM subjects.

Therefore, I conducted this study to determine whether textbook portrayals account for gender representations in STEM-related courses (at the tertiary level) and occupations (after tertiary graduation). Connell (2009) argues that textbooks can also serve the interests of those who hold power within society. In a study by March et al. (2016), Critical Discourse Analysis was a framework that informed the analysis to answer two research questions. Firstly, the researchers sought to understand the portrayal of men and women as social actors in the Prospect series. Additionally, they were interested in determining which ideological presumptions could clarify the variations. The findings implied that the studied textbooks carried biased ideologies. For example, 60% of the social roles were represented in studied texts as male-monopolised. Only 17% of social roles were female-monopolised. The researchers interpreted the results as a deliberate strategy to maintain societal stereotypical norms.

Besides stereotypical messages that conveyed social values of gender hierarchy, textbook critique also revealed other forms of power-related insights coded in the discourse, either written or spoken. These include classism, racism, neoliberal capitalism and hegemony. For example, Engelbrecht (2006) also mentions that during the Apartheid regime, textbooks promoted the ideology of the superiority of White domination in South Africa. All examples in Afrikaans language textbooks used only one group of Afrikaners. The assumptions suggest that racist, as well as sexist values, were evident.

The analysis of gender representations by Ndlovu (2019) found that in the Physical Sciences textbook, women were portrayed as “weaker vessels” (Buford, 2018) because textbooks depicted them carrying lightweight objects in comparison to men who were carrying heavy objects. In other instances, textbooks portrayed men as venturing out of the planet as inventors of scientific knowledge, while no women were examples of producers of scientific knowledge. Such textbook representations can connote to learners that occupational roles are gender specific. All these arguments suggest that language in textbooks has gendered stereotypes which discriminate against one group whilst elevating the other. Meaning-making is usually possible if the language is well understood (Riley, 2007). Consequently, the upcoming portion of this study will delve into the interplay between race, gender, and class in how textbooks depict these identities.

## **2.9 Reviewing the intricate correlations between social class, gender, and racial identity.**

In his work, Gottfried (2008) clarifies that intersectionality involves exploring the interconnectedness of gender, class, and race in Western settings. Extensive literature reviews suggest that the curriculum in African countries, which Europeans formerly subjugated to colonialism, has not adequately been de-colonised (Du Plessis, 2021; Shah & Pathan, 2016; Taki, 2008). Even after gaining autonomy, most of them remain entrenched in the precepts and convictions of the Western ideology that their former rulers instilled and this belief system is broadly disseminated through curriculum materials, including textbooks. Duda-Mikulín (2023) asserted that Polish women in the UK are kept in a place of inferiority due to the persistence of traditional practices that maintain them as second-class citizens. However, other studies show that African women are the ones who suffer the most because they bear the burden of gender and racial issues. Like gender, the concept of “race” is a product of social construction and the idea of “racial difference” is actively encouraged, maintained, and enforced by society (Gillborn, 2015).

de Jesus Ferreira (2019) established that the percentage of white men illustrated in Brazilian and Cameroonian textbooks was highly remarkable. It was observed that out of the 122 men detailed in the book, a substantially greater proportion 80.32% were white men, in comparison to the 19.67% that were black men. Significantly, the proportion of white men engaging in professional and intellectual activities was substantially higher than that of black men. Consequently, white men are represented as being more successful than black men, thereby

limiting the possibility of black men visualising themselves as successful within Brazilian society.

The textbook was disproportionately representative of white women, with a ratio of 4 to 1. Moreover, white women were often represented as having achieved professional status, engaging in leisurely and cerebral activities, and devoting time to their families. It was perceived as a propensity to grant White people a sense of inclusion in this teaching material and Black people a sense of alienation. Regarding depictions of professional and intellectual activities, Whites were illustrated 101 times compared to African Americans, who were only illustrated fifteen times.

Shah and Pathan (2016) carried out a study to assess the Western cultural impact on Pakistani English Second Language (ESL) textbooks. They compared the textbooks published by Oxford University Press (OUP) for use in elite and private schools against textbooks published in-country by the Sind Textbook Board (STB) used in government schools. They used textbooks from the 2011 edition. They classified textbooks according to whether they were suitable for elites or non-elites. The findings demonstrated the presence of classism. The discourses of ESL textbooks designed by OUP were predominantly composed of customs, traditions, ideas, beliefs, religion, nationalism, social practices, and language of the West. They concluded that textbooks of OUP had a hidden agenda to westernize the learners and entice them to accept Western culture as an acceptable norm.

Taki (2008) had previously observed that, in the Iranian context, EFL textbooks at an international level illustrated a discourse comparable to the Western economy and consumerism, whereas those produced locally illustrated the culture of local people. Both in national and international contexts, scholars questioned the textbooks as perpetuating knowledge which is legitimatised with a certain political and cultural agenda.

Pillay's (2017) research in South Africa determined that Business Studies textbooks, which are specifically employed to teach grade 10, actively engender Western ideals. In addition to women being depicted in a degrading way, African men and women were represented in low-remuneration, low-standing occupations such as small-scale farmers, domestic employees, and part of the non-formal economy. Generally, African women were depicted in a servile capacity, for example, obtaining water from a faraway spot. Pillay (2017) maintains that African women were depicted as being more economically taken advantage of by Whites than White women, demonstrating that, in addition to gender discrimination, African women are also faced with

the challenges of racism, and it is those in the least privileged classes of society who suffer the most from these issues. This literature illuminated to me that although the study's focus is gender, I need to look out for indicators of racism and classism during the analysis of textbooks. The next section will cover the international strategies utilised to confront gender discrimination and inequalities.

## **2.10 International strategies that were adopted to deal with gender discrimination and gender inequalities.**

### **2.10.1 UNESCO**

Through the efforts of UNESCO, a remarkable number of “illiterate and oppressed girls and women in slum areas throughout the world are gaining knowledge, skills and confidence that they need to live with dignity and to make progress in the daily struggle over adversity” (Power, 2014, p. 3). Power (2014) mentions that the duties of UNESCO involve facilitating international cooperation and capacity building in science and technology. The literature reveals that after WWII, science education in many countries was hindered by the shortage of qualified science teachers, equipment, laboratories, textbooks, and other LTSMs (Brugelles & Cromer, 2009; Clyton & Moses, 2017; Power, 2014). Hence, solutions were needed in this regard. UNESCO responded by pooling the available science-teaching expertise from its Member States. Power (2014) reports that this resulted in the development of low-cost science teaching equipment and materials. He continues to mention that major reforms were implemented in science teaching. Priority was given to secondary chemistry, physics, biology and earth science curricula. Gaps were also identified in science teaching methods.

Furthermore, Power (2014) reports that in the 1980s UNESCO worked with non-governmental organisations such as the International Council for Scientific Unions (ICSU), International Council of Associations for Science Education (ICASE) (Holbrook & Cavas, 2012; Özdem-Yilmaz, Kennedy, & Cavas, 2017), Commonwealth Association for Science, Technology and Mathematics Education (CASTME) (Akpan, 2010) as well Commonwealth Secretariat to develop agenda to promote science for all. They brainstormed ways to make science and technology education appropriate to the needs of society. For example, since 1992, UNESCO has been promoting Education for Sustainable Development (ESD) (Rieckmann, 2017).

This literature enlightens to us that science issues have been a global concern. The agenda of the Commonwealth to promote science for all tells us that the reforms that had to be made were also considering women because all include both men and women. Monsalve Lorente et al. (2018) reveal that UNESCO also worked on finding and addressing gender gaps in science. His study is similar to that of Muralidharan and Sheth (2016), who mention that the goal of recruiting women teachers in science education is to offer role models for girls and minimise gender discrepancies. However, in the UNESCO publication entitled *Cracking the Code: Girls' and Women's Education in STEM*, it is mentioned that there is still gender inequality in the teaching of STEM subjects (Colglazier, 2015; Monsalve Lorente, Gallardo Fernández, & Saiz Fernández, 2018).

Therefore, this literature makes this study significant as its purpose is to determine through student teachers as participants whether Physical Science textbooks as teaching resources promote gender equality. Monsalve Lorente et al. (2018) also mention that according to the UN's Sustainable Developmental Goals (SDGs) adopted in 2015, the 2030 Agenda envisages combating gender discrimination and promoting gender equality in STEM education. This would be achieved by effecting changes to "... improve quality of STEM education to take into account the learning special needs of young girls" (Monsalve Lorente et al., 2018, p. 3). The 2030 Agenda outcomes stress that STEM educational teaching methods and content should be free of gender discrimination and gender stereotypes. Considering this outcome makes my study relevant because Physical Sciences textbooks are repositories of science content that is deemed by the 2030 Agenda free of discrimination and stereotypes. Therefore, involving Physical Sciences student teachers as participants in the study will contribute to achieving improved STEM teaching methods. In this way, the learning special needs of young girls will be considered. In the next section, I discuss the UN's Education for All goals that were set in response to gender biases that were prevalent in worldwide textbooks.

### **2.10.2 The United Nation's Education for All (EFA)**

In response to the identification of the gender gaps in education including textbooks, nation-states that attended the Education for All conference in 1990 purposed to prioritise educating girls (Blumberg, 2008, 2015). During the conference, the nation-states adopted the following as one of the gender equity goals: Goal 5 of the Education for All (EFA).

By 2005, the objective was to abolish gender disparities in primary and secondary education, and by 2015, strive for gender parity in education by emphasizing providing girls with equal

and complete access to and success in basic education of superior quality (Blumberg, 2008, p. 3). The third objective of the Millennium Development Goals (MDGs), as outlined by the United Nations, is to actively foster gender equality and provide women with the necessary tools to achieve empowerment. One of the key objectives, specifically Target 4, outlined by Blumberg (2008), is to eradicate the existing gap between genders in primary and secondary education, with the desired timeline being no later than 2005 and across all levels of education by 2015. Blumberg (2015) mentions that the EFA goals were also a response to the gender bias that had been found in textbooks used worldwide. Such gender biases included the under-representation of women in textbooks, portraying women in domestic settings with few depicted in non-domestic settings, girls and women depicted as observers, while boys and men were depicted undertaking exciting endeavours and occupations (Blumberg, 2015, p. 1). This is similar to the findings of the study of Ndlovu (2019), who also found stereotypes of men depicted as astronauts in the studied Physical Sciences textbook, while women were abundantly depicted as nurses in the Biology textbook.

However, Blumberg (2015) reports that according to the 2004 UNESCO report, these gender-biased textbook portrayals seemed unproblematic to Pakistani women. Hence, those whom the UN tasked to bring reforms in Pakistan textbook production were opposed (p.2). One of the challenges encountered in Pakistan was the fact that women were not devoted to eliminating gender bias in educational material (Blumberg, 2015; Islam & Asadullah, 2018). Instead, they viewed the women's representations in textbooks as a true reflection of Pakistani society. The study by Durrani and Halai (2018) found that the Pakistani Studies curriculum promotes hegemonic masculinity. They mention that the Pakistani uphold the ideological and territorial integrity of the Muslim nation, which maintains gender injustice and the obliteration of women from history. They emphasise that women were eliminated from textbooks using, for example, the universal pronoun 'he' and gendered terms such as brother.

Furthermore, Pakistani textbooks perpetuated the economic subordination of women because men were depicted as leading women. It is, therefore, possible that Blumberg's (2015) findings that indicated Pakistani women opposing UNESCO reforms on textbook production was a demonstration of obedience and loyalty to Pakistani cultural norms. It means that UNESCO's Millennium Goal 3 which sought to achieve gender equality in the way education is presented and specifically empower women by 2015, could not be achieved in Pakistani.

On the contrary, fast progress in bringing changes in the way gender was represented in texts was noted in Hong Kong. The report states that “females and males were almost equally included and depicted in a similar range of activities and, remarkably, females were more visible than males in both illustrations and texts” (Blumberg, 2015, p.5). The EFA Global Monitoring Report also highlights that recent studies in the USA on gender bias in texts still show the underrepresentation of women (Blumberg, 2015; Cocoradă, 2018; Islam & Asadullah, 2018).

Despite UNSECO’s prescriptions and recommendations that nation-states should revise textbooks to remove prejudices and introduce reforms that promote gender equality (Dawar & Anand, 2017; Huyer, 2015), very little progress has been achieved. Hence, the EFA Global Monitoring Report (Blumberg, 2015) recommends that nation-states should consider the input from that nation’s gender, gender specialists and education specialists when reforming the textbook. It is one of the reasons this study included student teachers as participants. Student teachers, as future teachers and possibly future education specialists (when they receive promotions), are regarded as agents of change and curriculum disseminators. I believe that even if prejudices in South African textbooks are not removed overnight, by implementing strategies that they proposed, educators can successfully address gender biases in written materials, resulting in a marked increase in gender equality within Physical Science classrooms and potentially promoting a more diverse representation of genders in the STEM workforce. In the next section, I discuss the internationally recognised and legally binding agreement known as the CEDAW, which stands as a testament to the collective effort in combatting gender-based discrimination in all its manifestations.

### **2.10.3 The Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW)**

In 1979, the UN General Assembly agreed on the enactment of the CEDAW as the international treaty for the rights of women (Cole, 2016; Cook, 2012). CEDAW recognises and promotes gender equality, including equal pay for equal work, and is particularly against discrimination of women in all forms, including discrimination of women in public education (Cole, 2016). This is articulated in Article 17 of CEDAW. Hence, it requires that the nation-states, as members of the UN General Assembly, provide equal educational opportunities for all. As CEDAW is founded on the Commission on the Status of Women (CSW), some of the CEDAW’s mandate includes the promotion of “...women’s political, social, civil, economic

and educational rights” (Cole, 2016, p. 1). CSW also worked with UNESCO to foster women’s literacy and equal access to education. Cole (2016) mentions that nearly 97% of the world’s countries support and are members of CEDAW. By 2006, improvements as a result of the implementation of CEDAW were reported, with women enjoying better literacy rates, improved rates of partaking in the economy and better representation in parliament (Gray, Kittilson, & Sandholtz, 2006).

Gray et al. (2006) alluded to the fact that these improvements implied the gradual advancement of the status of women. However, they also observed that “women remain excluded from the more stable and higher-paying jobs in heavy industry” (Gray et al., 2006, p. 296). Hence, they concluded that a lot still needs to be done to remove barriers that confine women in the worst-paying jobs while men are employed in profitable ones. They regarded this exploitation of women as sexual harassment and gender discrimination. Notwithstanding the fact that women were engaged in paid labour, they were shamelessly subjected to exploitation in the form of meagre salaries, deplorable work settings, and minimal prospects for career progression.

Since this strategy (CEDAW) focuses on the identification of different forms of discrimination and addressing them in labour as well as in education to advance the status of women, it is also applicable to this study. Studying textbooks to identify different forms of gender discrimination from them and designing strategies to address those in the classroom will be part of advancing the status of women as envisaged by the South African Constitution. The student teachers will critically read the selected Physical Sciences textbooks to determine whether they present forms of gender discrimination. The findings of the study will contribute to the ongoing literature that reflects on the effectiveness of CEDAW’s promotion of gender equality in educational resources. In the next section, I discuss the impact of gender representations in science textbooks on learners’ conceptions of science.

### **2.11 The impact of gender in science textbooks on learners’ conception of science**

Zhang (2020, p. 797) regards the concept of learning science as “...how students conceive of their science learning based on their experiences”. He noted that these conceptions are stimulated by learners' beliefs as well as how the curriculum is implemented. In his study, *The Effects of Curriculum, gender and Students’ Favourite Science Subject on Indonesian high-school Students’ Conceptions of Learning Science*, he found that gender is one of the factors that significantly impact learners' conception of learning science. He noted that gender inequality emanating from the learning environment (which could be how gender is portrayed

in a textbook) has proven to negatively affect the achievement of learning outcomes by boys and girls. Chiponda and Wassermann (2015) also found similar results because they concluded that how textbook portrayals exhibit gender gives the textbook power over learners' attitudes and their conceptions of gender. They regarded some textbooks as displaying a constructive image of women by placing them on par with men in textbooks. They found such constructive portrayals from some Arabic textbooks where women were depicted in the same professions and education level as men. However, some Arabic textbooks were found to be promoting gender inequality through gender bias displayed in the content. It was understood that the negative framing of gender was a direct result of women being considered inferior to men in their societal roles. The authors also clarify that portraying women in a positive light in a textbook can positively alter readers' perceptions of gender equality.

## **2.12 The implication of the literature review**

Much of the literature reviewed shows that women continue to be underrepresented in STEM fields. It is evident that textbooks, as important parts of the curriculum, are not neutral. Indeed, they perpetuate inequalities by positioning girls and women as subordinate. In my curiosity to find out what other scholars have discovered about textbook research and what methodologies have been used to interrogate textbooks to understand their underlying meaning, I discovered that many scholars employ Critical Discourse Analysis and content analysis to uncover the symbols and signs coded in the textbook content.

I also discovered that most scholars of CDA do not use human participants to interrogate textbooks but present their interpretations. I did not find any studies that used student teachers as participants to analyse textbooks. Therefore, I considered this paucity of studies on student teachers' pedagogical responses to gender representations in textbooks as the gap that I could fill by responding to the questions: What are the student teachers' pedagogical responses to gender representations in selected Physical Sciences textbooks? What informs their pedagogical responses to gender representations in selected Physical Sciences textbooks?

The literature I have reviewed also informed me that one of the lenses that can be successfully used to understand participants' interpretations to gender representations in texts is Critical Discourse Analysis. March et al. (2016), as well as Barton and Sakwa (2012), successfully used Critical Discourse Analysis to understand how gender was represented in studied texts. Pillay and Maistry (2018) successfully used the Feminist Post-structural lens to guide their study on gender representation in Business Studies textbooks. They also used the Critical Discourse

Analysis as the data generation strategy during their analysis of Business Studies textbooks. Their findings informed me that I could also effectively use Critical Discourse Analysis to understand how gender is represented in selected Physical Sciences textbooks and why gender is represented in such ways in selected Physical Sciences textbooks.

Hence, I used Critical Discourse Analysis as the analytic strategy for this study. I also used the theory of the Social Construction of Gender, Critical Theory and Post-Structuralist Feminist Discourse Analysis to guide the study. A discussion of these theories and how they will guide the study is detailed in Chapter 3.

### **2.13 Conclusion**

In this chapter, I critically reviewed the literature relevant to my study on gender representations in selected Physical Sciences textbooks. The review unpacked the significance of textbooks, their functions and the history of textbook evaluation. I have also discussed the literature that demonstrates peoples' misconceptions of gender, previous research on the representation of gender in textbooks and the intersectionality between gender, class and race. I have also looked at strategies that international organisations have implemented to deal with gender issues. From the above discussion, I synthesised that education studies do interrogate gender to investigate how learning and achievement take place. Hence, this study became relevant because it sought to find out from student teachers how gender manifests in the selected textbooks under study and how they, as future teachers, intend to mediate their findings in the Physical Sciences classroom such that both boys and girls are encouraged to pursue STEM courses/degrees beyond schooling. I was also mindful of the factors of class and power that are mentioned by Hoveid et al. (2019) to find out whether these factors manifest in the manner gender is represented in selected Physical Sciences textbooks.

## **Chapter 3: Theoretical Framework**

### **3.1 Introduction**

In the previous chapter, I synthesised the literature I reviewed to find the niche for my study. Within this chapter, I delve into the theoretical framework that directed the analysis of the collected data and subsequent discourse on the discoveries.

### **3.2 Theoretical Underpinning**

A theoretical framework can be described as a comprehensive and fundamental examination of pre-existing theories, acting as a crucial blueprint that guides the formulation of the arguments and concepts to be employed within one's scholarly endeavours. When constructing a theoretical framework, it is essential to delve into the existing theories that serve as the foundation for your research, articulating how your work is deeply intertwined with and fortified by established concepts and principles (Varpio et al.2020). It can be postulated that a "theoretical framework" serves as a meticulously crafted amalgamation of viewpoints that a researcher utilises to gain a deeper understanding or perception of the world (Creswell & Creswell, 2018; Anfara & Mertz, 2014). It guides the study, reflects the researcher's stand intellectually, and justifies the researcher's understanding of the concept being researched. It also shapes what is looked at, as well as questions asked (Creswell & Creswell, 2018).

Different theories are intricately woven together to construct a fresh, coherent outlook that skilfully incorporates the merits and contributions of each theory in a synergistic manner. The presence of multiple theories addressing different dimensions of a complex phenomenon can work harmoniously to enhance each other's strengths. When these theories are synthesised and analysed together, they can yield a more profound and all-encompassing insight into the phenomenon. Creswell et al. (2007) posit that the theory serves a dual purpose, functioning not only as a lens through which to view human behaviour but also as a tool for uncovering the underlying meanings and motivations driving such behaviour. The theoretical underpinning of this study was deeply rooted in the complex and multifaceted Critical Theory, the elaborate theories revolving around the Social Construction of Gender, and the sophisticated Post-Structural Feminist Discourse Analysis theory. The discussion below begins with Critical Theory.

### **3.2.1 Critical Theory: Definition**

Winkle-Wagner, Lee-Johnson, and Gaskew (2019) regard the Critical Theory as a component of social change that is intended to deconstruct oppressive structures that sideline and sabotage particular groups of people and render them powerless.

### **3.2.2 Origin of the Critical Theory**

The Frankfurt School invented the Critical Theory in the 1930s in Germany, and its roots stem from the Critical Theory of Karl Marx and Hegel (Fuchs, 2021; How, 2017). Hegelian theory was concerned about class and racial struggles. His theory sought to critique societal structures and processes that ultimately hinder the freedom of individuals or groups (Winkle-Wagner et al., 2019). Marx opposed the capitalistic economic system that influences other social systems like education. His theory considered the two classes, the proletariat and Bourgeoisie, that battled for power and social privilege (Honneth, 2008).

However, Marx was criticised for putting emphasis on class and inequities but neglecting gender, race, and other categories (Gimenez, 2018; Winkle-Wagner et al., 2019). Then, in the 1940s, the Institute for Social Research in Frankfurt shut down when Hitler took over in Germany. So, many of the members of the Frankfurt School fled to the United States. Horkheimer (one of the members of the Frankfurt School) started a branch in New York. Some of the prominent Critical Theorists in the U.S. were Cooper and Du Bois. They were concerned about how to elevate the enslaved society (How, 2017; Valentine et al., 2004; Winkle-Wagner et al., 2019). Cooper and Du Bois used Critical Theory to fight for status, privilege, and power across racial groups in the United States. Winkle-Wagner et al. (2019) mention that Cooper was a writer who promoted the empowerment and education of women. In the United States, Critical Theories initially focused on literary criticism and the critique of language, symbols, and signs.

However, the Institute did not last in the United States, as it was raided, and its materials were confiscated with the fear of spreading communism in the U.S. In the 1950s, the Frankfurt School returned to Germany. The second generation of the Critical Theory emerged that modified the Critical Theory from its previous principles. They believed that it was not enough for the theory only to critique or pose questions but that it was necessary to bring about social change and transformation. Critical Theorists aimed to uncover the social and cultural forces

that perpetuate domination and serve as barriers to individual freedom (Horkheimer, 1972). They sought to critique society's ideology with the hope of achieving justice. In the 1980s, Habermas offered a normative adaptation to Critical Theory. It considered praxis as central to the theory (McKerrow, 1989; Winkle-Wagner et al., 2019). He recommended that actions be taken to change inequality. He opposed those who only posed questions without pointing out what needed to be done to liberate and emancipate society.

### **3.2.3 Critical Theory as an Effective Tool to Challenge Hegemonic Practices**

Critical theorists challenged the belief that women are inferior to men. Croucher and Cronn-Mills (2014) argue that a Critical Theory also aims to challenge the reproduction of inequalities and dominant discourses in educational research. They argue that education serves the interests of those who have power. It was also used to identify forces or interests that impose powerlessness on one social group and interrogate the legitimacy of the powerful (Cohen, et al. 2007). Pillay and Maistry (2018) mention that what can be known about the world is biased, always subjective and influenced by the social positioning of the dominant groups in society. They further mention that knowledge is not unbiased. Hence, I also considered the Physical Sciences textbooks to be studied as repositories of knowledge as prejudiced.

Critical Theory was also used to free Western society from capitalistic backgrounds (Fraser & Jaeggi, 2018). It is considered a lens that can be effectively used to scrutinise the categories of the oppressor and the oppressed in relationships. It seeks to expose oppressed classes and oppressor classes in society and how the two classes persistently struggle for power Fuchs (2021). It advocates that oppressed classes are deprived and underprivileged. In contrast, the oppressor classes are the privileged within the same society. It aims to emancipate the oppressed classes from the hegemonic practices of the dominant (Rezende & Ostermann, 2020). It propagates that the hegemonic practices are norms and stories that the oppressors perpetuate to justify their position of dominance. Hence, I also sought to find out whether selected Physical Sciences textbooks perpetuate hegemonic practices through gender representations.

The scholars of the Critical Theory are of the view that every communication channel promotes the power struggle between the oppressed and the oppressors (Pillay & Maistry, 2018). They regard oppression as all how a specific identity group is disadvantaged in society (Rezende & Ostermann, 2020). They emphasise that oppression can be maintained through dominating

cultural norms and symbols of society. They also consider the privileged as those who are not subject to the disadvantages of the oppressed. The Critical Theory seeks to emancipate the oppressed from the dominant through critiquing hegemonic discourse. It upholds that the oppressor or the dominant retain their position of power and control by forcing their ideology on everyone.

Critical Theory was useful in the analysis of gender representations in selected textbooks to illuminate how injustices in textbooks which could hinder learners' critical thinking. It assisted me to expose hegemonic practices that were concealed in textbooks that I studied. For instance, the textbooks that were examined portrayed solely men as illustrations of an astronaut, a doctor, and a meteorologist, which are considered to be highly esteemed vocations.

During the interviews, student teachers became aware of how textbooks can encourage or discourage learners from pursuing STEM subjects, which determines whether they can participate in STEM-related fields in the future. Hence, their engagement in the study possibly transformed their way of thinking, and possibly they will use the knowledge they gained through engagement in the study to influence girls during science lesson presentations positively. In this manner, the knowledge they have gained will possibly emancipate learners from the stereotypes that are imposed by textbooks as cultural tools.

#### **3.2.4 Summary of the strengths of the Critical theory**

As elucidated in the aforementioned section, Critical theory has gained a reputation for being highly efficient in analysing and evaluating the dialogue, with the specific aim of bringing to light and condemning the systemic prejudices of classism and racism. It is widely acknowledged that this approach also adheres to anti-capitalist beliefs, effectively shedding light on the power dynamics existing between the marginalised and dominant classes within the societal framework. The most notable attribute of Critical Theory is its capacity to enact shifts and deliver freedom to disenfranchised individuals within a community, by countering and liberating them from the prevailing, oppressive norms dictated by the ruling class (Fraser & Jaeggi, 2018; Rezende & Ostermann, 2020; Winkle-Wagner et al., 2019).

#### **3.2.5 Limitations of the Critical Theory in critiquing textbooks**

Even though the Critical Theory is widely recognised for its efficacy in challenging the prevailing belief in the inferiority of women to men, there appears to be a lack of emphasis among critical theorists on the societal mechanisms that play a role in shaping this belief. It does not delve deeply into the complex interplay between societal constructs and the formation of gender roles, illustrating a lack of exploration into how these norms are influenced and crafted by the cultural milieu. In the next section, I provide a discussion of the Social Construction of Gender as another theory that will guide the study.

### **3.3 The Social Construction of Gender**

#### **3.3.1 Origin and development of social construction of gender**

Scholars of social constructionism coined the Social Construction of Gender. It is rooted in the theories of feminism as well as sociology (Brickell, 2006; Burr, 2015; Butler, 2011; Rutter & Jones, 2018). These scholars believed that any reality could only be if it is socially constructed. They advocate that social expectations construct gender and that these expectations ultimately channel gender performances (Jenkins & Finneman, 2018). Social constructivists seek to problematise the concept of gender to determine how it functions as a social construct and who benefits from the way it is constructed (Cortes & Pan, 2018). They also reveal the multiple identities that are linked to these categories. They also investigate how culture and society shape gender roles and how roles associated with specific sex shape the person's behaviour (Lee & Collins, 2010). Numerous beliefs and conjectures surrounding the complex notion of gender, such as social construction, categorically dismiss the notion that gender is merely a by-product of natural inclinations and biological makeup. In agreement with this outlook, according to Connell (2005), gender can be understood as a socially constructed concept, in which power dynamics dictate the roles and privileges associated with being a man or woman within a given society.

Four aspects are interwoven into the construction of gender, namely, knowledge, power (Lindsey, 2015), language (Galbin, 2014), and society (Butler, 2011). Social constructionists believe that knowledge is produced by and is in society, which transmits it from generation to generation (Andrews, 2012). Gender roles that are assigned are coupled with the attributes of status, efficacy and self-respect. (Lindsey, 2015). Roles are assigned to suggest superiority and, consequently, power to one gender, while the other is assigned low-status roles to suggest inferiority and subservience to the former (Butler, 2011). Language is a significant aspect when the culture of society is created.

Galbin (2014) states that within the framework of social constructionism, language holds a paramount position in the interactive process that allows us to comprehend both our surroundings and our being. She further explains that according to constructionism, the child modifies and interprets information she or he experiences with her or his world. She regards social constructionism as a semiotic aspect that commences by interpreting a proverb or an idiom. One example of a proverb that is universally used is “*women are weaker vessels*” (Buford, 2018). Although the meaning of this proverb is learnt during the teaching of English as a subject, the representations of women in science textbooks can connote that the author maintains this proverb (i.e. women as weaker vessels).

Scholars of social constructionism emphasise that to understand how a concept (including gender) is coined, the researcher must consider that knowledge and meanings are not stable. Instead, they are continuously negotiated, modified and shifted (Adami & Kress, 2014). According to Connell (2009), language is a significant vehicle through which individuals can articulate their ideas and sentiments concerning the world.

### **3.3.2 The socialisation of women and men into gendered jobs**

West and Zimmerman (2009) contend that the concepts of a woman or a man are associated with a gender role than biological difference. They argue that gender roles are learned and enacted. They mention that the professional gender roles, such as a nurse, doctor, etc., are gender marked. For example, a female doctor or a male nurse connotes gender marking. The motive behind these gendered roles is to legitimise power and inequality (Garfinkel, 2005). West and Zimmerman (2009) state that gender is not only used to distinguish between biological sex but is also used by social powers to appropriate fundamental divisions of society.

They further describe gender as “an achieved status constructed through psychological, social and cultural means” (p.81). Gender roles are assigned around the conceptions of femininity and masculinity. Men and women conform to what is expected of them. This results in a hierarchical order where men dominate over women in terms of power and privilege. West and Zimmerman (2009) reveal that the social subordination of women by men influences the division of labour. For example, women are not expected to claim equality as men. Hughes (1945) relates a scenario of how a woman who studied engineering was made to feel that she had chosen a masculine profession. She was cautioned not to engage in what only men are fit for. A person is held accountable for engaging in an activity as a man and a woman. The behaviour and actions of men and women must abide by delineations of societal members to

be seen to be in accord with culturally approved standards. When they do not conform to the normative gender behaviour, they are regarded as displaying offensive behaviour. Hence, West and Zimmerman (2009) mention that individuals' behaviour is subject to "gender assessment". They observe that gender segregation is aggravated by the provision of resources that are meant to be used by men, different from those that are to be used by women. They mention that ladies' bathrooms are designed to be different from gentlemen's bathrooms in public, but in a home setting, the same bathroom is used by both men and women.

West and Zimmerman (2009) explain that society's expectations pull the two genders apart to reinforce the stereotype that their public roles are not the same. They mention that, for example, qualities that are associated with men are endurance, strength, and competitive spirit. They also state that even when boys are paired with girls or men paired with women, men are made to appear bigger and stronger than the women they are paired with. Hence, activities that need to be displayed with greater size and strength are usually reserved for boys and men. On the contrary, girls and women are commonly displayed to be weak and helpless next to objects that require strength. In certain instances, boys and men are displayed to be even wiser than girls and women.

Furthermore, O'Neill, Savigny, and Cann (2016) mention that in the world of work, women's status is weakened to such an extent that, to exercise their right to be heard, they must ask more questions, use more attention-seeking strategies, and fill more silences. Therefore, women are not assigned positions according to what they can do but according to who they are. In other words, being a woman means being assigned a job inferior to that assigned to a man because of the stigma of being seen as a weaker human resource. Bussey and Bandura (1999, p.13) assert that attributes and roles assigned to men are selectively regarded as "more desirable, effectual and of higher status".

Lorber (1994) mentions that the sex category is used to discredit women from displaying excellence in their professional duties solely because of what society expects of them. She makes an example of a female physician who may receive recognition for her skill and be addressed with the proper title but becomes subject to evaluation in terms of appropriate attitude and activities based on her sex category. She continues to state that her sex category may even be used to alienate her from her colleagues. Instead it is used to maintain her responsibilities as a mother and wife. Biological differences between men and women are used

to “justify inequities of power and privilege embedded in gender regimes” (Lorber, 2018, p. 2) and specifically render women subjugated (Bell, 2018).

Social Construction of Gender was used in this study to scrutinise the gender roles in selected textbooks to determine why gender is represented in the ways it is in selected Physical Sciences textbooks. For example, it empowered me to question visual depictions that perpetuated the stereotype of women exclusively in nurturing capacities and engagements connected to domestic duties. Delving deeply into the analysis, I meticulously parsed and thoughtfully deciphered the presented excerpts to uncover their underlying meanings, applying the theoretical underpinnings that shaped the study.

### **3.3.3 Summary of the Strengths of the Social Construction of Gender**

Theories surrounding the Social Construction of Gender delve deep into the intricate ways in which gender operates within society as a construct that is fashioned by social norms, beliefs, and practices. It provides a critical analysis of how societal norms and expectations play a significant role in shaping and influencing the way gender is perceived and expressed by individuals. The core focus lies in exploring comprehensively the beneficiaries of the particular methods used in the construction and portrayal of gender roles and distinctions. These theories rigorously examine the complex interplay between culture and society in shaping the expectations and behaviours assigned to individuals based on their gender and sex, illuminating the myriad ways in which these social constructs impact and shape an individual's sense of self and their interactions within their communities.

The social construction of gender delves deeply into the ways in which societal norms and expectations exert a significant force in driving a wedge between the two genders, ultimately perpetuating the widely held belief that their respective public roles are inherently distinct and unequal. One illustration of this is how the assignment of sex categories is utilised as a means to undermine and delegitimise the achievements and prowess of women in various fields. The prevailing notion suggests that when it comes to intellect and prudence, men are frequently depicted as outshining women, showcasing a superior level of wisdom and insight., while girls and women are commonly displayed to be weak and helpless next to objects that require strength. A profound insight is provided into how the concept of sex category is employed as a tool to perpetuate and uphold the societal expectations placed upon women, especially in their roles as caregivers and partners.

### **3.3.4 Limitations of the Social Construction of Gender in critiquing textbooks**

The theories surrounding the Social Construction of gender ultimately culminate in offering critiques of the societal norms and cultural influences that play a role in its formation, without necessarily promoting or advocating for a shift in the existing status quo. Their efforts fail to champion the empowerment and liberation of the individuals or groups who find themselves suppressed and constrained by the prevailing norms and structures of society. Furthermore, it is worth noting that the individuals in question also do not aim to bring to light issues related to classism and racism. The proponents of these ideas do not place a strong focus on shedding light on the capitalist ideologies that underpin the dominant social group.

In the next section, I discuss the Feminist Post-Structural Discourse Analysis (FPDA). It is important to highlight that although the FPDA is a theory that is also used to understand how gender is constructed by society, it is not the same thing as the Social Construction of Gender. The FPDA has the discourse analysis aspect incorporated into it, which makes it suitable to critique gender in written texts and spoken words (Baxter, 2016; Butler, 2011). Furthermore, the FPDA is not limited to critiquing and understanding how gender is constructed, it is a strategy used to bring transformation (Lorber, 2018), the details thereof are discussed below.

### **3.4 Feminist Post-Structural Discourse Analysis (FPDA)**

The Feminist Post-Structural Discourse Analysis (FPDA) is used to challenge women's issues in society as well as in discourse (Lorber, 2018). Feminist Post-Structural Discourse Analysts study classroom discourse, texts, and other media representations of gender (Baxter, 2016; Lazar, 2005). It has a transformative agenda, seeking to represent the voices of women who have been omitted, silenced, and marginalised in discourse. Butler (2011, p.18) mentions that signs in discourse have inadequately and falsely represented women. She also points out that FPDA scholars critique the hegemonic Western representation and examine the overarching assertions of a male-centric system of meaning. Butler (2011) mentions that Feminist Post-Structural Discourse Analysts expose unequal social arrangements perpetuated through language. She mentions that the constraints of analysing gender discourses limit and anticipate the potential for different gender expressions to emerge in culture. She further explains that the Feminist Post-Structuralist Discourse Analysts intend to bring social transformation and

emancipation. This theory is used to understand how hierarchical power is maintained through discourse.

The FPDA scholars also investigate the underlying structures in texts (Balzer & Moulines, 2011) that marginalise and disempower women. They investigate how knowledge is produced (Lazar, 2005; Pillay & Maistry, 2018)). They are for the notion that to understand the text; the researcher needs to understand both the text and the systems of knowledge that produced it. They view patriarchy as an obstacle to women's emancipation and investigate how discourse reproduces gender inequalities. According to Lazar (2005, p. 1), there exists a belief that the functioning of gender ideology and unequal power dynamics within discourse are adopting increasingly nuanced manifestations. She, therefore, proposes textual deconstruction to expose the subtle forms of hegemonic power relations that are discursively produced.

FPDA 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 in discourse. The utilisation of feminist viewpoints proved to be a highly effective tool within this study, as it allowed for a critical analysis of the student teachers' attitudes towards gender portrayals. It exposed subtle forms of hegemonic practices encrypted in language and semiotic modalities used in the construction of knowledge in selected Physical Sciences textbooks. I managed to uncover gender imbalances and found that women scientists, in the Physical Sciences textbook studied, are not being represented as they should be. An illustration of this was evident when examining the contents of Textbook A, where female scientists were shown to be subservient to men, devoid of any mention of them autonomously innovating in the field of science.

#### **3.4.1 Summary of the Strengths of the FPDA**

Through the utilisation of the Feminist Post-Structural Discourse Analysis (FPDA) approach, a researcher can critically examine and address the multifaceted issues that affect women within the societal framework and in the context of discourse.

#### **3.4.2 Limitations of the FPDA in critiquing textbooks**

However, the FPDA theorists show a reluctance to immerse themselves in a detailed and scrutinising analysis of the multifaceted ways in which social powers play a pivotal role in the

construction and definition of gender norms. Moreover, they do not show the mechanisms through which these social powers ascribe and reinforce specific gender roles that serve to perpetuate and bolster the existing hierarchical divisions present in society.

### **3.5 The Significance of the Theoretical Framework to the Study**

The **Social Construction of Gender** applies to this study because it is used as a lens to understand how society uses gender to assign roles associated with femininities and masculinities. It was, therefore, suitable to critique how gender was represented in selected Physical sciences textbooks and why gender was represented in the ways they do. The theory assisted me in making sense of student teachers' interpretations and pedagogical responses to gender (in the manner men and women were depicted by images in selected textbooks). The theorists of the Social Construction of Gender also claim that professional gender roles, such as an engineer and a nurse, are learned and enacted. Also, these roles are gender marked, such as a male doctor or a male engineer, to legitimate power and inequality. They also investigate how roles associated with specific sex shape the person's behaviour (West & Zimmerman, 2009). Hence, it was an effective lens for me to investigate how culture and society mould gender roles. It empowered me to justify my interpretations about what (from the interpretations of student teachers) textbooks as cultural tools imply about women's participation in STEM-related fields.

The **FPDA** is used to critique gender in texts and discourse to theorise how and why women are omitted, silenced and rendered invisible in discourse (Baxter, 2016; Butler, 2011). Consequently, it assisted me in reaching the inference that the deliberate absence of scientific knowledge contributed by woman scientists, coupled with the inadequate representation of women scientists, implied that they were essentially silenced and marginalised in the realm of textbook discourse. And that this was possibly done to perpetuate gender discrimination, women's subordination, and gender inequality in texts and visuals. Research question four sought answers on what informs the student teachers' interpretations of gender representations in selected Physical Sciences textbooks. Therefore, the FPDA's emancipatory purpose made it suitable to use it as a lens to understand the interpretations of student teachers regarding gender representations in selected textbooks. Butler (2011, p. 35) mentions that the power of language "...subordinates and excludes women...". Thus, this FPDA claim allowed me to draw a sound and definitive conclusion regarding the potential ramifications of gender

depictions within the examined textbooks on the extent of women's participation in STEM-related disciplines.

Insights of the **Critical Theory** enabled me to be critical when analysing textbooks. According to the arguments put forth by Winkle-Wagner et al. (2019), the Critical Theory serves a twofold function, serving not only as a perspective through which to examine human actions and unearthing the deep-seated significances and impetuses that propel said actions but also as a mechanism for the transformation of the society. Through the utilisation of this particular lens, I was able to ascertain that textbooks may potentially function as a tool to propagate classism and advance a capitalistic agenda. It also empowered me to reach the empowering realisation that the messages found within the pages of textbooks I have diligently studied subtly perpetuate man superiority and woman subordination. I arrived at the realisation that there existed a clear and distinct disparity in the depiction of boys and men compared to that of women and girls, with the former being consistently portrayed in a position of superiority and privilege. In contrast, the latter was consistently portrayed as being subjected to prejudice and powerlessness.

As Critical Theory is also utilized to address issues of status, privilege, and power among different racial groups, as suggested by Fuchs (2021), it enabled me to observe from participants' responses that the strategies proposed by student teachers aimed to enhance the status of girls and women, highlighting how gender stereotypes could be detrimental in the studied textbooks.

Equally significant to its primary function, the Critical Theory plays a crucial role in the examination and, ultimately, dismantling of oppressive structures that operate to marginalise and subjugate particular communities, effectively stripping them of their ability to assert their rights and pursue their goals. Consequently, Critical Theory provided me with the ability to decipher the interpretations of student teachers, which indicated tactics that could be implemented to dismantle repressive notions conveyed by the textbooks being examined. The utilisation of these specific strategies was widely perceived as an act of transformation due to the widely-held belief that their implementation could effectively counteract the damaging effects of unfavourable stereotypes commonly portrayed within the pages of science textbooks.

### **3.6 Conclusion**

In this chapter, I discussed the theoretical framework that guided the study. It included the Critical Theory, which has a transformative agenda. Horkheimers's Critical Theory, as a theoretical foundation for this research, brought to light Capitalistic dynamics embedded within social groups that bestow legitimacy on the subordination of one group whilst elevating the other (Fuchs, 2021; Horkheimer, 1972). I also drew from Feminist Post-Structuralist Discourse Analysis with ideas of Butler (2011), which astutely demonstrates how women have been inadequately and inaccurately portrayed in discourse, and Baxter (2016), which explored the use of classroom discourse, texts, and other media representations of gender to amplify the voices of women that had previously been neglected, silenced, and excluded in discourse. By employing the concept of the Social Construction of Gender, as posited by West and Zimmerman (2009), the revelation of underlying factors contributing to the establishment of gender roles based on notions of femininity and masculinity was brought to light.

## **Chapter 4: Methodology**

### **4.1 Introduction**

This chapter outlines the methodology that I followed to generate data, analyse and present the findings of this study. It includes the details on the study's methodological approach, paradigm, design of the study, sampling and how participants were recruited. Finally, I discuss data production methods, data analysis methods and ethical considerations. The methodology of the study is organised into two phases. The approach and the paradigm for both phases are the same. Consequently, these two aspects of the methodology of the study are discussed once in sub-sections 4.1 and 4.2.

In subsection 4.3, I discuss the location of the study, and in sub-section 4.4, I discuss the context of the study. Phase 1 is detailed in subsections 4.5, 4.6 and 4.7. In this phase, I, the researcher, analysed the gender representations in the selected textbooks to generate data to account for research questions 1 and 2. The phase one discussion is about sampling of textbooks (in subsection 4.5), the data generation methods and tools (in sub-section 4.6) that I employed to generate data to respond to research questions 1 and 2. Additionally, data analysis methods and tools (in sub-section 4.7) that I employed for phase 1 are discussed.

After that, I provide the discussion for phase 2 in sub-section 4.8. In this sub-section, I provide details on data generation methods and tools that I employed during the interviews to generate data to respond to research questions 3 and 4. Subsequently, I provide a discussion of data analysis methods and tools that I employed to analyse the data generated using two staged interviews, i.e. firstly face-to-face, and remotely using WhatsApp voice notes. The section below begins by discussing why I opted for the qualitative approach.

### **4.2 Qualitative Approach**

The methodology employed in this research was qualitative, facilitating the gathering and examination of data using open-ended queries. (Liamputtong, 2020). According to Denzin and Giardina (2016), the Qualitative Approach seeks to respond to the question through a predefined set of procedures and to present findings that were not pre-determined. Furthermore, Qualitative research involves the population it studies to understand the research problem

(Mack & Woodson, 2005). Denzin and Giardina (2016) align with this view by mentioning that meanings are not objective, but researchers establish them through social interaction and politics of representation. In other words, this methodological approach makes the voices and opinions of the studied population heard.

Consequently, to make the voices of the population studied heard, I recruited and interviewed student teachers (STs) as participants. I have provided the details thereof in sub-section 4.8.2. Additionally, in chapter 6, I have presented and analysed the findings from interviewing student teachers (to make the voices of participants heard).

The qualitative data generation techniques employed were instrumental in thoroughly understanding gender as a multifaceted social construct in its natural environment. Additionally, they were effective because I sought to generate data to respond to the why, how, and what research questions (Brooks et al., 2018). This stance correlates with my research questions detailed below:

- How is gender represented in selected Physical Sciences textbooks?
- Why is gender represented in the ways it is in selected Physical Sciences textbooks?
- What are student teachers' pedagogical responses to the gender representations in selected Physical Sciences textbooks?
- What informs student teachers' pedagogical responses to how selected Physical Sciences textbooks represent gender?

Maxwell (2021) claims that the qualitative approach addresses social issues using focus groups, ethnography, interviews, content analysis, critical discourse analysis (CDA), case studies and record-keeping to find the truth. Furthermore, Liamputtong (2020) mentions that qualitative researchers seek to use these strategies to understand a research question by involving people's beliefs, experiences, and attitudes. Hence, I employed the CDA and interviews as qualitative data generation strategies.

Brooks et al. (2018) assert that qualitative approaches can be problematic to some researchers because they are time-consuming and use small samples when gathering data. To overcome this, I used the bricolage of CDA and individual interviews. I first gathered data by reading and analysing the selected textbooks using CDA. Then, I involved student teachers as participants

and interviewed them individually, face-to-face and telephonically using WhatsApp voice notes.

During face-to-face interviews, I presented participants with excerpts from the selected textbooks and used the interview schedule I had prepared to determine their interpretations and pedagogical responses to how selected Physical Sciences textbooks represented gender.

Berger (2018) discusses the criticisms that have been levelled against qualitative researchers, who have been reproached for constructing interpretations that seem abnormal, lacking substance, and even idiosyncratic in nature (p.7). He, therefore, alerts qualitative researchers to guard against infringing on personal and private issues when using this approach. Hence, I ensured that I supported my interpretations by excerpts from the selected textbooks. In line with Berger (2018), who shows that the qualitative approach evaluates, interprets and explicates using concepts, I also conducted the interviews to show my analysis to student teachers. I did this to generate data for the research question that sought answers to, “What are the student teachers’ pedagogical responses to gender representations in selected Physical Sciences textbooks? I also sought to understand how they would mediate their findings to the learners in Physical Sciences classrooms.

Allan (2020) also mentions that one of the desirable features of qualitative research is that it provides satisfactory explanations of social activities from the participants' views. Furthermore, Allan (2020) recommends a qualitative approach because it is adaptable at any stage of the research work. The researcher also selects the participants from a particular group in economical ways. Hence, the qualitative approach benefited me as I spent a few rands during interviews to make copies of the interview schedule for each participant. During the CDA analysis, I only spent a few rands to buy the e-books. I found e-books cheaper than physical textbooks.

Merriam and Grenier (2019) state that the qualitative approach lacks transparency in procedures and processes. They also mention that the analytical steps give very little about the characteristics of the study sample. However, in this study, I attempted to be more transparent about my procedures and processes. I have outlined details on the procedures and processes that I followed in this study in sub-sections 4.6.1 (sampling of textbooks), 4.6.2 (data generations methods for phase 1) 4.7 (data analysis, procedures and tools used for textbooks) 4.8.1 (recruiting participants and sampling participants for phase 1), 4.8.2 (data generation

methods for phase 2), 4.8.3 (data analysis for phase 2), 4.8.4 (Analysis of interview transcripts using thematic analysis), 4.9 (rigour in research) and 4.10 (ethical considerations).

Creswell and Poth (2016) further state that a qualitative approach enables the researcher to conclude because s/he understands the underlying assumptions and motives behind the issue under study. In the next section, I discuss the paradigm for this study.

### **4.3 Paradigm**

The term “research paradigm” encompasses a set of commonly accepted beliefs and agreements among researchers, shaping their approach to comprehending and addressing issues within their field of study (Anand et al., 2020). This perspective encompasses fundamental beliefs regarding the essence of existence (ontology) and the acquisition of understanding (epistemology), the techniques employed by the researcher to explore reality, as well as the values and beliefs upheld, as outlined by Cohen et al. (2013). This study adopted the critical research paradigm, and the discussion of it is detailed below.

#### **4.3.1 Critical Research Paradigm**

The critical paradigm stems from Critical Theory, which has a transformative and emancipatory agenda for individuals and groups in a democratic society (Creswell et al., 2007; Paradis et al., 2020). I chose the critical paradigm to understand and explain student teachers' interpretations and possibly steer them to devise strategies to transform how gender in textbooks is interpreted by learners in science classrooms (Cohen et al., 2007). Theorists who use this paradigm aim to expose the social and cultural forces that perpetuate domination and serve as barriers to individual freedom (Horkheimer, 1972; Paradis et al., 2020). They seek to critique society's ideology with the hope of achieving justice. Pillay and Maistry (2018) mention that what can be known about the world is biased and always subjective and that knowledge is not unbiased. Hence, I studied the selected Physical Sciences textbooks to conclude whether they present biased knowledge.

Critical Theorists challenge the belief that women are inferior to men. Croucher and Cronn-Mills (2014) argue that a Critical paradigm also aims to challenge the reproduction of inequalities and dominant discourses in educational research. They say that education serves the interests of those who have power. The Critical paradigm, therefore, became suitable for this study, which sought to illuminate how selected Physical Sciences textbooks represented

gender and to provide the justifications for why it was represented in the ways it was. The critical paradigm also identifies forces or interests that impose powerlessness on one social group and interrogates the legitimacy of the powerful (Cohen, Manion & Morrison, 2007). Through CDA, I exposed the injustices and prejudiced messages in the way gender is represented.

I have provided details of such prejudiced and discriminatory manifestations in Chapter 5. Through interviews that I conducted, I hope that student teachers have become aware of how textbooks can empower or disempower learners from pursuing STEM subjects, which determines whether they can participate in STEM-related fields in the future. Their engagement in the study has possibly transformed their way of thinking, and they will probably use the knowledge they have gained to positively influence girls during science lesson presentations to remain in STEM classes during schooling and pursue STEM-related courses after graduation. In this manner, the knowledge that student teachers have gained can emancipate learners from the effects of stereotypes that are imposed by textbooks as cultural tools.

#### **4.3.2 Ontology of the critical paradigm**

Ontology, as stated by Scotland (2012), pertains to the underlying nature of reality. If someone studies ontology, he or she is studying what 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). Ontology is concerned with portraying the entire nature of the existence of a particular phenomenon (Edirisingha, 2012). Brooks et al. (2018) assert that ontology is concerned about the assumptions and claims that the inquirer makes about the nature of reality. Scholars of Critical paradigms seek reality by acquiring knowledge that exists external to the researcher to answer research questions. For this reason, I triangulated CDA with individual interviews to acquire knowledge that is external to what I had discovered from my analysis using CDA.

There may be multiple realities that can be the result of the inquiry depending on who does the inquiry and when / where it is conducted. Killam (2013) argues that the ontology of the critical paradigm is that politics shapes multiple beliefs and values to perpetuate the interests of one social power that is privileged and dominating over the other, which is also under-represented. The study of Scotland (2012) shows that besides politics, there are also social, cultural, economic, and gender values that form part of the reality in the critical paradigm. Therefore, in line with the ontology of the Critical paradigm, this study looked at only gender, among

other factors that are mentioned by Scotland (2012). In the next section, I discuss the epistemology of the Critical paradigm.

### **4.3.3 Epistemology of the Critical Paradigm**

Goertz and Mahoney (2012) state that epistemology is about the very basis of knowledge and how it can be acquired and communicated to human beings. They further mention that epistemology is about answering the question: what techniques do we choose to apply in our attempt to know? Burrell and Morgan (2019) argue that according to the Critical paradigm, communities of practice, media, institutions, and society all play a role in socially constructing knowledge through various modes of understanding. I chose CDA and interviews as methods of data generation in this study as ways of knowing how gender is socially constructed. I critically read the chapters in the selected Physical Sciences textbooks and then answered research questions 1 and 2. I also presented excerpts from the studied textbooks to the participants and then interviewed them. Data generated through interviews was then used to respond to research questions 3 and 4. It is aligned with the fundamental principles upheld by critical realists, who maintain the notion that knowledge is primarily shaped by societal constructs rather than being definitively determined by objective factors. Therefore, epistemology is internal to the researcher because it was the researcher who chose the suitable techniques to acquire the truth (Creswell & Poth, 2016).

Chouliaraki and Fairclough (2010) mention that ways of knowing the language rest on critiquing relations of power, domination, and hegemony in discourse. They view language as mutually constitutive of the social discourse that is dialectically related to others. Hence, they mention that the epistemic interest is in explicating how relations of power shape dialectical processes. Furthermore, through critical research, dialectics of discourse figures are explicated to determine how they perpetuate injustices and inequalities through analysis (Chouliaraki & Fairclough, 2010; Fairclough 2013). For this reason, I considered CDA as one of the effective data generation strategies and I used it to critique textbook language and visuals to determine if they were used as instruments of power to perpetuate social injustices and inequalities. I then presented some of the excerpts from the textbooks I studied to the students who were the sample of the study to determine from their perspective whether how humans were represented in texts and visuals (in selected Physical Sciences textbooks) privileged one gender while restricting and hindering the other. In the next section, I discuss the location of the study.

#### **4.4 Location of the study**

Participants of the study were selected from a selected University in the province of KwaZulu-Natal in South Africa. Participants were 2<sup>nd</sup>-year students of Bachelor of Education, studying Physical Sciences as one of the majors in their teacher training. The campus is populated by African, Indian, Coloured and White racial groups. The Africans are dominant in numbers, followed by Indians and Coloureds. Very few Whites enrol for Bachelor of Education at the University of Durban. For example, when I came to recruit students who would be interested in the study, I found only one White student enrolled for the Bachelor of Education studying Physical Sciences as one of the major subjects.

I selected this University because it is the University that is the main supplier of qualified teachers to KwaZulu-Natal (KZN) schools where the study is conducted. Initially, I believed that the findings of the study could be significant to KZN schools. However, as I interacted with participants during interviews, I discovered that the participants were from various parts of the country, including the Eastern Cape. One participant was from outside South Africa, Swaziland. As a former Master of Education student at the selected University, I anticipated that it would be easy to find participants. I recruited participants through the Physical Sciences lecturer. I emailed two lecturers requesting permission to come during their lesson presentations to recruit participants. Both lecturers of Physical Sciences granted me permission to come and recruit participants. However, I only used participants from one class as I managed to get the sample size I had aimed for.

#### **4.5 Context of the study**

Coetzee (2001) states that in South Africa, in line with patriarchy, women were restricted to specific inferior jobs compared to those assigned to men. (Coetzee, 2001, p. 302). Barnard (2018) reported that in South Africa, women tend to pursue careers like social work instead of STEM careers. She states that even those who start pursuing STEM courses in higher education tend to switch to non-science disciplines before graduation. She also mentioned that girls are socialised into nurturing and mothering roles in childhood, while boys are socialised into scientific roles. Owings (2015) reports that Pontsho Maruping, an executive at South Africa's Technology Innovation Agency (TIA), declared that participation of women in STEM should be encouraged because it contributes to the diversity in the workforce, which positively

enhances the country's economic growth. She recommended that the government should strategise to publicise women entrepreneurs to inspire future women scientists.

Therefore, to investigate gender representations in Physical Sciences textbooks, I chose to include Physical Sciences student teachers because they use Physical Sciences textbooks when preparing lessons for their teaching practice. Physical Sciences textbooks are the main resources that have detailed content to be taught in each grade in the FET phase. Therefore, I deemed it necessary to include pre-service teachers of Physical Sciences as participants in this study because they rely on textbooks for lesson preparation, presentation and assessment. I assumed that they probably use similar textbooks during teaching practice and as teachers (after graduation).

The findings of the study by Ndlovu (2019) in South Africa revealed that women scientists and their achievements did not feature in selected science textbooks that are used to teach in South African schools. It was, therefore, necessary to analyse textbooks to critique power relations and possibly hegemonic practices that learners may be exposed to when they learn science. The biased naming and man foregrounding restrict the learners' creative thinking, particularly the non-white girl learners from townships and rural areas. It was on this premise that I decided to engage student teachers using face-to-face individual interviews. I sought to establish student teachers' interpretations of gender representations in selected Physical Sciences textbooks and to find out how they intended to mediate the controversial messages in the science classroom.

I also interviewed student teachers through telephonic devices using WhatsApp voice notes to establish what informs their pedagogical responses to gender representations in selected Physical Sciences textbooks. In the next section, I discuss phase 1 of the study, during which I selected and analysed the Physical Sciences textbooks.

## **4.6 Phase 1**

### **4.6.1 Sampling of Textbooks**

I used purposive sampling to select three Physical Sciences textbooks that are used to teach in the Further Education and Training phase (FET), i.e. grades 10 - 12. The reason for choosing textbooks from the FET phase was the fact that Physical Sciences is taught in the FET phase only.

The criterion for their selection was that they should be on the catalogue prescribed by the Department of Basic Education. I chose the Physical Sciences textbooks that are most widely used in South African schools.

In the majority of educational institutions, the subject of Physical Sciences is typically taught by a single educator. It has come to my attention through careful observation that, more often than not, teachers opt to utilise textbooks exclusively from a singular publishing company for students in the 10th to 12th grades. As a result, my focus was on gaining insights from the student teachers included in the sample regarding the probable influence on learners' understanding of gender representation, should they select Physical Sciences textbooks from a sole publisher for the entirety of the Further Education and Training (FET) phase. To put it differently, I aimed to investigate whether the partiality present in the educational materials used during the 10th grade persists throughout the subsequent academic years, or undergoes any alterations. Below is a table showing the sample of textbooks that were analysed.

**Table 4.1 Textbooks that were analysed**

| <b>Name of the textbook and grade</b> | <b>Publisher</b> |
|---------------------------------------|------------------|
| Textbook A (pseudonym) Grade 10       | Cambridge        |
| Textbook B (pseudonym) Grade 11       | Cambridge        |
| Textbook C (pseudonym) Grade 12       | Cambridge        |

#### **4.6.2 Data generation methods: CDA**

Data generation methods are strategies that are used to generate data. Brooks et al. (2018) mention that the qualitative researcher can access numerous qualitative data generation methods and choose the one that best suits him or her. They state that these qualitative methods include individual interviews, qualitative surveys, focus group discussions, critical discourse analysis and observation. They further state that observations involve recording what you have seen, heard, or encountered in detailed field notes. Interviews involve asking people questions in one-on-one conversations. Focus groups involve asking questions and generating discussion among a group of people. However, in this study, CDA was conducted by the researcher, and the discussion below explains why it was suitable as a data generation strategy in this study.

It is important to highlight that during that during the first phase, I, as the researcher, had to conduct CDA first so that I could use the findings of my analysis to interview the student teachers. Additionally, it is imperative to highlight that CDA commences with the analysis of secondary data to interpret the underlying meaning of text framing and the role of visuals (Maposa, 2015). Maposa (2015) regards textbook analysis as both empirical and non-empirical because the researcher is not engaging with the producer of the text. Instead, he argues, she or he analyses data that is already available in the public domain, which was not initially intended for research but as an “educational media” (p.127). Therefore, the discussion below provides a discussion of CDA as a strategy for textbook analysis.

According to Van Dijk (2015), ideologies are embedded in texts, and this signals how groups interpret a specific domain in society to legitimate power and inequality. In his later study, Van Dijk (2016) mentions that CDA reveals how truth is concealed in texts to protect the interests and resources of dominating groups, irrespective of how this unjustly privileges the oppressed. So, I used CDA to find out whether gender representations in selected Physical Sciences textbooks are likely to legitimate power and inequality to one gender while oppressing the other. The discussion below begins with outlining the origin of the CDA.

The Critical Discourse Analysis (CDA) emerged from Discourse Analysis (DA), and the two are not synonymous (Machin & Mayr, 2012). Discourse refers to the communication of thoughts through words that were spoken or written (Catalano & Waugh, 2020) and Discourse Analysis originated in the United States (Powers, 2001) as a method of research that was used originally in the branches of philosophy, sociology, linguistics, and literary theory (Jacobs, 2021; Powers, 2001) to analyse language, texts and signs. It has been carried to a variety of other disciplines like anthropology, communication, education, and psychology (Machin & Mayr, 2012). It has been transformed into Critical Discourse Analysis. The reason for its transformation was the fact that Discourse Analysis lacked the critical aspect that was deemed by discourse analysts as necessary to interpret texts. The study by Waitt (2005) states that “Foucauldian discourse analysis stands in stark contrast to other critical methodologies typically utilised in the study of texts, including content analysis, semiology, and iconography” (p.163). This statement shows that the discourse analysis lacked a critical aspect because it was regarded as a break from other critical methods.

Critical Discourse Analysis is a term that is used to cover analysis of all spoken and written forms of language used as social practice (Catalano & Waugh, 2020). Wood and Kroger (2000)

align with this view and state 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. The Critical Discourse Analysis analyses how text positioning promotes the interests of one dominant social class while refuting the interests of the other, which is also weakened by this social act (Wood & Kroger, 2000). Therefore, it 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 a particular way while they conceal these intentions from the untrained eye (O'Halloran, 2019).

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 (Machin & Mayr, 2012; Fairclough, 2014). Furthermore, Fairclough (2014) states that ideologies are established in ideas and images that are embedded in and inhabit an individual's mind. They elaborate that power is about members of one group exercising control over another.

Therefore, 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. Furthermore, they critically analyse how language and visual images in texts and speech can be used to control minds in subtle forms.

Scholars of CDA are of the view that injustice and oppression shape the social world. Additionally, Fairclough (2013) describes the CDA as a method of research that is used to critique the discourse in linguistics and social sciences. Consequently, it encompasses semiotic practice, which is the study of visual images and non-verbal movements as part of texts. Analysis of visual images and graphics in notions of text and discourse is used to reveal gender inequalities (Wood & Kroger, 2000). Written texts and visual images are interrogated to expose ideological assumptions, thereby empowering teachers to guide learners on how to resist media assaults (Fairclough, 2014). Huckin (1997) shows that it is used to study power relations, ideology and social identities as social elements.

Fairclough (2014), therefore, regards CDA as part of critical social analysis. He shows various types of semiosis, i.e. language, visual images and body language. He also recommends that CDA should focus not only on semiosis but also on how semiotic elements are related to other social elements in the discourse. In other words, he suggests that words that are spoken or

written are a product of certain structures that manipulate the minds of all to believe that this is how reality should be. He also recommends that when discourse is analysed, time and place should be considered. He maintains that in CDA, three levels interact, namely, structures, events and practices. For example, he mentions that the discourse can be the result of structures and events or structures and practices. In other words, behind people's discourses, there are hidden messages that subtly persuade them to think in a particular way.

Moreover, van Leeuwen (2014) emphasises the importance of considering multimodalities when analysing texts. He regards multimodality as the integrated use of different semiotic resources, for example, language, images, sound and music. He suggested that words, either written or spoken, should not be isolated from the accompanying non-verbal communication. In other words, the visual image that accompanies the text conveys a message to the readers. In his book, "Critical Discourse Analysis and Multimodality", he suggests that many forms of contemporary written language can only be fully understood when the reader not only focuses on the language but also on "...images, colour, layout and typography".

He also mentions that three distinct traditions inform multimodal studies. He mentions these as social semiotics, interaction analysis, and cognitive theory. He states that semiotic resources develop in response to social and cultural needs. He further maintains that meaning-making should consider the macro, social and cultural context. He, therefore, recommends that discourse be analysed at the levels of ideational, interpersonal and textual meaning.

When Critical Discourse Analysts engage in the process of studying the meaning of symbols and signs to make communication meaningful, the process is called semiotics (Machin & Mayr, 2012; van Leeuwen, 2014; Kress and van Leeuwen, 2020). They study how authors use semiotic resources in specific contexts and how they justify their actions (van Leeuwen, 2005, 2011). Halliday and Matthiessen (2013) refer to the grammar of language as the semiotic resource for making meaning. 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 visual images but encompass everything that we do, all these activities possess a so-called "semiotic potential". van Leeuwen (2011) makes an example of a frown on a person's face as a symbol of disapproval to confirm this claim. Halliday and Matthiessen (2013) further mention 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.

Kress and van Leeuwen (2020), in their book “*Reading the Images: The Grammar of Visual Design*”, show another aspect of critical discourse analysis that is called symbolic processes. This aspect is focused on interpreting images. They suggest that, when interpreting the image that accompanies the text, it is important to establish what the participant (depicted person in the image) that accompanies the text means to the viewers. They make an example of the salient participant who may be foregrounded through exaggerated size, well-lit or fine detail. They show that through visual means, the conveyance of information can effectively portray subjects within the image as if they are actively engaged in a dynamic exchange between the originator and the observer of the visual representation. (p.114). They regard the person depicted in the image as the represented participant and the viewer of the image as the interactive participant. They state that although the represented and interactive participants do not know each other, they communicate. In other words, the producer of the image coded the message to the image depicted and it is meant to be received and interpreted by the viewer or the reader.

Therefore, semiotic analysis empowered me to understand the possible motives behind how the visual images were depicted. For example, I challenged the human images that were small in comparison to those that were large, 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.

Machin and Mayr (2012) also mention that multimodality is an important aspect of CDA. In their book “*How to Do Critical Discourse Analysis*”, they state that CDA is rooted in critical linguistics and aims to demonstrate how grammar and language are used to disseminate ideology. They maintain that authors communicate ideas in a manner that persuades the readers to think in a particular way, yet they conceal their intentions to an untrained eye. They, therefore, provide a set of criteria that one can use to analyse both language and visual images to expose the hidden messages coded in texts. They refer to the analysis of how graphics are used with the language as multimodal critical discourse analysis.

As discursive analyses are moulded in diagnostic practices, my purpose was to investigate textbooks of Physical Sciences to demonstrate 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 statements are made while others

are excluded. I challenged texts to expose institutions that control the production and circulation of discourse.

Critical Discourse Analysis suited this study because it was used to generate data to exhibit how gender is represented in selected Physical Sciences textbooks. So, textual analysis (textual description), processing analysis (textual interpretation), and social analysis (explanation) were applied in selected Physical Sciences textbooks, which I have mentioned in the sampling section. Description of text (textual analysis) and processing (textual interpretation) answered my research question, “How is gender represented in selected Physical Sciences textbooks?” Social analysis answered the research question, “Why is gender represented in the ways they do in selected Physical Sciences textbooks?”

#### **4.6.2.1 Using CDA to uncover ideology and power in language**

Fairclough (2013) shows that language can be used as a resource for domination and oppression. CDA is therefore regarded as an effective tool in revealing how power is conceptualised in terms of the lack of equality between groups in a society. Furthermore, it can be used to reveal how power is “conceptualised in terms of unequal capacity to control how texts are produced, distributed and consumed” (p.1). He maintains that grammatical features such as metaphors, grammar presupposition and implicatures, speech exchange and lexical choices can be ideological. He also mentions that ideology can be implicitly hidden in “taken-for-granted assumptions (presuppositions)”. Therefore, CDA became an effective method to challenge texts and human visuals to determine if they elevated one gender into a position of power whilst disempowering the other.

#### **4.6.2.2 Relationship between discourse and sociocultural change**

Fairclough (2013) also indicated that social structures can use discourse to reproduce culture across generations as well as to bring about change in society. Similarly, Bourdieu (2018) aligns with this view by mentioning that cultural reproduction can be achieved by social institutions such as schools to transmit cultural ideas that maintain the supremacy of the dominant group in society. Furthermore, he shows that the power of the dominant groups is based on economic and political capital. Therefore, the dominant groups strive to enforce their supremacy through their symbolic production, one of which is discourse. Consequently, Fairclough (2013) proposes that CDA be used to uncover the role of societal discourse in sociocultural reproduction. His three-

dimensional framework for CDA shows three forms of analysis, namely: analysis of language texts (written or spoken), analysis of discourse practice (processes of text production, distribution and consumption) and analysis of discursive events (sociocultural practice). Fairclough (2013) mentions that his framework of analysis drew from the hegemony theory of Gramsci which astutely underscores how power structures function to impede and commandeer the potential for productivity and originality in the exercise of discourse. He also drew from Bakhtin's theory of genre, which highlights the intertextuality of texts. In other words, he shows that textual analysis should incorporate intertextual analysis, showing how genres and discourses are incorporated into texts.

Fairclough (2014) recommends that the framework for analysis of texts should encompass analysis of institutional and discursual practices embedded in texts. In other words, when analysing text, one should consider the processes involved in text production and analysis of text in favour of audience reception. Furthermore, he suggested that one should also consider that the interpretation of texts embodies a dialectical process which can "be the result of the interface of variable resources that people bring when interpreting texts". He recommends that textual analysis should include an analysis of practices of production and consumption. It implies that we need to examine how text sociocultural practice link is mediated by discourse practice. We, therefore, need to interrogate how discourse practice ensures the "continuity of historicity of discursive events" (p. 45). Therefore, during the analysis of the selected Physical Sciences textbooks using CDA, I purposed to find out who the producer of Physical Sciences textbooks is, how textbooks are distributed, and who the consumer is. Put differently, I would be empowered to conclude whether textbooks were used to transmit political ideology by how gender was represented.

#### **4.6.2.3 Multi Semiotic Texts**

Multi-semiotic texts combine language with other semiotic forms, such as music, visual images and sound effects (van Leeuwen, 2005). According to Fairclough (2014), the written text becomes multi-semiotic when the graphic design of a page is considered a salient factor in the evaluation of written texts. Therefore, he recommends that textual analysis include the analysis of the text's texture. It must look at what is absent in the text and what is in the text, for example, what topic is included or excluded or what characters were included or excluded. Studying what

is in the text includes asking what thematisation is, foregrounding and backgrounding, as well as what is implicit or explicit from what is in the text.

Fairclough (2014) also shows that language in text can function ideationally, interpersonally and textually. It functions ideationally when it represents how ideas form in the mind. It can also function interpersonally when it represents social interaction between participants in discourse as well as textually, thereby tying parts of the text together into a coherent whole and linking texts to situational contexts.

## **4.7 Data analysis, procedures and tools**

### **4.7.1 Analysis of selected Physical Sciences textbooks using CDA**

Data analysis is a process where the researcher transforms a mass of data into significant, meaningful insights (Mudaly & Ismail, 2016). Smith and Firth (2011) mention three categories that are inherent to qualitative data analysis. The first category involves the use of sociolinguistic methods to explore the use and meaning of language in discourse (McCreddie & Payne, 2010). I read the data that I generated from the selected textbooks using CDA to respond to research question 1; “How is gender represented in selected Physical Sciences textbooks?” According to Fairclough (2013), there are three processes of analysis in CDA, namely textual description (text analysis), processing analysis (textual interpretation), and social analysis (explanation). The discussion below begins with explaining how I analysed it to provide a textual description.

#### **a) Stage 1 of the processes of CDA: Textual description**

Before I analysed the textbooks, I had to read them for the first time to find out whether there were gender representations because I had chosen them as they were suggested by the textbook suppliers as widely used textbooks (Fairclough, 2013; Machin & Mayr. 2012; Kress and van Leeuwen, 2020). I analysed one textbook at a time. As indicated in the sample section, only three textbooks were analysed, each representing a different grade, i.e. grades 10, 11, and 12. As recommended by Fairclough (2013), the first stage of CDA should be textual description. I began to read each textbook to find out which pages had human representations.

Similarly, Huckin (1997) suggests that the CDA analyst should begin by reading uncritically to understand what the text is about. It took a lot of my time to do this. However, since I was

reading the e-books instead of the hard copies, as I read for the first time, I took screenshots of the pages where I noticed human participants. I read through the material a second time, this time with a critical eye, and paid particular attention to the pages I had captured in screenshots. Huckin (1997) refers to the second stage of reading critically as “revisiting text” to elicit questions and envisage or visualise how it could have been composed differently.

I intently directed my attention towards the elements within the texts that appeared to possess the capability of causing confusion and misguiding the unsuspecting reader. I used the electronic colourful pen to highlight the screenshots. In most instances, I cropped the screenshots to remove the text passages that had irrelevant information so that I could paste edited screenshots to the thesis in the findings chapter. For example, as I read each textbook, module by module, I formulated the table to note the scientists that were represented in the textbook, their gender, their inventions and scientific discovery, their names and the page where they appeared in the textbook. I noted the number of man and woman scientists that were used in each textbook.

### **Stage 2 of processes of CDA: Textual Interpretation (processing analysis)**

At this stage, I began decoding text word by word (Huckin, 1997, p.81). I interrogated the texts to determine what statements and visual images might signal to the readers. I used the CDA constructs in Table 4.2 to guide my interpretation. These CDA constructs were used as codes. I attached them next to words and visuals in the data where they were associated and made notes next to where they were attached. As suggested by Fairclough (2013), Machin and Mayr (2012), and Van Dijk (2015), effective reading involves challenging ideological assumptions in written texts. I used pronouns to expose the gender of human representations in text passages. It helped me to conclude how male and female pronouns and nouns were used as representations of men and women. For example, he, she, his, hers, the boy, the girl, the mother, the man, and the father are pronouns I scrutinised. Table 4.2 below shows the CDA constructs that guided textual interpretation (processing analysis).

**Table 4.2 Framework guiding textbook analysis (Adapted from Al Ghazali (2007); Huckin (1997); Machin and Mayr (2012))**

| Criteria for CDA              | Explanation / Meaning and Application to the Study   |
|-------------------------------|--|
| Indexical signs               | Are linked directly to the thing referred to. e.g., a pram is linked to a baby, and a skirt and high heels are directly linked to a woman. Pushing a baby in the pram is linked to a nurturing role – an index conveys information more simply.        |
| Foregrounding / Backgrounding | It is an act of emphasising certain aspects, giving them textual prominence while de-emphasising others.   |
| Claim-counterclaim            | It refers to text patterns used to show two contrasting points of view.  |
| Iconic signs                  | The way a picture can refer to something by resembling it as a photograph resembles a person, usually a drawing that resembles an object or a person.  |
| Omission/silences             | Silences deal with what is said versus what is left out. Interrogates the text to determine what was not included about the scientist.   |
| Lexical choices               | It is the choice of vocabulary in naming the character.  |
| Framing                       | How is the content of the text presented? And what perspective is the writer taking?   |
| Presupposition                | Use of language in a manner that appears to take certain ideas for granted.  |
| Hyperbole                     | It is the use of exaggeration as a figure of speech to evoke strong feelings and create strong impressions. It also means using language that overstates the truth.  |
| Functionalisation             | Refers to the tendency of the authors to reduce or promote people to the roles in which they function. It helps to define what someone does.   |
| Agent-patient text framing    | It occurs when people are depicted such that one is the agent, meaning he or she is depicted as initiating actions, thereby exerting power. The other may be depicted as a patient, meaning he or she may be depicted as being passive or a recipient. |
| Specification                 | It can be done by representing people by mentioning them by their real names.  |
| Collectivisation              | It can be done by representing people as a generic group.  |
| Reiteration                   | It occurs when words are used repetitively in discourse to express major controversy about the issue that is discussed. It gives special prominence to the issue to attract the listener's attention.  |
| Presupposition                | It is the manipulative strategy of the writers to display text as if certain ideas are "taken for granted as if there were no alternatives" (Huckin, 1997, p.82).  |
| Overlexicalisation            | It occurs when there is excessive or unnecessary overuse of words in the language, resulting in redundancy and repeating the same features in the text is a strategy to persuade the readers to accept the ideology implicated.                        |

Therefore, textual description and processing analysis empowered me to respond to research question 1, which sought answers on how gender is represented in selected Physical Sciences textbooks. In the next paragraph, I discuss the last phase of analysis, the social analysis.

### **Stage 3 of the processes of CDA: Social Analysis (explanation)**

Stage 3 of the process of CDA has been successfully concluded within the contents of Chapter 7, which focuses on the detailed and comprehensive discussion surrounding the various findings that have been unearthed. At this stage, the theories that guide the study informed the discussion of the findings. These include the Social Construction of Gender, Critical Theory and Feminist Post-Structuralist Discourse Analysis. Through the Social Construction of Gender as a lens for this study, I was able to conclude who benefits from the way gender is constructed in selected Physical Sciences textbooks. Furthermore, I was able to conclude why one specific gender was portrayed in a manner that connoted elevation to power, for example, by being depicted as producers of scientific knowledge, whilst the other was portrayed in gender roles that connoted domesticity or non-STEM careers such as hairdressers.

The study was also guided by the Critical Theory, which seeks to expose the social forces that perpetuate domination in society. Winkle-Wagner et al. (2019) mention that Critical Theory was effectively used in the USA to critique language, symbols and signs. Moreover, Croucher and Cronn-Mills (2014) show that Critical Theory also aims to challenge the reproduction of inequalities in discourses. Furthermore, Fraser and Jaeggi (2018) mention that it can be used effectively to free society from capitalistic backgrounds and to expose the oppressed classes and oppressor classes in society. Consequently, it enabled me to uncover which gender was portrayed as oppressed and how the selected Physical Sciences textbooks were used as tools for perpetuating hegemonic practices (possibly).

Additionally, Critical Theory was effective in providing the conclusion about what the CDA findings in this study imply and the possible motives of the text producer. Finally, through the FPDA lens, which also seeks to challenge women's issues in discourse, I was able to determine whether the selected Physical Sciences textbooks promoted patriarchy. It also empowered me to explain the motive behind the omission of women's achievements and contributions to science. Through the FPDA lens, I was able to show how language was possibly used to perpetuate hierarchical power. The feminist lens also empowered me to expose subtle forms of hegemonic power relations that are discursively produced. Therefore, the theoretical

framework for this study enabled me to provide answers to research question 2, Why is gender represented in the ways it is in selected Physical Sciences textbooks? The section below provides a discussion of phase two of data generation for this study.

## **4.8 Phase 2**

### **4.8.1 Recruiting and sampling of participants for interviews**

Cohen et al. (2013) define the process of sampling as a crucial methodology that involves the careful selection of individuals or sampling units from a considerable population to procure a representative sample to conduct research or analysis. Naicker (2020) mentions that the researcher critically selects participants who comprise the sample because they are deemed to possess crucial information that is needed to answer the research questions. Therefore, I utilised the purposive sampling strategy to recruit ten student teachers who were willing to participate in the study. The sample for this study comprised four women and six men from the University of Durban (pseudonym). The criteria for selection included first being registered as second-year students at the University of Durban. The reason for selecting student teachers in the second year of study was to ensure that they would still be available from the time the study was conducted until it was finished. The motive behind recruiting 10 participants was to have a manageable number but still acquire adequate insights and diversified opinions on the phenomenon studied. Furthermore, Tongco (2007, p. 147) defines purposive sampling as the deliberate choice of participants from the population due to the qualities they possess. Therefore, I purposely included student teachers who specialised in Physical Sciences in my sample because the textbooks to be analysed were for Physical Sciences.

I wrote an email to two lecturers of the Physical Sciences module for second-year and fourth-year students, requesting permission to recruit the student teachers during their lesson presentations. Both lecturers permitted me to come during their lesson presentations to recruit student teachers. On the day I came to recruit, I gave a brief presentation on what the study was about and what I hoped to achieve. A total of 13 student teachers showed interest in participating in the study by raising their hands. I gave each of them consent forms as all of them were competent to consent. They all signed the consent forms and included their cell phone numbers for further communication. I did not need to recruit from another lecturer's class as I had obtained the maximum number I was looking for. I needed a minimum of 4

participants and a maximum of 10 participants. I did not reject the interested people who were above the number I was looking for because I anticipated that some of them might reconsider their decision and drop out of the study. However, only ten participated in the study. Table 4.3 on the next page shows the information about the sample of student teachers who participated in the study.

### **Justification for selecting student teachers as participants**

I recruited student teachers as participants in the study because I sought to acquire an understanding of student teachers' perspectives on gendered Physical Sciences textbooks. I anticipated that by being part of the study, they would likely expand their knowledge and skills in recognising and managing media assaults. Additionally, Bartlett and Burton (2020) suggest that learning in education necessitates a critical engagement and an interrogative approach as the researcher synthesises knowledge from other disciplines to explore how social factors such as gender, income, ethnicity, and life chances influence teaching and learning. Moreover, the involvement of student teachers in the study was to acquire unique insights as they are actively engaged in teaching Physical Sciences and utilise textbooks as their main source of content during practice teaching.

In the selection process, purposive sampling was employed to specifically target student teachers, as they represent a crucial demographic among the stakeholders utilising Physical Sciences textbooks for instructional purposes.

Various stakeholders use the Physical Sciences textbooks, including Subject Advisors, qualified teachers, teacher trainees, learners, and examiners. The study was not comparing groups that use the Physical Sciences textbooks as Learner Teacher Support Materials, but only student teachers were chosen not to represent all, rather, because the title of the study was about student teachers and not qualified teachers. Additionally, my intention was to carve out a distinctive focus for my research, as existing literature has indicated a notable lack of attention on the experiences and perspectives of student teachers in this context.

**Table 4.3 Participants who formed the sample**

| <b>Pseudonym</b> | <b>Race</b> | <b>Sex</b> | <b>Major subjects</b>   | <b>Year of Study</b> |
|------------------|-------------|------------|---|----------------------|
| Elelo            | African     | Male       | Physical Sciences (FET) /<br>Mathematics and Natural (Senior phase)         | 2 <sup>nd</sup>      |
| Wane             | African     | Woman      | Physical Sciences (FET) /<br>Mathematics and Natural Science (Senior phase) | 2 <sup>nd</sup>      |
| Pro              | African     | Female     | Physical Sciences (FET) /<br>Mathematics and Natural Science (Senior phase) | 2 <sup>nd</sup>      |
| Phiwo            | African     | Male       | Physical Sciences (FET) /<br>Mathematics and Natural Science (Senior phase) | 2 <sup>nd</sup>      |
| Mon              | African     | Male       | Physical Sciences (FET) /<br>Mathematics and Natural Science (Senior phase) | 2 <sup>nd</sup>      |
| Nature           | African     | Male       | Physical Sciences (FET) /<br>Mathematics and Natural Science (Senior phase) | 2 <sup>nd</sup>      |
| Yanda            | African     | Male       | Physical Sciences (FET) /<br>Mathematics and Natural Science (Senior phase) | 2 <sup>nd</sup>      |
| Ntsiki           | African     | Female     | Physical Sciences (FET)/<br>Mathematics and Natural Science (Senior phase)  | 2 <sup>nd</sup>      |
| Mdu              | African     | Male       | Physical Sciences (FET) /<br>Maths and Natural Sciences (Senior phase)      | 2 <sup>nd</sup>      |
| Snezzy           | African     | Female     | Physical Sciences (FET) / Maths and Natural Sciences (Senior phase)         | 2 <sup>nd</sup>      |

In the following section, I discuss interviews as a data generation strategy for this study.

#### **4.8.2 Data generation methods for phase 2: Why Interviews?**

Interviews are one of the data generation strategies used by qualitative researchers to seek answers to research questions by involving the population that is being studied to understand the phenomenon that is investigated (Denzin & Giardina, 2016). Furthermore, Denzin and Giardina (2016) assert that in a qualitative methodological approach, "...truth is socially constructed through politics of representation..." (p.6). In other words, this methodological approach makes the voices and opinions of the studied population heard. Therefore, involving Physical Sciences student teachers enabled me to generate answers for research question 2, which asked, "What are the student teachers' pedagogical responses to gender representations in selected Physical Sciences textbooks?" I gained insight from their responses, as they confirmed that they had familiarity with studied textbooks as they were similar to the ones they use for teaching preparation and presentation. In the next section, I provide a discussion of how I sampled the participants of this study.

#### **Face-to-face and Remote Interviews as Data Generation Method for this study**

Brooks et al. (2018) show that interview types are different and that each is selected to meet a specific purpose. They further mention that one needs to decide whether he or she needs to use individual or group interviews when collecting qualitative data. They further show that individual interviews can be conducted face-to-face or remotely through telephone or video conferencing (Archibald et al., 2019). In the conventional interview, the researcher sits down face-to-face with the participants to ask them questions, and they respond to them (Brooks et al., 2018). However, there are also remote interviews. These include telephone interviews, video conferencing and webcams, emails and instant messaging. Remote interviews are highly commended for allowing the researcher to involve the participants who are geographically distant (Archibald et al., 2019).

#### **Semi-structured Interviews**

Semi-structured interviews are interviews where the researcher can probe the participants for additional details if he/she deems it necessary to do so. A researcher can easily adapt it to increase the effectiveness of the interview process (Newcomer et al., 2015). Therefore, it minimises the need for the researcher to conduct interviews several times because additional probing allows the researcher to get more details about participants' thoughts, feelings, and

opinions (Brooks et al., 2018). Furthermore, semi-structured interviews permit the possibility of conducting interviews over the phone and in person (Newcomer et al., 2015). Data generation necessitated that I conduct interviews in two sessions. The first session of interviewing participants was done face-to-face, whilst the second session was done remotely through WhatsApp voice notes.

Furthermore, semi-structured interviews bring a qualitative nature to the study because they are a blend of the characteristics of structured and unstructured interviews to give richer and more meaningful results (Cohen et al., 2013). For example, the desirable characteristic of a structured interview is that questions are designed such that they require less thinking from the respondents and are easy to complete. Although the unstructured interviews require respondents to think harder, they are known to give rich, in-depth insights as they allow respondents to express their views. Hence, I adopted semi-structured interviews (which blend the characteristics of both the structured and unstructured) to encourage participation and to ensure that participants complete the interview schedule. Given my choice of semi-structured interviews, where the researcher had the flexibility to probe further if needed, I arranged more sessions to carry out these interviews remotely.

Consequently, semi-structured interviews were suitable to generate data to respond to research questions 3 and 4. Each participant met twice with the researcher to be interviewed. The pilot study was conducted to determine the smooth flow of the questions, identify the possible gaps in the interview schedule, and fill them. Furthermore, it assisted me in identifying problems with wording to determine if there was a need to clarify any questions. Lastly, it assisted me to confirm that the time I had estimated for the interview was enough. (Brooks et al., 2018).

Brooks et al. (2018) state that qualitative interviews are conducted to focus on people's actual experiences rather than general beliefs and opinions. They further allude that interviews enable participants to present their understandings and experiences of the phenomenon that is investigated. They allude to the fact that interviews become suitable when the researcher wants to answer the research questions that seek answers from participants' experiences and understandings. Thus, it matched my purpose to generate responses for research question 3, "What are the student teachers' pedagogical responses to gender representations in selected Physical Sciences textbooks?" as well as research question 4, "What informs the student teachers' pedagogical responses to gender representations to selected textbooks?".

Initially, I conducted face-to-face interviews to generate answers for question 3. I presented the excerpts from the selected textbooks to the participants. Then, I interviewed them to share their views on how they intended to address the biases from the Physical Sciences textbooks to learners in a manner that will motivate and possibly increase the number of Physical Sciences learners who pursue Science-related courses after schooling. Therefore, I assured the participants at the beginning of the interview session that there were no wrong or right answers and that it was important that they freely share their opinions without fear of being judged, as the purpose was to find ways to benefit all Physical Sciences learners they would teach in the future.

However, I realised that these interpretations were not enough for research question 4, which asked, “What informed student teachers’ pedagogical responses to how gender is represented in selected Physical Sciences textbooks?”. Since I had chosen semi-structured interviews, I made appointments again to conduct interviews remotely. These semi-structured interviews were done using WhatsApp voice notes. In my proposal, I indicated that I would decide between conducting face-to-face interviews and remote interviews after recruiting participants. I said this because the ethical clearance was granted whilst the country was in lockdown due to the COVID-19 pandemic. Therefore, I wouldn’t be able to conduct face-to-face interviews if it was during that season in the country. However, having read and understood what remote interviews entailed helped me to conclude my second session of interviews, as they took place during holidays when all participants were not in the University’s surroundings. Otherwise, it would have meant that I needed to wait until the student teachers came back from holidays before I made appointments. Furthermore, I considered that if I waited, I might not find the participants as student teachers tend to be away (from the university lodgings) for a month or more for practice teaching.

### **Session 1: Face to face interviews**

Brooks et al. (2018) mention the six factors that need to be considered before the actual face-to-face interview is conducted. These factors include interview setting, recording, building rapport, how to ask questions, probing, as well as starting and finishing. Similarly, Bowden and Galindo-Gonzalez (2015), whose research objective was “...to develop an email interviewing methodology”, also considered these factors when conducting interviews. Furthermore, they mention that it is important to “...identify constraints, adequately prepare for the interview, establish a rapport, ask appropriate questions, listen actively and end the

interview appropriately” (p.79). They mention that it is important that the interview setting provides comfort and privacy to the participants as well as the interviewer.

One of the things that we promise the participants whilst recruiting them to the study is confidentiality. This confidentiality does not only refer to not disclosing their names but also that the interview process remains as private as possible. Brooks et al. (2018) further emphasise that the interviewee needs to be comfortable both physically and psychologically. Hence, the location that is selected needs to be quiet, and this also helps to avoid unnecessary background sounds and echoes being recorded when the interview is audio-recorded. Although it is highly recommended to have the interviews audio-recorded, Brooks et al. (2018) mention that handwritten records may also be kept because, in most instances, the device that is used to record the interview session may have technical problems and therefore, this would mean the researcher will have no data collected. Brooks et al. (2018) also stress the importance of obtaining consent from the participants to audio-record the interview, as it is within their rights to agree or disagree. Building rapport is about how you make the participants trust you such that it becomes easy for them to disclose personal feelings to you as the researcher. It may include ensuring that participants have a proper understanding of the whole interview process.

Therefore, I requested permission from the University’s librarian to use one of the conference rooms in the research commons to ensure that each interview session was private. I had already made appointments with each participant, and the interview sessions were to be finished in three days as the selected dates were during the long weekend. In the letter that I gave each participant when I came to recruit, I explained that interviews would be recorded, and each participant consented to audio-recorded interviews.

For the participants that were interviewed in the library’s conference room, I waited outside the library to escort each participant to the research commons, as only the PhD students could use student cards to open the door to enter and exit. I welcomed each participant by greeting them and thanking them for considering participating in the research. I showed each participant where to sit. The room was comfortable, with a table and comfortable chairs. This arrangement allowed eye contact between the participants and me. The interview was private as I had booked the room solely to be alone with each participant during the interview session. Then, I reminded each participant that the interview was audio-recorded as they had consented to this. I also reminded each participant that they were not obliged to answer all questions,

in other words, they could omit questions that they were not comfortable answering.

I began by taking 30 minutes to show each participant chapters from selected textbooks with findings and summarised how I interpreted gender representations in each textbook. I showed the participants the texts and visuals from each textbook where human participants were used to either introduce the section, show the founder of scientific knowledge to be learnt or as examples to illustrate scientific concepts. I took about 5 minutes to orientate each participant to questions, explaining what each question entailed. During this session, the question-and-answer method was employed. I asked one question at a time and waited for the participant to answer. I took about 30 minutes to interview each participant. In certain instances, I would refer to the pages I had shown the participants to clarify questions. However, I was initially shocked that all participants could refer to the texts and visuals without asking me to reopen the textbooks that I used to show my findings. Until more than half of the participants confirmed that they knew what was in each textbook we had perused as they had used them whilst they were learners of Physical Sciences during their schooling years. It was confirmed to me that the textbook suppliers had guided me correctly when they told me that those textbooks were the ones that were widely used to teach Physical Sciences in South Africa.

The qualitative methods provided me with opportunities to allow student teachers to interpret gender manifestations that were extracted from the selected Physical Sciences textbooks. I opted for individual face-to-face interviews because all participants were studying in one institution. I assumed that I could interview them on-site, and this meant saving money. Additionally, I had anticipated that if I designated 1 hour for each participant's interview, I could finish ten interviews in 2 days. Also, face-to-face interviews helped me to build a good relationship with participants as they told me that they all found me friendly, and this made them not feel victimised when they answered questions.

I also noticed that they were very frank in expressing their views when they did not agree with my opinion. This atmosphere confirmed that, through my nature of being a friendly person who smiles and finds anything to appreciate from students to provide a warm atmosphere, a good rapport had been set for the process to occur in the absence of any indications of victimisation.

Individual face-to-face interviews were done at two sites. The first site was the university's library at the research common's conference room. I had arranged with the librarian to use the library's conference room for my meetings. A total of 7 participants were interviewed on this site. The second site was 22 kilometres away from the University's campus, in the students' residences. Only 3 participants were interviewed on this site.

The participants were interviewed in three days. During the first day, only 1 participant was interviewed because he had indicated that he would not be available for other dates as he was leaving for home. After all, it was the long weekend. On the second day, 5 participants were interviewed. The first three offered their residences as private places for interviews as they stayed away from the University's residences and needed to use public transport to come to the campus. So, I offered to come to their residence. However, each participant was alone with me during the interview. The other 2 of the five were interviewed at the University's library conference room (also individually). The last four were interviewed on the third day, also at the university's library conference room at the research commons. The table below provides detailed information on appointments for interviews with participants.

Table 4.4 Information on face-to-face individual interview appointments

| <b>Pseudonym</b> | <b>Race</b> | <b>Gender</b> | <b>Time</b> | <b>Venue</b>            | <b>Major subjects</b>                                      | <b>Year of Study</b> |
|------------------|-------------|---------------|-------------|-------------------------|--|----------------------|
| Elelo            | African     | Male          | 4 pm        | Library                 | Physical Sciences (FET) / Maths and Natural Sciences (GET) | 2 <sup>nd</sup>      |
| Wane             | African     | Female        | 10:30 am    | University<br>Residence | Physical Sciences (FET) / Maths and Natural Sciences (GET) | 2 <sup>nd</sup>      |
| Pro              | African     | Female        | 11:30 am    | University<br>Residence | Physical Sciences (FET) / Maths and Natural Sciences (GET) | 2 <sup>nd</sup>      |
| Phiwo            | African     | Male          | 12:30 pm    | University<br>Residence | Physical Sciences (FET) / Maths and Natural Sciences (GET) | 2 <sup>nd</sup>      |
| Mon              | African     | Male          | 2:00 pm     | University Library      | Physical Sciences (FET) / Maths and Natural Sciences (GET) | 2 <sup>nd</sup>      |
| Nature           | African     | Male          | 5:00 pm     | University Library      | Physical Sciences (FET) / Maths and Natural Sciences (GET) | 2 <sup>nd</sup>      |
| Yanda            | African     | Male          | 6:30 pm     | University<br>Residence | Physical Sciences (FET) / Maths and Natural Sciences (GET) | 2 <sup>nd</sup>      |
| Ntsiki           | African     | Female        | 10:00 am    | University Library      | Physical Sciences (FET) / Maths and Natural Sciences (GET) | 2 <sup>nd</sup>      |
| Mdu              | African     | Male          | 11:00 am    | University Library      | Physical Sciences (FET) / Maths and Natural Sciences (GET) | 2 <sup>nd</sup>      |
| Snezzy           | African     | Female        | 12:05 pm    | University Library      | Physical Sciences (FET) / Maths and Natural Sciences (GET) | 2 <sup>nd</sup>      |

All the data captured in the audio recording were transcribed verbatim.

## **Session 2: Remote interviews**

Although the first interviews for participants were conducted towards the end of April, the second interviews, which entailed finding out how participants were socialised to generate data for research question 4, were conducted towards the end of June. The reason for this was that May and June became hectic for me as I teach six classes. I had to set quality examination question papers for four different subjects in May, coupled with their marking guidelines (memoranda). I also had to engage in extensive marking after each examination question paper had been written to ensure that learners' marks were captured timeously for parent reporting. Furthermore, in June, the participants finished their half-yearly assessments at the University. They were all available to finish the interviewing process. However, as I mentioned earlier, these interviews were conducted remotely using WhatsApp voice notes. First, I phoned each participant, requesting permission to finish the interviews as I had indicated to each one of them. However, this time, there were no fixed appointment dates and times for each participant, as I gave them the liberty to send their interpretations via voice notes when they were ready. I did this because most of them had indicated to me that they were tired and felt they needed to rest during the holidays. Ultimately, I did not want them to withdraw from the study at that stage because of feeling an extra burden. The table on the next page shows the detailed information for the second interview with participants:

Table 4.5 Details of participants' interviews using WhatsApp voice notes

| <b>Pseudonym</b> | <b>Race</b> | <b>Gender</b> | <b>Major subjects</b>                          | <b>Year of Study</b> |
|------------------|-------------|---------------|--|----------------------|
| 1. Elelo         | African     | Male          | Physical Sciences (FET) / Maths (Senior phase) | 2 <sup>nd</sup>      |
| 2. Wane          | African     | Female        | Physical Sciences (FET) / Maths (Senior phase) | 2 <sup>nd</sup>      |
| 3. Pro           | African     | Female        | Physical Sciences (FET) / Maths (Senior phase) | 2 <sup>nd</sup>      |
| 4. Phiwo         | African     | Male          | Physical Sciences (FET) / Maths (Senior phase) | 2 <sup>nd</sup>      |
| 5. Mon           | African     | Male          | Physical Sciences (FET) / Maths (Senior phase) | 2 <sup>nd</sup>      |
| 6. Nature        | African     | Male          | Physical Sciences (FET) / Maths (Senior phase) | 2 <sup>nd</sup>      |
| 7. Yanda         | African     | Male          | Physical Sciences (FET) / Maths (Senior phase) | 2 <sup>nd</sup>      |
| 8. Ntsiki        | African     | Female        | Physical Sciences (FET) / Maths (Senior phase) | 2 <sup>nd</sup>      |
| 9. Mdu           | African     | Male          | Physical Sciences (FET) / Maths (Senior phase) | 2 <sup>nd</sup>      |
| 10. Snezzy       | African     | Female        | Physical Sciences (FET) / Maths (Senior phase) | 2 <sup>nd</sup>      |

All the voice notes were transcribed verbatim as most people delete messages on their WhatsApp due to insufficient storage in their cell phones. In the next paragraphs, I discuss how data generated from interviews was analysed.

#### **4.8.3 Data Analysis for phase 2: Analysis of interview transcripts**

Before the actual analysis of data that I had generated from participants, I realised I needed to transcribe it from being voices in audio recording devices to words that were written. During the actual interviews, I did not take field notes. I relied solely on the audio recording device that I had brought along to capture data.

Before I analysed data that I had generated through face-to-face and telephonic interviews, I transcribed all audio recordings verbatim (Sutton & Austin, 2015). Many qualitative researchers describe transcribing as the process of converting spoken words into written words (Eaton et al., 2019; Hill et al., 2022). This process took me several days because transcribing data from each participant required that I listen to an audio recording device and pause it several times whilst typing what the participant had said. Sutton and Austin (2015) show that transcribing a 45-minute interview can take 8 hours. Eaton et al. (2019) align with this view by stating that verbatim transcription can even delay the availability of research findings. However, they show that it is the only way of capturing participants' data correctly. Although my recording device was perfect for taking voices (Brooks et al., 2018), in certain instances, participants lowered their voices during the interviews. The reason for this was the fact that English was not the mother tongue of participants, so when they ran short of English vocabulary words, they lowered their voices. Therefore, I had to reverse the recording several times to get explicitly what the participant was communicating to me. During the process of transcription, all participants were anonymised (Sutton & Austin, 2015). As recommended by Sutton and Austin (2015), before I proceeded from one participant to the next during the transcribing process, I listened to the audio recording again whilst reading what I had written to edit errors and to ensure I had captured all the data correctly.

Once all participants' interviews had been transcribed, I saved the transcripts in PDF format, sent a copy to each participant and requested them to validate if I had interpreted them correctly (Lemon & Hayes, 2020).

All this was quick because all transcripts were sent via WhatsApp instant messaging. I attached a message stating that participants could indicate where they felt they were misinterpreted. I

indicated that they should make me aware if they felt that they wanted to withdraw the words they had used or add to them if they so desired. This principle is in line with Anney's (2014) proposition that the researcher needs to present the findings of the study in a manner that preserves the dignity and respect of the participants. However, one participant requested that I correct one of the opening sentences he had used. All other participants responded by stating that they were satisfied with how I interpreted conversations and wished me good luck with report writing. It was only after this stage that I felt that I could start my data analysis.

Therefore, despite the delays that come with audio-recorded data that is captured during interviews, such as lengthy hours involved during the transcribing process and delays in the availability of the findings, I recommend this process to researchers who conduct data analysis after several weeks. The reason is that audio recordings keep all the important information that transpired during the interview fresh. Taking only field notes requires one to analyse the data whilst the memory is still fresh; otherwise, some important and useful data may be omitted. In the next section, I discuss thematic analysis as the strategy that I adopted to make meaning to data so I could respond to research questions.

#### **4.8.4 Thematic Analysis of Interview Data**

Thematic Analysis is regarded as a qualitative method of data analysis that results in identifying patterns and themes in data (Maguire & Delahunt, 2017). Braun and Clarke (2012) define thematic analysis as the reflexive tool that enables the researcher to give a detailed account of data. Furthermore, in their later study, they show how thematic analysis empowers the researcher to classify and categorise datasets systematically to make meaning (Braun & Clarke, 2012). In other words, the researcher identifies the commonalities from the interpretations of different participants to conclude about the phenomenon that is studied. Additionally, the researcher who uses thematic analysis as an analytic strategy focuses on relevant data to answer the research questions.

Moreover, Braun and Clarke (2012) allude to the fact that thematic analysis offers flexibility to researchers because the researcher can opt for investigating one aspect of the phenomenon (from the dataset) at a time or analyse the entire dataset one time to make meaning from participants' interpretations. Therefore, they show three approaches to analysis using thematic analysis, namely, inductive, deductive or blended approach.

If the researcher chooses the inductive approach, it means that codes and themes that will be used in meaning-making will emerge from the data. In other words, it is grounded in the data. Therefore, Braun and Clarke (2012) refer to this approach as the ‘bottom-up’ because the researcher prioritises the participants and, therefore, gives a voice to their interpretations. On the contrary, if the researcher chooses to follow the deductive approach, which is regarded as the ‘top-down’ strategy, he or she will bring ideas, concepts and topics to make meaning to the participants’ interpretations. In other words, the researcher uses the predefined codes to interpret data. In this case, the researcher uses the theory to formulate the codes because he or she is “coding for a particular theory construct”, and this strategy is driven by research questions (Maguire & Delahunt, 2017). However, they emphasise that the analytic lens must not completely override the stories of the participants. Finally, in the blended approach, they mention that the researcher uses the combination of both the inductive and deductive approaches. They show that in a blended approach, the researcher may start inductively by ensuring that the analytic lens does not completely override the stories narrated by the participants. Additionally, the researcher will analyse deductively using theory to make visible what is not explicit in participants’ stories. However, they emphasise that the most important aspect of thematic analysis is coherence and consistency in analysing what is important.

Consequently, the thematic approach became suitable for this study as it became the precise method that I could employ to analyse the data I had generated during the interviews (face-to-face and telephonically). The deductive approach became more relevant to me as I analysed the participants’ interpretations to answer research question 3, which sought answers to “What are the student teachers’ pedagogical responses to gender representations in selected Physical Sciences textbooks?”. I read the participants' interpretations critically, firstly, to find the wording that agreed or disagreed with the interpretations I had made when I conducted CDA. Consequently, in the findings chapter, I pasted the paragraphs, sentences, and words from the participants’ transcripts to show their interpretations of gender representations in physical science textbooks. Therefore, in this manner, an inductive approach was used, and this made the voices of participants heard as I extracted their interpretations from the transcripts and pasted them into the chapter on relevant findings. Subsequently, I analysed and interpreted the extracts that I had presented for meaning-making using the theories that guided the study.

Finally, as I read the transcripts that were derived from the WhatsApp voice notes, I also approached the data deductively since the narratives were meant to answer research question 4, which sought answers on “What informed their pedagogical responses to gender

representations in selected textbooks”. I generated the possible themes using the theories that guided the study first, and then, as I read critically, I checked whether I could find links to what they had narrated.

Braun and Clarke (2012) show 6 steps of qualitative data analysis. In the next section, I provide a discussion of how I employed these steps of thematic analysis to provide the findings and their interpretations in the next chapters. They include acquainting yourself with data, generating initial codes, identifying themes, re-evaluating potential themes, defining and naming themes and producing a report. I followed the chronology in which these themes are written to analyse the data. Therefore, the discussion below starts with phase 1, familiarising yourself with data.

### **Step 1: Familiarising yourself with data.**

Firstly, I printed all transcripts as hard copies so that whilst I was reading, I could underline or highlight words and sentences and make notes on the data. I read the data from transcripts and listened to audio tapes several times. I listened to the audio recordings first to transcribe data from the voice format to the written format. At this stage, I was not listening critically. I listened again whilst reading the transcript to edit errors such as adding what had been mistakenly omitted and even editing spelling. I then read attentively several times to immerse myself in the data. I made notes as I read analytically and critically. I did not focus on one transcript at a time. I read the entire first page of all transcripts and then began to highlight words that were similar in each transcript (Braun & Clarke, 2012).

### **Step 2: Generating initial codes.**

As I read the data again, I labelled and made notes of what it evoked in me as I read. At this stage, I was guided by research questions. I analysed one transcript at a time, labelled the data with codes and attached notes. I kept reminding myself that I was looking for participants’ interpretations of gender representations from excerpts I had shown them during interviews to answer research question 3. Braun and Clarke (2012) show that codes can be descriptive or interpretive. They mention that descriptive codes stay close to participants’ meanings while interpretive codes move beyond participants’ meanings and provide an interpretation of data content.

Instead of coding line by line, I segmented the portions of data and then labelled them with specific codes guided by the theories that guide the study, such as hegemony, masculinity,

inequalities, subordination, dominance, and discrimination. Working in hard copies made it easy and quick for me at this stage. It is also important to mention that I had to code the transcript fully before I proceeded to the next. Some codes changed as I progressed, and some segmented datasets were coded more than once.

### **Step 3: Searching for initial themes.**

Maguire and Delahunt (2017) regard the theme as a set of information that is captured from data that has relevant and interesting information about the research question. Such a set of information or wording is usually repeated in interpretations of more than 1 participant. However, in my case, I found that most participants were not repeating the same words, but the mentality behind spoken words from different participants became fit to be grouped under one theme. For example, one participant declared that the authors wanted to write science history about men only because men were overrepresented in selected textbooks. The other participant mentioned that more man scientists were portrayed in the selected textbooks than woman scientists and regarded this as an indication of gender inequality. Other participants also mentioned that nice, colourful pictures of real persons mostly represented men, whilst shades or sketches represented women. I analysed these extracts under one theme because, in all cases, the participants' interpretations used a comparison between man and woman scientists who were represented in selected textbooks. These interpretations signalled to me the presence of what is known as gender differentiation because there was a significant difference between how men and women were portrayed according to participants' interpretations. However, later, the initial themes were grouped into broader themes that aligned with a research question.

### **Step 4: Review of themes**

During this phase, each theme was interrogated to establish if it made sense and, most importantly, if the data analysed matched the theme where it was allocated.

In other words, I had to challenge datasets from different participants that I had used under the same themes and decide whether they were fit to be placed and discussed together. I attempted to analyse in a manner that shows where there were relationships in the way participants responded. I also searched if there were any conflicting conclusions around similar concepts. For example, I found that participants had different conceptualisations of gender. Although how they understood the meaning of gender was different, it was still discussed under the same

theme. Additionally, this is how the theme provided interesting data that enriched the study's findings.

#### **Step 5: Define themes.**

At this stage, I had to ascertain the essential elements at the core of each theme that Maguire and Delahunt (2017) termed as “the essence of what theme is about”, without which it loses its identity. During this stage, I re-evaluated the themes to check what the theme was about, the possibility of developing sub-themes and how they were interconnected to the main theme.

#### **Step 6: Writing –up**

This stage entailed writing up chapters 5, 6 and 7 as part of the findings. In Chapter 5, I presented and analysed data acquired through conducting CDA in three selected Physical Sciences textbooks. In Chapter 6, I presented and analysed the findings from interviewing participants face-to-face and telephonically. In Chapter 7, I interpreted and discussed the study's findings. In Chapter 8, I wrote the conclusion of the study and recommendations.

Since the Critical Theory moves beyond critiquing to emancipating individuals, I believe that student teachers who engaged in the study will possibly engage critically with existing materials and hopefully revolutionise the Physical Sciences classrooms for more than three decades in different parts of the country where they will be employed (despite the presence of gender biases in texts). Eventually, the learners they will teach, who could experience the effects of the change that these student teachers might bring, are likely to transmit the change to the next generations, and the cycle of this change in the Physical Sciences classroom might continue. It is worth noting that all Physical Sciences student teachers were convinced that gender biases in texts would not disappear overnight. However, they committed to engage learners they will teach in ideology critique of texts and visuals to reduce the stereotypical effects in teaching and learning of Physical Sciences.

### **4.9 Rigour in research**

Many researchers recommend the principles of trustworthiness to achieve rigour during the research (Guba, 1981; Machin & Mayr, 2012; Wood & Kroger, 2000). A trustworthy inquiry demonstrates that an inquirer can persuade their audience that the study is worth paying attention to and is worth taking into account (Lincoln & Guba, 2000). Therefore, I followed

the criteria that are proposed by Lincoln and Guba (2000) to establish trustworthiness in the study. These criteria include validity, credibility, transferability, dependability, and confirmability. Details on how these criteria were applied in this study are discussed below.

#### **4.9.1 Credibility**

Credibility is defined as the assurance that the research conclusions are the correct interpretations of the participants' original thoughts, attitudes and views (Anney, 2014). Anney (2014) mentions that to achieve credibility, the researcher needs to minimise distorting and misinterpreting the information during data interpretations. The interviews were audio-taped to ensure that I listened to the respondents' narratives several times in order not to misinterpret what was communicated. Credibility was also achieved through prolonged engagement, persistent observation, and triangulation (Lincoln & Guba, 2000). I employed prolonged engagement when I listened to the audio recordings and voice notes for the first time when I was transcribing. In this phase, I replayed the recordings multiple times to capture the participants' verbal expressions accurately. After that, I read the transcripts again whilst listening to the recordings again to edit errors and to maximise the integrity of the data. I read the data again and coded data to eventually form the themes. Persistent observation was employed during the analysis of texts and visual images during the analysis of textbooks using CDA. It enabled me to compare how visual images of women were portrayed differently from those of men, e.g. portraying a woman pushing a 5kg box whilst depicting a man pushing a box that has no weight indicated ideological subversion.

Anney (2014) also proposes that the researcher also conducts "member checks" as a strategy to improve the quality of qualitative data. Guba (1981, p. 85) mentions that member checks mean that data and analyses are repeatedly evaluated as they are derived from members of various audiences and groups from which data are procured. He elaborates that member checks are achieved by sending the analysed and interpreted data to the participants to enable the participant to verify if he/she is happy or not about how he/she is interpreted. If the participant is not happy with the researcher's interpretations, he/she may suggest changes. This step eliminates the researcher's bias during analysis and interpretation.

Therefore, I sent transcripts of interviews to each participant and requested them to validate how I had interpreted them. Additionally, I mentioned that they must state areas where they felt they were misinterpreted. I emphasised that they should indicate if they wished to withdraw

certain statements. All the participants sent messages that they were happy with how they were interpreted.

Guba (1981, p.85) also recommends that the qualitative researcher “seeks support from other professionals willing to provide scholarly guidance... to improve quality of the findings”. My supervisors helped me change some of the questions in the schedules and read the first transcript to determine if the findings would be enough to answer the research questions. Anney (2014, p.277) also proposes that the researchers “should present study findings to peers to receive their comment and obtain the perceptions of peers in developing the conclusion of the study.” Consequently, I continuously share my interpretations with my friend, who is also doing a PhD to serve as my critical friend.

#### **4.9.2 Transferability**

Lincoln and Guba (2000) mention that transferability can be achieved by validating that the findings of the study can be practical in other contexts. Anney (2014) elaborates that the researcher makes the study transferable through thick description and purposeful sampling. He states that thick description is achieved through a detailed description of the research process. In other words, the researcher must provide details of the data generation methods that were employed. I have discussed the data generation methods for this study in sub-section 4.6 and 4.7 of this chapter. I have also used purposive sampling as the technique of selecting participants for the study. Purposive sampling is defined as “...consciously choosing units (e.g., individuals, groups of individuals, or institutions) based on specific purposes aligned with answering a research study’s questions” (Teddlie & Yu, 2007, p. 77). According to Anney (2014) and Cohen et al. (2013), purposive sampling empowers the researcher to choose people who are experts in the knowledge of the concept under investigation, and this results in greater in-depth findings. Subsequently, I purposely selected Physical Sciences student teachers as the sample for the study because the textbooks to be studied are for teaching and learning Physical Sciences as a school subject. The interpretations of the participants have made the findings from the CDA even more meaningful because they had experienced what I had discovered in the selected textbooks first-hand whilst they were learners of Physical Sciences during their schooling years and their practice teaching as student teachers of Physical Sciences.

### **4.9.3 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). Furthermore, Wood and Kroger (2000) argue that keeping analysis notes and transcripts ensures that the findings are grounded in the data and that they can be made available for audit trail. Consequently, I have kept the transcripts (in electronic storage encrypted with a password) that I used during the analysis so that they can be made available for re-analysis.

### **4.9.4 Dependability**

#### **4.9.4 Dependability**

Anney (2014, p.278) mentions that dependability is done to ensure that the researcher’s findings and recommendations are backed by the facts established by participants of the study. Consequently, I pasted participants’ interpretations to the chapters where they were analysed and discussed. I sent interview transcripts to participants to verify whether how I presented the findings was consistent with the data they provided. I also established dependability through audit trail, stepwise replication, code-recode strategy, and peer examination, as recommended by Schwandt, Lincoln, and Guba (2007). The details thereof follow below.

#### **a) Audit trail**

I have saved all the original data documents, such as transcripts of interviews, copies of audio recordings and the notes generated during my analysis of textbooks using CDA in OneDrive. These documents will be made available on request by the internal auditors (supervisors of this study) as well as external auditors (internal and external examiners). The availability of these documents will enable auditors of the study to cross-check the inquiry process, including how the data was collected, recorded and analysed to validate the dependability of the study.

#### **b) Stepwise replication**

Stepwise replication involves two or more researchers independently analysing the same data and comparing their results (Anney, 2014). This procedure is conducted to identify and address discrepancies that may arise, thereby improving the dependability of the study. I asked my critical friends, who are also PhD students, to analyse the data I had gathered from

textbooks and then compare the findings. This helped me because both of them are also language teachers. Hence, they were able to confirm that I had interpreted some CDA constructs they were familiar with correctly. As an instance to highlight their expertise, they demonstrated a thorough understanding of CDA constructs, acknowledged as rhetorical elements in the field of English language studies, such as hyperbole, reiteration (which employs synonyms), and presupposition. Moreover, they were instrumental in validating the proper utilisation of CDA constructs that serve as parts of speech including pronouns and claim-counterclaims which incorporate conjunctions such as ‘but’ or ‘however’.

#### **c) Code-recode strategy**

I coded the same data twice, giving a week’s gestation period between each code (Anney, 2014). Chilisa and Preece (2005) elaborate that coding twice enables the researchers to compare the results from their coding at different occurrences to determine if they are the same or different. If the results are the same, it increases the dependability of the study. Therefore, I read the transcripts several times, coding data each time I read it. I have found the data dependable because results came out the same every time it was coded.

#### **d) Peer examination**

Anney (2014) states that peer examination is the same as member checks. I have outlined how I have carried out member checks under the section on credibility principle. I have also ensured consistency in the manner in which I analysed each participant’s document to increase the dependability of the study. Wood and Kroger (2000) mention that records of documents and the way the discourse analysts exhibit the basis of their arguments are necessary to convince the reader that the analysis was done cautiously. Therefore, I directly quoted the participants’ interpretations to the thesis to authenticate my analysis. Lincoln and Guba (1986) further mention that dependability is about showing that findings are consistent and can be repeated. Consequently, I have outlined the research design fully so that future researchers can repeat the study to verify the findings in a different context.

### **4.10 Ethical considerations**

I requested permission from the Registrar of the University to conduct the study at the selected University. The ethical clearance was granted and is attached in the appendices section.

After recruiting the participants to the study through the Physical Sciences lecturer, I provided each recruited person with consent forms. Having each recruit fill in and sign the consent form was a means of declaration that each recruited person agreed to participate in the study and consented to be audio-recorded. Mohd Arifin (2018) states that consent should be given voluntarily, and participants should understand what is asked of them. Therefore, I explained the consent form to participants, line by line and stressed that no one was forced to participate.

Furthermore, I gave each recruited student teacher a letter that explained the purpose of the study and data generation strategies. In the letter, I also clarified that a participant could withdraw from the study at any stage as participation was voluntary (Cohen, Manion, & Morrison, 2013). All participants consented to audio-recorded interviews. Three of the recruited student teachers did not show up for interviews. Although they had given their cell phone numbers, I did not pressurise them as I respected the fact that I had told them that they were at liberty to withdraw from the study at any stage should they so desire.

Mohd Arifin (2018, p. 30) also mentions, "The protection of participant anonymity and confidentiality is crucial and should be maintained by not disclosing their names or identity throughout the process of data collection, analysis, and reporting of study results.". Therefore, I used pseudonyms when referring to participants during the thesis write-up. Furthermore, the letter to the recruited participants clarified that the findings from collected data would be solely used for a Doctoral thesis and that there would be no monetary gain for participating in the study (Cohen et al., 2013). The findings of the study are saved in my OneDrive, which is encrypted with a password to ensure that they are safe and can be made available whenever they are needed. Although hard copies were made for efficient analysis, they were scanned into my computer after analysis and are also kept in my OneDrive storage. The hard copies were destroyed. The findings will, therefore, be kept in these password-encrypted electronic devices for five years and then disposed of.

#### **4.11 Conclusion**

In this chapter, I discussed the methodology that I employed to generate, present and analyse data. The study was qualitative in nature, located within the Critical paradigm. Purposive sampling was employed to select 3 Physical Sciences textbooks that are used to teach grades 10 to 12 in South African schools. Critical Discourse Analysis was employed to generate data from the selected textbooks. The study also engaged student teachers to get their insights on biases in selected texts and strategies that Physical Sciences teachers could employ to disrupt

gender norms and stereotypes that may be prevalent in Physical Sciences textbooks. Face-to-face and remote interviews through WhatsApp voice messaging were employed to generate data from student teachers. Thematic analysis informed the analysis of participants' interview transcripts. Delineations of how rigour was achieved by following principles of trustworthiness are detailed in sub-section 4.8 of this chapter. Ethical considerations are discussed in section 4.10.

## **Chapter 5: Analysis of selected textbooks**

### **5.1. Introduction**

In this chapter, I present my analysis of gender representation in the selected textbooks used to teach Physical Sciences in grades 10 – 12 in South Africa. I used Critical Discourse Analysis (CDA) to analyse how gender is represented in the three selected textbooks. The constructs used are defined in Table 4.1 in the methodology chapter of this thesis. The findings in this chapter respond to the first research question:

#### **How is gender represented in selected Physical Sciences textbooks?**

The analysis occurred in three phases proposed by Fairclough (2013): textual analysis, interpretation and social analysis. During textual analysis, the CDA constructs that I used to describe how gender was portrayed in the selected textbooks include lexical choices, claim-counterclaims, silences, reiteration, high angle of the camera, foregrounding, presupposition, focus, framing, indexical and iconic signs (Al Ghazali, 2007; Huckin, 1997; Machin & Mayr, 2012 & van Leeuwen, 2005). These CDA constructs assisted me in interrogating texts and visuals to expose the ideological messages hidden in the way gender was represented in the selected Physical Sciences textbooks.

The interpretation of the findings was guided by theories that underpin this study, such as the Social Construction of Gender, Critical Theory and Feminist Post Structuralist Discourse Analysis (FPDA). The discussion below shows that textbook messages promoted gender inequality in favour of men.

### **5.2 Gender inequality being disseminated through textbooks**

Gender inequality is regarded as a social phenomenon whereby people in a society are not treated equally and do not have equal rights based on their gender (Kalpazidou Schmidt & Cacace, 2017; Ponthieux & Meurs, 2015). According to the United Nations and World Health Organisation, gender inequality emanates from differences in the social construction of gender roles (Gutiérrez-Martínez et al., 2021). Women and men do not have access to equal opportunities. Therefore, gender inequality signals a violation of the human right to gender equality. Downey et al. (2014) mention that ideologies in texts can produce a social world that is characterised by social inequality because of the unequal distribution of authority.

Van Dijk (2016) supports this statement, elaborating that ruling classes exercise their power to disseminate gender inequality through texts. Discourses in selected Physical Sciences textbooks showed different forms in which gender inequality was disseminated, one of which was the overrepresentation of men as producers of scientific knowledge. The discussion is detailed hereunder.

### **5.2.1 Representation of men and women scientists**

The analysis of all the textbooks selected for this study shows that men were overrepresented as producers of scientific knowledge. When I began my analysis, I read through the entire textbook to get a general orientation of the text and its contents. After that, I noted pages that had human representations in the form of text and visuals. I took screenshots of the noted pages and focused only on them when I read critically for the second time.

In Textbook A, Marie Curie is the only woman I found producing scientific knowledge. She is the founder of the concept of “radioactivity”. As I continued searching for producers of scientific knowledge, I found fourteen (14) men as producers of scientific knowledge in Textbook A. In Textbook B, I found 17 men depicted as producers of scientific knowledge. Although the two women I also found were addressed as specialists of scientific knowledge, the textbook did not mention what they produced or invented. One is regarded as the Chemist, whilst the other is portrayed as the Physicist. In Textbook C, no women were depicted as scientists or producers of scientific knowledge. The analysis results of Textbooks A, B, and C are demonstrated in this Chapter on pages 104 – 17, respectively.

**Table 5.1: Representation of men/women as producers of scientific knowledge in Textbook A**

| <b>Pseudonym-Textbook A: Grade 10</b> |  |               |             |
|---------------------------------------|--|---------------|-------------|
| <b>Name of the scientist</b>          | <b>Scientific invention or discovery</b> | <b>Gender</b> | <b>Page</b> |
| 1. Leucippus                          | Atomic model                             | Man           | 56          |
| 2. Democritus                         | Atomic model                             | Man           | 56          |
| 3. Dalton                             | Law of Multiple proportions              | Man           | 56          |
| 4. Thompson                           | A Cathode ray tube                       | Man           | 57          |
| 5. Rutherford                         | Atomic Model – protons and electrons     | Man           | 57          |
| 6. Becquerel                          | Atomic model                             | Man           | 57          |
| 7. Bohr – Danish Physicist            | Electrons move in orbits                 | Man           | 57          |
| 8. Robert Brown                       | Brownian motion                          | Man           | 57          |
| 9. de Broglie                         | Electrons have wave-like properties      | Man           | 57          |
| 10. Schrodinger /                     | Electron clouds/                         | Man           | 69          |
| 11. Weisenberg                        | behaviour and energies of electrons      | Man           | 69          |
| 12. Henry Moseley                     | Periodic table                           | Man           | 69          |
| 13. Dimitri Mendeleev                 | Periodic table                           | Man           | 81          |
| 14. Linus Pauling                     | Electronegativity                        | Man           | 136         |
| 15. Marie Curie                       | Radioactivity                            | Woman         | 57          |

**Table 5.2 Representation of men and women as examples of producers of scientific knowledge in Textbook B**

| <b>Name of the scientist</b> | <b>Scientific invention or discovery</b>  | <b>Gender</b> | <b>Pages</b> |
|------------------------------|---|---------------|--------------|
| 1. Galileo Galilei           | Astronomer/Physicist- observed that objects cannot move unless force is applied.        | Man           | 22           |
| 2. Isaac Newton              | Formulated Laws of motion and the Universal Law of Gravitation.                         | Man           | 22           |
| 3. Albert Einstein           | Founder of the theory of relativity who also improved Newton's Laws.                    | Man           | 22           |
| 4. Emile du Chatelet         | French Physicist- translated Newton's work.   | Woman         | 49           |
| 5. Ibn Sina (Avicenna)       | Persian Physicist and philosopher – examined the classic work of Ancient Greek.         | Man           | 82           |
| 6. Gilbert Lewis             | Lewis dot symbols   | Man           | 91           |
| 7. J. van der Waal           | van der Waal's forces   | Man           | 108          |
| 8. Willebrord Snellius       | Snell's Law- Law of refraction of light   | Man           | 144          |
| 9. Christiaan Huygens        | Dutch Physicist- Huygens' principle was used to explain the diffraction of water waves. | Man           | 152          |
| 10. Robert Boyle             | Irish Chemist- formulated Boyle's Law.  | Man           | 162          |
| 11. Jacques Charles          | French scientist- formulated the Charles' Law.  | Man           | 165          |
| 12. Lord Kelvin              | Founder of the Kelvin temperature scale.  | Man           | 166          |
|                              |   |               |              |

|                      |   |       |     |
|----------------------|---|-------|-----|
| 13. Gay-Lussac       | French scientist- formulated Gay-Lussac's Law.                                  | Man   | 169 |
| 14. Amedeo Avogadro  | Italian scientist- formulated Avogadro's Law.                                   | Man   | 171 |
| 15. Pierrette Paulze | Chemist – assistant in laboratory/ translated Lavoisier's scientific documents. | Woman | 189 |
| 16. Charles Coulomb  | Formulated Coulomb's Law.   | Man   | 206 |
| 17. Hans Oersted     | Danish scientist-discovered electromagnetism.                                   | Man   | 215 |
| 18. Michael Faraday  | Faraday's Law –describes electromagnetic induction.                             | Man   | 219 |
| 19. Svante Arrhenius | He formulated the definition for an acid and a base.                            | Man   | 260 |

**Table 5.3: Representation of Men/women as producers of scientific knowledge in Textbook C**

| <b>Name of the scientist</b> | <b>Scientific invention or discovery</b>           | <b>Gender</b> | <b>Page</b> |
|------------------------------|--|---------------|-------------|
| 1. Friedrich Wohler          | Discovered organic compound urea.                  | Man           | 75          |
| 2. Charles Goodyear          | Developed vulcanised rubber.                       | Man           | 131         |
| 3. James Wright              | Invented Silly Putty.                              | Man           | 132         |
| 4. Earl Warrick              | Invented Silly Putty.                              | Man           | 132         |
| 5. Heinrich Hertz            | Production and reception of electromagnetic waves. | Man           | 132         |
| 6. A. Doppler                | Theory for sound waves.                            | Man           | 171         |
| 7. Le Chatelier              | Founder of Le Chatelier Principle.                 | Man           | 221         |
| 8. Joseph Thomson            | Investigated ultra-violet light.                   | Man           | 313         |
| 9. Albert Einstein           | Description of the photoelectric effect            | Man           | 307         |
| 10. Martin Lowry             | Developed the Bronsted- Lowry acid-base theory.    | Man           | 239         |
| 11. Soren Sorensen           | Founder of pH scale                                | Man           | 342         |
| 12. Thomas Edison            | Invented light bulb.                               | Man           | 293         |
| 13. Nikola Tesla             | Found AC as the primary source of power.           | Man           | 293         |
| 14. Michael Faraday          | Pioneer for electrochemistry.                      | Man           | 328         |
| 15. Fritz Haber              | Haber process for making ammonia.                  | Man           | 364         |

All three textbooks foregrounded the scientific contributions of men. Women were side-lined and marginalised in these textbooks. Therefore, data from the selected Physical Sciences texts depicted the inherent bias against women. I also found that the studied textbooks maintain the stereotype of men as scientists. This bias has the potential to normalise Physical Sciences as a masculine domain, thereby discouraging girls and young women. In the following sub-section, I present and analyse the findings demonstrating men and women in active and passive science roles.

### **5.2.2 Representation in Science Active and Science Passive roles- texts and visuals**

This study uses "science active" as the depiction of individuals or groups, regardless of gender, to demonstrate a scientific concept, which may involve using scientific tools or contributing to scientific knowledge. Furthermore, science passive involves using men and women as examples to explain scientific concepts, even though their actions are not scientific.

The analysis of all textbooks revealed a predominance of male characters in science, both in active and passive roles. As an example, Textbook A presented a total of 36 men and 11 women. Textbook A noted that 17 out of 36 men were science-active, and 19 were passive. As for women, the figures were 5 and 6 respectively for science active and science passive. There were 24 men and nine women identified in Textbook B. Of the 24 men discovered, 19 were science-active, and five were science-passive. As for the women, five were science-active, and four were science-passive. Table 5.4 on the following page summarises the representation of men's and women's science and active and passive roles in texts and photographs.

**Table 5.4**The totals of men and women in science active and science passive roles.

| <b>Pseudonym</b>  | <b>Gender</b> | <b>Science active</b> | <b>Science passive</b> | <b>Images</b> | <b>No image</b> | <b>Named</b> | <b>Not named</b> |
|-------------------|---------------|-----------------------|------------------------|---------------|-----------------|--------------|------------------|
| <b>Textbook A</b> | Women         | 5                     | 6                      | 7             | 4               | 1            | 9                |
|                   | <b>Total</b>  | <b>11 women</b>       |                        |               |                 |              |                  |
|                   | Men           | 17                    | 19                     | 25            | 11              | 15           | 21               |
|                   | <b>Total</b>  | <b>36 men</b>         |                        |               |                 |              |                  |
| <b>Textbook B</b> | Women         | 5                     | 4                      | 7             | 2               | 2            | 9                |
|                   | <b>Total</b>  | <b>9 women</b>        |                        |               |                 |              |                  |
|                   | Men           | 19                    | 5                      | 22            | 2               | 18           | 6                |
|                   | <b>Total</b>  | <b>24 men</b>         |                        |               |                 |              |                  |
| <b>Textbook C</b> | Women         | 4                     | 8                      | 5             | 2               | 5            | 7                |
|                   | <b>Total</b>  | <b>24 women</b>       |                        |               |                 |              |                  |
|                   | Men           | 31                    | 4                      | 10            | 21              | 27           | 7                |
|                   | <b>Total</b>  | <b>35 men</b>         |                        |               |                 |              |                  |

In Textbook C, the number of men was 35, and the number of women was 12. Of the 35 men, 31 actively participated in science, while the remaining four were passive. Four of the 12 women depicted were presented as science-engaged and eight as science-inactive. Hence, the chosen textbooks uphold gender bias because men are prominently featured in science-active roles.

Most Figures in Textbooks A and B depicted in passive roles were men. Textbook C revealed that women outnumbered men in science passive roles by 50%. Even though the scientific passive roles marginally increased women's visibility due to the similarities between men and women, the outcomes still demonstrate gender differentiation. The representations of women in science passive roles do not inspire students to take STEM courses. Learners may believe these science passive activities demonstrated are designated for women and girls because this is where they are primarily visible. In the following sub-section, I present and analyse how the selected textbooks showed gender differentiation in photographs of men and women.

### **5.2.3 Visuals are disproportionately male-oriented.**

In all analysed textbooks, it was noted that more men were represented through visual images. Additionally, visuals of men were large and colourful, and the persons depicted were named. There were considerable differences in the number of visuals that represented women compared to men. For example, in Textbook A, there was a total of 25 images that represented men compared to 7 visuals of women. None of the female visuals were used in science active roles. Textbook B showed 22 visuals of men versus 7 of women. Only two visuals depicted women in active science roles, and they were named. In Textbook C, 11 visuals represented men and five represented women. Furthermore, the visuals of women were used in science passive roles. This analysis is summarised in Table 5.4 on the preceding page.

Although there were cases where sketches or freehand drawings represented both men and women, only women were represented by tiny black sketches. All the sketches representing men were large and colourful, such that some could be mistaken for photographs. For example, in Textbook C, five human sketches were found. Of the total of five sketches, 4 were women. In Textbook B, there was a total of 13 human sketches. Of the total of 13 human sketches, nine sketches represented men and four represented women. However, all male sketches were large and colourful. On the contrary, 2 out of 4 representing women were very small; 1 was large, and the other was medium. In Textbook A, six human sketches were found, three representing men and four representing women.

Three sketches that represented women were small, and one was medium. Therefore, men were overrepresented in three categories: as producers of scientific knowledge, in active and passive science roles, and in the number of visual images that represented them. In the next section, I present and analyse findings that connoted that men and women were indexed to different gender roles.

### **5.3 Physical Sciences textbooks index differentiated gender roles.**

The studied textbooks were also found to index different gender roles for men and women, and these were hierarchical. For example, men were primarily represented independently in scientific roles, while women were foregrounded in roles that suggested that they were either found in domestic settings or as helpers of men. The messages coded in texts in studied textbooks were analysed and decoded. In the following sub-sections, I show how lexical choices were used to foreground men as scientists whilst backgrounding women scientists by portraying them as laboratory assistants and translators of scientific documents.

#### **a) Lexical choices**

Lexical choices refer to the choice of vocabulary in either naming the characters or the option of verbs used in the text to depict the main character (Huckin, 1997). Machin and Mayr (2012) state that lexical choice refers to the author's choice to use a specific term to convey authority to particular persons or to claim that they are specialists in knowledge. The texts displayed below from selected textbooks portray women who are chemists differently from men who are chemists. Different words were chosen to depict men and women as chemists. The following excerpts attest to this.

The following excerpt also shows a man as a chemist. Again, the words chosen to describe his achievements are different from those used to describe Paulze as a woman chemist in Quote 1.

#### ***Quote 1: (Textbook A, p. 69)***

*The Russian chemist Dmitri Mendeleev... found that elements' physical-chemical properties vary periodically with increasing atomic mass. His findings are known as the Periodic Law...*

**Quote 2: (Textbook B, p. 189)**

*...Lavoisier was the first scientist to weigh reactants and products during chemical reactions, providing the Law of Conservation of Matter...*

The words chosen to describe the achievements of Lavoisier and Dmitri are similar. Dmitri Mendeleev is described by Textbook A as a chemist who found the Periodic Law. Lavoisier is described as the founder of stoichiometry. Furthermore, the men depicted as chemists from Textbooks A and C are mentioned with their discoveries or inventions, so they are portrayed as specialists in scientific knowledge. Another example in the following excerpt is Soren Sorensen, described by Textbook C as a chemist who developed a pH scale.

**Quote3: (Textbook C, p. 342)**

*The chemist Soren Sorensen developed the pH scale...*

In simple terms, to develop something means to create something that has never existed. Hence, being able to "develop" something that never existed before is like being a founder or the father of knowledge. Therefore, Sorensen in Quote 3 is also depicted as a more proficient scientist than the women scientists du Chatelet in Quote 4 and Paulze in Quote 5 below. The following excerpts show that authors used the same vocabulary to describe women scientists practising in professions that are different from men's and of lower status than what they are qualified for.

**Quote 4: (Textbook B, p. 49)**

*Emille du Chatelet (1706- 1749), the French Physicist who translated Newton's work...*

**Quote 5: (Textbook B, p. 189)**

*"Paulze was married to Lavoisier (regarded as the father of stoichiometry) but was a chemist in her own right. She assisted him in the laboratory and translated English scientific documents. Lavoisier was the first scientist to weigh reactants and products during chemical reactions, providing the Law of Conservation of Matter..."*

Quote 4 above portrays Emille du Chatelet as the translator for Newton, although she is a qualified physicist. Her portrayal is similar to Paulze's in Quote 5 who was also mentioned as the translator of English scientific documents, although she was a chemist. Hence, the lexical

compound ‘translator of scientific documents’ demotes Paulze and du Chatelet from being specialists in scientific knowledge to mere translators of documents that were originated by men. In the following excerpt, the authors used different lexicals to portray a man as a physicist in a more esteemed scientific role than du Chatelet, the woman physicist in Quote 4 (on the preceding page).

**Quote 6: (Textbook C, p.171)**

*“Christian Andreas Doppler (1803 – 1853) was an Austrian mathematician and physicist. ...he proposed that the observed frequency of light and sound waves depends on how fast the source and the observer moved relative to each other... now referred to as the Doppler Effect...”*

Doppler, as a man physicist, is again depicted as the founder of the Doppler effect. He is also portrayed as an essential contributor to scientific knowledge. What he had proposed about sound waves and frequency of light was accepted and later became known as the Doppler effect. Hence, the choice of words depicted women as scientists in inferior roles as translators whilst choosing different adjectives to depict men in similar roles (as women’s) but highly esteemed as the founders of scientific knowledge. In the following sub-section, I show how I used claim-counterclaims to uncover the underlying meaning behind portrayals of men and women in different scientific roles. I use the same quote from Textbook B about Paulze as there were only 3 women scientists that were found in all 3 textbooks studied. Hence, Paulze’s representation was the one (of the three) that showed claim-counterclaim.

**b) Claim-counterclaim**

The extract from Textbook B (about Paulze) in Quote 5 above also shows the positive and negative claims. Al Ghazali (2007) shows that words of contrast, such as “but” or “however”, are used in a sentence to introduce claims and counterclaims, which indicate “the focus of ideological struggle” (p.13).

This extract shows that there is a claim that Paulze is a chemist. The counterclaim is also evident in showing Paulze as an assistant to Lavoisier. Working as a laboratory assistant of a husband only does not tally with being a qualified chemist. This extract emphasises Paulze’s duties as a wife of Lavoisier more than being a chemist.

Although the text uses the conjunction word “but” to tell the readers about another achievement of Paulze, being a chemist, the text then elaborates on her duties as a wife who assisted Lavoisier (the husband) in the laboratory. Nothing else is mentioned that portrays her as an independent scientist (chemist). It is questionable how being a chemist capacitated her to only assist in the laboratory and translate English scientific documents. Furthermore, it seems she rendered these services to her husband only and possibly free of charge. Feminists regard the acts portraying women in services rendered free of charge as gender discrimination. How Paulze is portrayed in this sentence presupposes that Paulze studied chemistry to qualify to be Lavoisier's wife.

### **c) Foregrounding and backgrounding**

Both Paulze and Lavoisier mentioned in Quote 4 were qualified chemists. However, the authors used the phrases “father of stoichiometry and first scientist” to describe Lavoisier in practice. On the contrary, Paulze, a woman chemist, is described as a laboratory assistant and translator of scientific documents. The text producer chose verbs like “was married” and “assisted him” to describe the good qualities of Paulze, a woman and a chemist, in Textbook B.

Although Paulze was also a qualified chemist, the text from Textbook B emphasizes her role as Lavoisier's wife. It is also noted that being married is mentioned before mentioning that she was also a chemist. Something that is mentioned first is considered the most important. Hence, mentioning that Paulze was a chemist only after stating that she was married to Lavoisier backgrounds her scientific profession. Machin and Mayr (2012) state that elements mentioned later or positioned further back may become inferior. Similarly, Huckin (1997) also believes that whatever is placed first in the text is considered the most important by the readers. Therefore, the text framing at the sentence level presupposes that being married is more important for a woman than being a qualified chemist. In the following sub-section, I show how repetition was used to emphasize men while downplaying women.

### **d) Reiteration**

Successively, the text used implicit reiteration using synonymy to give prominence to Lavoisier as the scientist.

**Quote 7: (Textbook B, p. 189)**

*“... Lavoisier (regarded as the father of stoichiometry) but was a chemist in her own right... Lavoisier was the first scientist to weigh reactants and products during chemical reactions, providing the Law of Conservation of Matter”*)

In the first line, “father of” was used. In the last sentence, “founder of” and “the first scientist” were used to describe Lavoisier as the producer of scientific knowledge. The noun father is the synonym of the noun founder, meaning the inventor or the first person to conduct a particular activity. Al Ghazali (2007) mentions that synonyms are used as implicit rewording in the text to emphasise the discussed idea. Furthermore, the text used the concept of stoichiometry in the first line and then used reiteration implicitly by explaining the concept of stoichiometry in the last line: “to weigh reactants and products during chemical reactions.” Therefore, this text foregrounds Lavoisier as a man in a scientific role whilst backgrounding Paulze (in Quote 5) as a woman chemist. Machin and Mayr (2012) explain backgrounding as the tendency of the authors to portray participants in a manner that connotes subordination to their counterparts.

Therefore, highlighting Paulze in the domestic role as a wife who uses her scientific knowledge only to assist her husband can make the learners (who learn from this textbook) think that women chemists receive different proficiency than men chemists. The last thing that is likely to be memorable about Paulze is being the laboratory assistant and translator of documents.

These gender representations push women out of the world of science to the role of wives, the servants of men. Portraying women in inferior roles in textbooks intensifies children’s sexist perceptions and behaviours towards other children of the opposite sex. It can also exacerbate the adverse effects of gender inequalities in society. In the next section, I present and analyse data that evidenced the marginalisation of women scientists.

#### **5.4. Marginalisation of women scientists**

Through careful interrogation of the texts, I found that women were marginalised through omission and depicted as scientists but not named. Such depictions indicate gender biases. The following sub-section presents data analysis that suggests that women as scientists were marginalised from selected textbooks through exclusion.

#### 5.4.1 Silences about women's scientific contribution to knowledge

Huckin (1997) suggests that CDA analysts should interrogate text to determine why certain statements appear and what is possibly left out that should have been said. He elaborates that “if the text type ordinarily includes certain kinds of information and yet one does not find such information, it gives the analyst the reason to suspect that the writer deliberately left it out” (p. 82). Quotes 4 and 5 from the previous subsection are repeated below as no other women scientists were found in Textbooks to demonstrate that women's contribution to scientific knowledge was omitted when selected textbooks were produced.

**Quote 4: (Textbook B, p. 49)**

*Emille du Chatelet (1706- 1749), the French Physicist who translated Newton's work...*

**Quote 5: (Textbook B, p. 189)**

*“Paulze was married to Lavoisier (regarded as the father of stoichiometry) but was a chemist in her own right. She assisted him in the laboratory and translated English scientific documents. Lavoisier was the first scientist to weigh reactants and products during chemical reactions, providing the Law of Conservation of Matter...”*

Quote 4 from Textbook B portrays a woman as a physicist, Emille du Chatelet. However, the text does not mention the scientific achievements of du Chatelet as in the case of the man physicist from Textbook C, Andreas Doppler. Although du Chatelet was a physicist, she is depicted as only working as a translator of Newton's work. Similarly, in Quote 4, the text is silent about Paulze's (Lavoisier's wife) scientific discovery or contribution as a qualified chemist.

Similar to du Chatelet, Charles Coulomb, who shares the same profession as a physicist, had his scientific contributions extensively discussed in the text. The excerpt below illustrates this.

**Quote 8: (Textbook B, p.206)**

*“In the 1870s, the French physicist Charles Coulomb investigated the electric forces between the charged particles using a torsion balance...found a similar relationship to those Newton described...”*

The textbook further elaborates that Coulomb investigated the electric forces between charged particles. The textbook does not portray him as dependent on someone like the other two women scientists who had to wait for men to publish so they could translate. Instead, he is portrayed as an independent investigator whose findings are like Newton's. Therefore, women were sabotaged and sidelined because their scientific discoveries or inventions were not included when these textbooks were produced. These excerpts from the selected textbooks indicate the presence of ideological subversion. These acts of undermining women in Physical Sciences textbooks can introduce demoralisation in girls. Girls may be sceptical about pursuing highly prestigious STEM-related fields if these gender biases are not addressed.

In all the selected textbooks, men who were depicted as physicists were mentioned with their inventions. Being a physicist does not match working as a translator, possibly indicating that women as physicists received different scientific knowledge than man physicists. One wonders if the text producer omitted women's scientific achievements and discoveries to suggest that it is not rewarding for girls and women to pursue STEM-related fields because although you can become qualified as men, you will only work as a translator of documents or laboratory assistant. Therefore, the vocabulary used to depict women and men as scientists differently can heighten gender inequalities in the classroom during Physical Sciences teaching and learning. In the following sub-section, I present and analyse data that show how women were sidelined by depicting them in science-active roles but not named.

#### **5.4.2 Women scientists marginalised through not naming.**

Figures 5.1 and 5.2 below depict two women portrayed independently as science-active. However, the textbook does not mention who they were and whether they were students or qualified scientists.

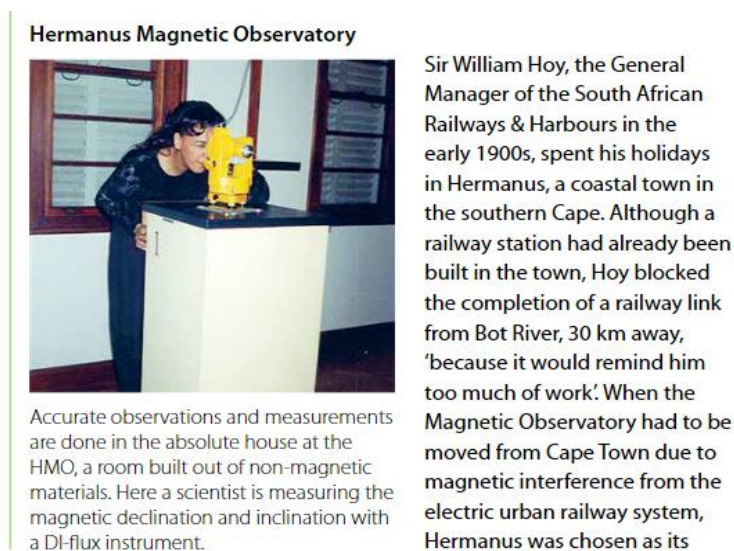


*Figure 5.1 A woman is depicted science active (Textbook A, p. 188)*



*Figure 5.2 Science active woman depicted as a student (Textbook A, p.188)*

The woman in Figure 5.2 looks like a learner because her clothing resembles a school uniform. Additionally, she is not wearing full laboratory clothing. Although working with chemicals, she did not wear a laboratory coat as protective clothing. Additionally, the woman in Figure 5.1 may be a tertiary student from a technical college or university. She is wearing the full protective gear whilst working with chemicals. The text producer did not mention their names and status, i.e. whether they are qualified scientists or students. Although there are cases where men were also portrayed as science-active and not named, they were few compared to women. Hence, these portrayals marginalise women and can send ambiguous messages to learners. In other words, the authors left it to the reader to decide whether the depicted persons should be viewed as scientists or students. Schiebinger (2000) regards not naming as the implicit strategy to render women invisible in discourse. In the following excerpt, the woman scientist is also depicted in a contradictory manner.



*Figure 5.3 A woman scientist is not named (Textbook A, p. 188)*

Figure 5.3 depicts a female scientist measuring magnetic declination and inclination with a di-flux instrument. Although the text states that she is a scientist, she is also not named. Instead, a long autobiography mentions the man Sir William Hoy alongside her visual. The text does not tell the readers whether Sir William Hoy has expertise in science. Furthermore, the text does not end in naming him. It further explains his superior position as the South African Railway Harbours general manager, which introduced controversy. It can make the readers wonder whether the motive was to direct the attention to the man Sir William Hoy implicitly and to forget about the woman scientist. It is also questionable that whenever the woman

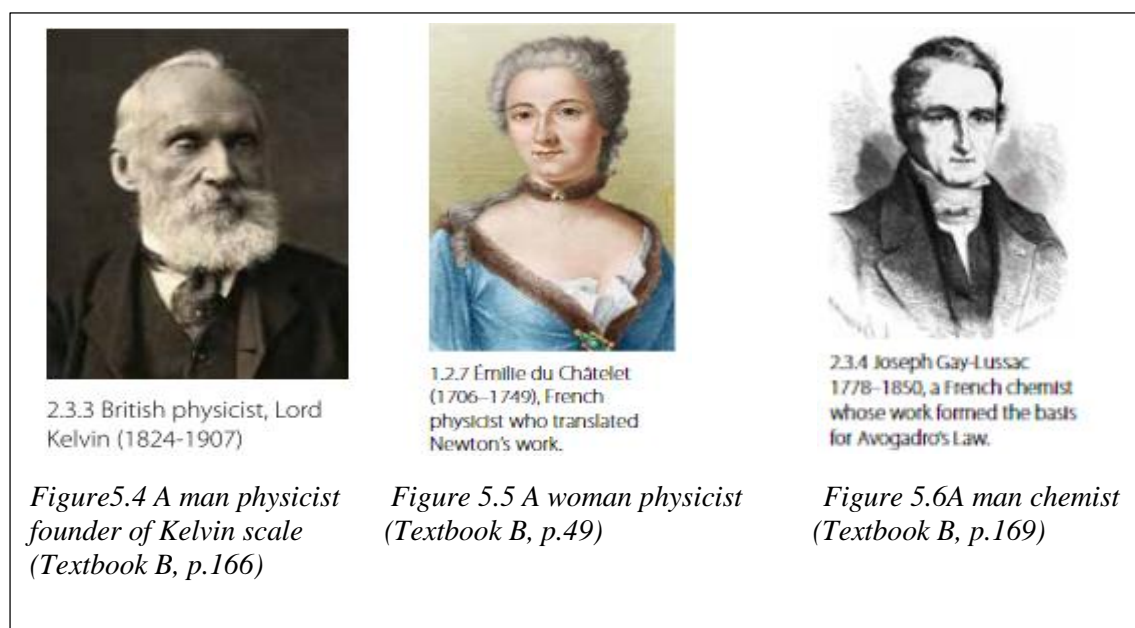
scientist is mentioned, a man must shield her glory. This marginalisation presupposes that this woman scientist is working for the harbour manager. Therefore, attention is drawn to the man.

### 5.4.3 Biased visual representations of men and women

Butler (2011) regards the marginalisation of women by portraying them in a manner that devalues and undermines their status as another form of gender discrimination. The camera's angle was used to see how photographs of women differed from those of men. Figures 5.4 to 5.6 depicted below attest to this.

#### The angle of the camera

van Leeuwen (2005) and Kress and van Leeuwen (2020) identify the camera's vertical angle as another semiotic tool used by social structures to empower or disempower. They state that photographs taken from a low angle make the represented participant look larger and closer to the viewers. Figures 5.4 to 5.6 below were taken from a low angle.



The photographer used a low angle to portray the women and men scientists depicted in Figures 5.4 to 5.6. Therefore, Kelvin, du Chalet and Gay-Lusaac will be memorable to learners who use this textbook to learn Physical Sciences because their images are more prominent and closer to the viewers. However, the accompanying texts suggest different messages regarding how du Chalet will be remembered as opposed to Kelvin and Gay-Lusaac. du Chalet will only be remembered as the translator of Newton's documents, Gay-Lusaac will be remembered for

the significant contribution he made to the formulation of Avogadro's Law and Kelvin will be memorable for setting up the temperature scale known as the Kelvin scale.

van Leeuwen (2005), as well as Kress and van Leeuwen (2020), continue to mention that photographs taken from a high angle may result in a decreased size of the represented participant and result in a participant being further away from the viewers (also known as interactive participants). They further mention that the represented participants seen from a high angle are rendered powerless, making the viewers, as the interactive participants exercise symbolic power over the represented participant (in the image). Figure 5.7 below is evidence of this.



*Figure 5.7 A woman chemist, Paulze (Textbook B, p. 189)*

The high angle of the camera was used to depict Pierrette Paulze in Figure 5.7. Her image is small. Although Paulze is a chemist just like Gay-Lussac, she is likely to be less memorable to the learners as the viewers because her visual image is further away from the viewer.

van Leeuwen (2005) states that people choose role models by imitating examples of high-status people whose work is recommended as best practice. He added that people can admire role models from mass media. He explains that if people are asked why they behave in a particular way, they would say, "...because so and so does it." (p.56). Therefore, these representations reinscribe hegemonic patriarchal rules, which support the notion of men pursuing high-status professions in science (Chambers, 2005; Schiebinger, 2000). Feminists such as Baehr (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. In the

opinion of Ndlovu (2019), girls' academic success may be hindered by this and result in underachievement within the schooling system and education in general. Therefore, figures 5.4 to 5.7 display an act of gender discrimination against women. In the next section, I show how the lack of gaze in Figures 5.8 and 5.9 was possibly used to sideline the women depicted.

## Gaze

Machin and Mayr (2012) state that gaze is another important CDA construct that can be used to uncover biases in texts. Gaze refers to depicting the represented participant in a photograph looking at the viewer and signifies that the interactive participant is invited to the activity depicted and to emulate the person depicted. In the excerpts depicted in Figures 5.8 and 5.9 below, women were depicted showing their backs. These figures, therefore, show a lack of gaze.



This patient is wearing a lead-impregnated vest to protect her during a dental X-ray.

*Figure 5.8 A woman's radiograph (Textbook A, p.135)*



3.1.5 An observer sees an image of the candle in a mirror.

*Figure 5.9 A woman photographed from the back (Textbook B, p.137)*

These visuals depicted in Figures 5.8 and 5.9 above show women as examples in explaining scientific concepts. Their images are taken from a low angle, making their image visuals large and closer to the viewer. However, the represented participants do not look at the viewers. Machin and Mayr (2012) state that when the person depicted does not look at the viewer or looks downward, 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. Although it is a known fact that a radiograph is usually taken from the back, it is controversial that the text producer chose only a woman as an example, concealing

her face. The pronoun ‘her’ reveals that the person depicted is a woman. The other woman depicted in Figure 5.9 was also photographed from behind. Therefore, lack of gaze implies that the interactive participants or viewers are not invited to the activity depicted. Hence, they can also possibly be quickly forgotten by the viewers. It is also questionable that the text producer chose only women as examples to illustrate scientific concepts that need photographs taken from behind.

Figure 5.10 depicted below illustrates gender equality because both the girl and the boy are handling the scientific apparatus, and they are both not named. However, their images also demonstrate a lack of gaze.



*Figure 5.10 A woman and a man exemplifying gender equality (Textbook A)*

The size and the quality of their pictures are the same and can be an example of photographs that can be used in the introductory sections of the Physical Sciences textbooks to welcome all the learners into learning the content knowledge in the textbook. However, Machin and Mayr (2012) state that if the represented participants do not look at the viewer, the interactive participant is not welcome to the activity demonstrated. Therefore, the represented participant is likely less memorable to textbook readers. However, visual images like this one (with a positive gaze) can be used to encourage girls who use these textbooks to pursue STEM-related courses because they depict gender equality. In the next section, I present data that illustrate how textbook portrayals showed evidence of stereotypes that implied that men are physically strong and well-abled for specific tasks and women are weak and incapable of functions that men perform.

## 5.5 Stereotypes that perpetuate gender power imbalance.

In this theme, hyperbole, presupposition, indexical signs, iconic signs, and potent cultural symbols were used as CDA to uncover the underlying meaning of how men and women were represented. In the next sub-theme below, I describe findings that imply the use of hyperbole to portray women as weak and incapable.

### 5.5.1 Stereotypes of women as weak

#### Hyperbole

Hyperbole is using exaggeration to evoke strong feelings and create strong impressions. It also means using language that overstates the truth. The excerpts below are evidence of the use of hyperbole. The difference between the weight that a woman and a man handle is exaggerated. This example is evidence of quantitative hyperbole (Burgers et al., 2016) because it shows an exaggerated difference between the quantity that a woman and a man handle. The following excerpts illustrate this.

#### *Quote 9: (Textbook C, p.45)*

*“An astronaut of a mass of 75kg carries a mass of 25kg. He accidentally separates from his spacecraft and floats in space to a distance of 15m from the craft. The astronaut knows the only way to get back to the spacecraft is to push away his pack.”*

#### *Quote 10: (Textbook C, p.48)*

*“Zanele investigates the motion of a 2kg trolley along a frictionless horizontal track. She applies a constant horizontal force of 10N so that the trolley, which was initially at rest, attains a velocity of  $4\text{m}\cdot\text{s}^{-1}$ .” (Textbook C, p.48)*

Quote 9 above shows a man in a mechanics' module as an example of an astronaut carrying a 25kg mass. In the same module, an example is made of a woman named Zanele (Quote 10), but she is portrayed investigating the motion of a 2kg trolley (see the second excerpt above). The choice of quantity to be handled by a man increases exponentially compared to the one a woman handles. The intention was possibly to portray women as unsuitable for mechanics-related fields because of the assumption that they have weaker physiques.

I also found it controversial that when the woman is depicted as science-active in a manner that can encourage girls to emulate her, she is not named. However, when women are depicted demanding, they are named like in the excerpt portraying Zanele above. Women were used as examples in all cases as weak and handling the tiniest weight compared to their counterparts. The man depicted as an astronaut in the excerpt from Textbook C above is portrayed as carrying a 25kg mass. Depicting men carrying objects with greater weight while depicting women handling the tiniest objects was possibly another cunning strategy used to depict women as weak and less capable whilst depicting men as strong and well-abled. The textbook maintains the stereotype of women as weak and men as strong. It is a form of gender bias and gender discrimination. As both boys and girls learn Physical Sciences, it can be discouraging to girls to constantly see women represented in this manner in the textbooks they use to learn.

These portrayals confirm social constructivists' view that gender roles are learnt and enacted rather than born with (Baxter, 2015; Butler, 2013). Jenkins and Finneman (2018) advocated that gender is constructed by social expectations, which ultimately channel gender performances. Therefore, these portrayals can reinforce society's norms about gender performance. They can strengthen society's beliefs that women are suitable for activities and jobs that require little human energy, which can ultimately push women to the margins of the Physical Sciences stream.

Another example of the use of quantitative hyperbole is shown in Figures 5.11 to 5.13 on the next page. Figures 5.11 and 5.12 were extracted from Textbook C, which is used to teach Physical Sciences in grade 12. Again, the girl is depicted in a passive science role in a demeaning manner. The author is mocking her because she is depicted pushing something that requires little effort, yet she is shown to push ridiculously hard. This discourse also shows that the text producers were hyperbolic in the manner that they depicted the girl who was pushing a 5kg object compared to the boy. A girl and a boy are depicted in a manner that suggests gender differentiation, although they are used as examples to demonstrate the same activity in the mechanics module on different pages of Textbook C. The girl is portrayed as weak, while the boy is depicted as strong.

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**

1.  $W_F = F\Delta x \cos \theta$   
 $= 20 \text{ N} \times 10 \text{ m} \cos 0^\circ$   
 $= 200 \text{ J}$   
 The work done by the girl is 200 J.
2.  $P = \frac{W_F}{\Delta t}$   
 $= \frac{200 \text{ J}}{5 \text{ s}}$   
 $= 40 \text{ W}$   
 The power of the girl is 40 W.


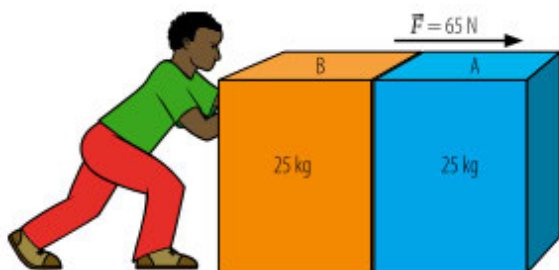



Figure 5.11 A girl pushing a box (Textbook C, p. 161) Figure 5.12 A boy pushing a box (Textbook C, p. 146)

Both the boy and the girl are pushing a box in Figures 5.11 and 5.12. However, in the case of the girl, the box looks more significant than the boy's, yet it is labelled to weigh 5kg, a minimal weight. The portrayals indicate there is an exaggeration. The boy's box is not labelled and looks smaller than the girl's box. Again, in 5.13, a boy is shown pushing two crates that weigh 25kg each, with a force of 65N. Therefore, the total weight that Siphso pushes is 50kg.



5. Siphso pushes two crates forwards with a force of 65 N. Each crate has a mass of 25 kg and a frictional force of 15 N.
  - a) Draw separate free-body diagrams to show the horizontal forces on each of the crates.
  - b) Calculate the acceleration of the crates.  
(0,70 m·s<sup>-2</sup>)
  - c) Calculate the magnitude of the force that the two

Figure 5.13 A boy pushing 2 X 25kg boxes (Textbook B, p.84)

Figure 5.13 also shows the evidence of quantitative hyperbole. Siphso, in Figure 5.13, is depicted pushing very hard, like the girl in Figure 5.11. However, the way Siphso is depicted pushing is justified by the fact that he is pushing a significant quantity (50kg) compared to the girl who was pushing 5 kilograms. The girl is brought into the spotlight by implying that she seems to have less strength, pushing a 5kg object so hard that the skirt is twisted and bent over. The clothing worn by the girl makes her look older than a girl. She looks like a short older woman.

Additionally, in workshops where mechanics is practised, women are also expected to wear pants. The woman is depicted as a misfit to what she is used to demonstrate because her clothing does not match the work that she is doing. These illustrations can send wrong messages to learners who read from these textbooks. They can reinforce the stereotype of men as strong and suitable for specific activities and jobs. Therefore, if learners who study from these textbooks are not adequately coached to deal with media biases, they can get wrong messages from how gender is represented in the textbooks they use to learn Physical Sciences. The mechanics module orientates learners to professions such as mechanical engineering. Therefore, Figures 5.11 to 5.13 are likely to implicitly suggest that women are not welcome in mechanical engineering and other mechanics-related fields because they are depicted as weak. Many studies have shown that when learners are emotionally insecure, their academic progress is also hampered (Banerjee, 2016). In the following sub-section, the textbook discourses show evidence of the use of presupposition, also sending stereotypical messages to learners who learn from these textbooks.

### **Presupposition**

According to Huckin (1997), presupposition is the manipulative strategy of the writers to display text as if specific ideas are “taken for granted as if there were no alternatives” (p.82). Careful analysis of women and men in passive and active science roles further revealed that the selected textbooks portray women in a manner that presupposes that they need to pursue careers or professions that do not require a tertiary qualification. Such professions are also low-paying and do not promote the status of women in society. Furthermore, the text framing shows that the text producer selected primarily women as examples in low-status non-STEM professions. The following excerpts illustrate low-status professions that are non-STEM related.



*Figure 5.14 Women in the river  
(Textbook A, p.313)*



*Figure 5.15 Lisa jogging  
(Textbook B, p269)*

Figure 5.14 depicts women collecting water from the river, which is a domestic role that non-educated people in deep rural areas usually do. Although it is good to include the importance of indigenous (endemic to the area) knowledge in science teaching and learning, the textbook did not depict men as examples in similar roles or settings. Therefore, the text presupposes that women are to remain uneducated and perform domestic roles.

Furthermore, the women in the river are represented by freehand sketches, which can arouse anger in girls who learn from these textbooks. They might question why women are depicted in ugly pictures in non-profitable roles. Additionally, Figure 5.15 shows a colourful sketch of a woman running the race. This activity is also non-STEM related. Therefore, it also presupposes that these are the alternatives that women have as careers instead of STEM-related professions, which the Physical Sciences is meant to orient learners to. Additionally, it is questionable that men also engage in sporting activities, but in textbook B, only a woman was depicted in a race. The sketch depicting a woman in a race also presupposes that only women must pursue non-STEM professions such as athletics whilst men and boys pursue STEM-related professions like being chemists, specialist surgeons and physicists.

Figure 5.16 depicts women in a salon. One represented participant is possibly a client, and the other is possibly an employee (hairdresser) applying a hair relaxer to the client's hair. This figure can also sideline girls from the course of learning Physical Sciences.



4.3.10 Hair relaxer being applied.

*Figure 5.16 Women in Salon (Textbook C, p.249)*

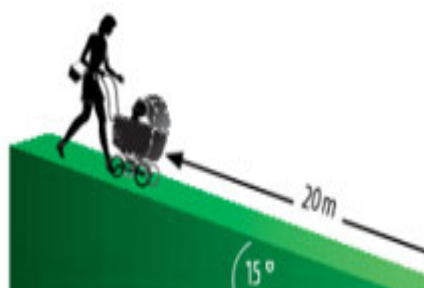
The picture is large, colourful and a photograph of real people. This image also presupposes that women must work in salons to apply the products of science. It is noted that none of the women were depicted as producers or inventors of scientific knowledge. Coincidentally, the hair relaxer is the product that is discussed in the subject knowledge of Physical Sciences

content. The text producer chose only women as examples of people who use this product. This portrayal reinforces gender discrimination against women because men also work in salons. However, Textbook C presupposes that it is the women who are suitable for such jobs. Therefore, these portrayals can subtly mislead learners who read from these textbooks that science is for boys and men only.

These portrayals align with poststructuralist views, such as that of Foucault, that the beliefs and understandings that people hold about the nature of reality are significantly shaped and moulded by their social interactions, as filtered through the utilisation of language and other forms of semiotic representation. (Huckin, 1997, p. 79). Therefore, this textbook portrayal can cause the learners to believe that working in salons is a reality for girls only. In the following sub-section, I describe the evidence of data that illustrate how indexical and iconic signs were used to send different messages about men and women in selected Physical Sciences textbooks.

### **The indexical and iconic sign**

Figure 5.17 below depicts a small freehand sketch of a woman pushing a child in a pram. The description below shows how this figure was used as an indexical and iconic sign. Huckin (1997) proposes that when analysing pictures that are used in the text, one should establish whether they are used as indexical signs, which are direct links to the things they refer to (represent). Additionally, he proposes that one should determine the purpose of an iconic sign, which refers to something by resembling it. Therefore, a mother pushing her baby in Figure 5.17 is an indexical and iconic sign. The description beneath the Figure portrayed explains this.



**A mother pushing her child in a stroller, approaches an incline**

*Figure 5.17 A mother pushing a child (Textbook C, p.163)*

This Figure is firstly used as an indexical sign linking women to the nurturing role. This representation shows only a woman pushing her baby in a stroller, yet it is a well-known fact that the baby belongs to a mother and a father as parents. However, the text used the feminine

possessive adjective “her” to indicate that the baby belongs to the mother depicted only. Figure 5.17, therefore, presupposes to the readers that the role of women is to nurture children because they are the ones who own children. The noun mother refers to someone who raises a child even if she is not a biological mother, i.e. the one who gave birth to the baby. Therefore, showing a woman alone as a mother pushing a baby is likely to channel women into nurturing roles. The small black sketch showing the skirt and high heels is an iconic sign of a woman. Therefore, the text used this sketch of a woman as an icon to emphasise that it is the woman's role to nurture children and babies.

It would have been enough to use the noun mother, but the icon used reinforces to the readers that it is women who must raise babies. It is again noticeable that the icon of the father is omitted in this illustration, presupposing that he is not supposed to raise children. Therefore, figure 5.17 emphasises to the readers that women's role is to nurture children alone.

It is questionable that the same textbooks referred to men as fathers of knowledge, like Lavoisier, who is regarded as the father of stoichiometry. There is no other mention of the noun father in all three textbooks that were analysed except when it was used to refer to fathers of knowledge. Furthermore, it is questionable why the same publisher used the indexical sign (a black sketch of a person with a skirt and high heels on) to represent a woman as a mother (of a baby), whilst the glossy, colourful large photograph of a real person was used to represent Lavoisier as the father of knowledge. This portrayal insinuates that men are influential because where they are to be represented as fathers, photographs of real persons are used, whereas when women are represented as mothers, small black sketches are used. Machin and Mayr (2012) suggest that Critical Discourse Analysts should challenge the text to understand why women are referred to as wives and mothers more often. In the next sub-section, I show that text producers also used potent cultural symbols to possibly disseminate the messages or maintain the stereotype that Physical Science is for boys and men only.

### **Potent cultural symbol**

According to Machin and Mayr (2012), objects carry cultural symbolism; e.g. a stethoscope signifies medical practice. A potent cultural symbol is a strong and forceful physical manifestation that signifies the ideology of a particular group of people. Cultural symbols transmit cultural values to a specific group. The word “potent” is an antonym for impotent, which means the lack of power and control. Hence, the adjective “potent” in the compound word “potent cultural symbol” connotes that the ideology is transmitted forcefully and

powerfully in the minds of the readers who process the meaning of the symbol depicted. Consequently, Figure 5.18 demonstrates the scientific apparatus handled by a male person (man or a boy). This Figure illustrates the use of a potent cultural symbol for science practice.

### Skills needed for practical investigations



*Figure 5.18 Students observing a demonstration of skills in the laboratory (Textbook A p.17)*

Figure 5.18 above depicts (possibly) students or learners and possibly a teacher or laboratory assistant during the demonstration of skills needed when conducting experiments. It was extracted from the introductory section of the studied textbooks, orientating learners to Physical Sciences. It is used as a potent cultural symbol to subtly perpetuate the ideology that science is for men and boys only. It sidelines women and girls in science because, in this group photograph, only one face of a woman is visible. Other visible faces are men's.

Additionally, the visible woman is not handling the apparatus; it is the man who is handling the scientific apparatus. On the opposite side of the man who is handling the apparatus, the photograph shows the second pair of hands also working with the equipment. Unfortunately, the face is only shown on the side; therefore, it is not clear whether it is a woman or a man. Depicting men as the majority and the ones who handle scientific apparatus might be unwelcoming to female readers of Textbooks A and C, where this visual is depicted. Therefore, this figure also foregrounds men in science-active roles and can send the message that only boys are permitted to handle or are capable of handling scientific apparatus. Women are

backgrounded because they are not the ones who are handling scientific equipment, and their faces are not clearly shown. Hence, this could be one of the reasons that make girls shy away from chemicals during practical investigations and instead ask boys to conduct investigations for them to get marks.

In such cases, they don't learn anything, and it is possibly the reason why most of them fail to stimulate their critical and problem-solving skills even during science examinations. In the next section, I present and analyse data that indicates that women were positioned as subservient in the selected textbooks that are used to teach Physical Sciences.

### 5.5.2 Subservient positioning of women

The selected textbooks also portrayed men and women in a manner that is likely to suggest the stereotype of women as subordinates of men whilst depicting men in positions of power. Women's subservience to men was also demonstrated through overlapping.

#### a) Overlapping

Machin and Mayr (2012) regard overlapping as the tendency of the authors to place some aspects in front of others to give the impression that they come first. In the extract below, the female scientist, who should have been depicted independently as the contributor to scientific knowledge, is mentioned together with and after the male scientist. This portrayal demonstrates overlapping.

Nuclear science started in 1896 when **Antoine Henri Becquerel**, a professor in Physics in Paris, began to study the fluorescent properties of substances. One of Becquerel's students, **Madame Marie Curie**, suggested the name radioactivity to describe the spontaneous emission of nuclear radiation.

*Figure 5.19 A woman scientist portrayed as a student (Textbook A, p.51)*

In the extract above, the woman is again suppressed by the text producer. Marie Curie made a significant contribution to science. She is the one who came up with the term radioactivity, which is still used today. The discovery is as old as 1896. Becquerel is put in front of Marie Curie. Furthermore, the text presupposes that she remained a student because it is not mentioned whether she later graduated. Marie Curie is also rendered invisible because a visual image does not represent her. Additionally, she is mentioned after the man who founded

nuclear science. How Marie Curie is depicted is not convincing that she is the founder of radioactivity. This portrayal is another example of depicting women as subservient to men. The author did not portray Marie Curie alone as the founder of radioactivity but as completing what Becquerel had started. The text portrays Becquerel as the pioneer of nuclear science, “nuclear science in 1896 when Antoine Henri Becquerel...began to study”. This “overlapping” makes Becquerel important in this discourse as the pioneer of nuclear science.

In the following sub-section, I show how the writers of the selected textbooks used functionalisation to either reduce by depicting people in inferior roles or promote by depicting people in terms of what they do.

### b) Functionalisation

Machin and Mayr (2012) regard functionalisation as the tendency of the authors to reduce or promote people to the roles in which they function. It is also used to define what someone does.

Nuclear science started in 1896 when **Antoine Henri Becquerel**, a professor in Physics in Paris, began to study the fluorescent properties of substances. One of Becquerel's students, **Madame Marie Curie**, suggested the name radioactivity to describe the spontaneous emission of nuclear radiation.

*Figure 5.19 A woman scientist portrayed as a student (Textbook A, p.51)*

In the excerpt above, a male scientist was elevated to the position of authority by mentioning his functional role as a professor, whilst the woman scientist was devalued by mentioning that she was a student of the professor, although she is the founder of the term radioactivity. This discourse reveals functionalisation. Instead of using nomination only, which refers to people by their real names, the text producer referred to Becquerel by his functional name, “professor”, and Marie Curie as “student.” Being a professor denotes a higher status than being a student. Such lexical choices by the author indicate ideological subversion. In other words, it suggests that values and principles are contradicted to sabotage the woman who was supposed to be the focus as the founder of radioactivity. Another example of referring to a person by using a functional name is evident in the extract below.

*“Paulze was married to Lavoisier (regarded as the father of stoichiometry) but was a chemist in her own right. She assisted him in the laboratory and translated English scientific documents. Lavoisier was the first scientist to weigh reactants and products during chemical reactions, providing the Law of Conservation of Matter...” (Textbook B, p. 189)*

*Emille du Chatelet (1706- 1749), the French Physicist who translated Newton's work...  
(Textbook B, p. 49)*

Although the text mentions that Paulze was a chemist, her function was to translate scientific documents. To make matters worse, mentioning that Paulze is the translator of scientific documents contradicts being a chemist, which was mentioned earlier when she was introduced. Again, it is possible (likely) that mentioning that Paulze was the translator of scientific documents is what will be more memorable to readers than being a chemist. It is also ironic to mention that du Chatelet is a physicist and later shows that she functions as the translator of scientific documents for Newton. Therefore, these discourses show that the text devalued Marie Paulze and Emille du Chatelet by referring to them as translators of scientific papers when one was a qualified chemist and the other a physicist. This text framing implies hegemony. Hegemony refers to the dominance of one group over another in a society, usually maintained through established norms and ideas. This text framing can, therefore, send discouraging messages to the readers that women study chemistry to become translators of documents published by men.

In the excerpt below, the author also used the functional name to represent a man in a highly prestigious profession.



*Figure 20 A man meteorologist (Textbook A, p.87)*

Neither the actual name of the person nor the gender of the person depicted is revealed in the text alongside the photograph. However, the face of the person depicted is a man's face. He functions as a meteorologist, investigating the ozone layer. Again, the authors chose the man to represent a high-status science profession. This repeated tendency of selecting men and boys to represent highly esteemed science professions can send the wrong message to the learners who read from this textbook that science is for boys and men only. In the following sub-section,

I identified the agent-patient relationship in discourse that portrays women as followers and men as leaders.

### c) Agent-patient relationship

Text framing in the excerpts below indicates agent-patient relations in discourse. According to Huckin (1997), agent-patient text framing occurs when persons are depicted such that one is the agent, meaning they are depicted as initiating actions, thereby exerting power. The other may be depicted as a patient, meaning they may be depicted as passive or a recipient of those actions (p.83). The extracts below are evidence of this.

*“...Paulze was married to Lavoisier (regarded as the father of stoichiometry) but was a chemist in her own right. She assisted him in the laboratory and translated English scientific documents. Lavoisier was the first scientist to weigh reactants and products during chemical reactions, providing the Law of Conservation of Matter...” (Textbook B, p. 189)*

*Emille du Chatelet (1706- 1749), the French Physicist who translated Newton’s work... (Textbook B, p. 49)*

Lavoisier is depicted as the initiator, publishing the documents, and Paulze is depicted as a follower, translating what he has published. Similarly, du Chatelet is also depicted as the follower translating for Newton and many examples from the three selected textbooks depicted men as publishers of scientific documents. The fact that Paulze was a chemist in her own right raises suspicion that she must have helped Lavoisier compile the article as they were married. However, the text producer (possibly) chose to show only the man as the publisher and the woman as the translator. Hence, the text framing in textbooks A and C also presupposes that women are not capable of initiating but are only recipients of what men start.

Furthermore, in all three selected textbooks, the following photograph is depicted in the introductory sections to orientate learners to Physical Sciences as a school subject.

## Skills needed for practical investigations



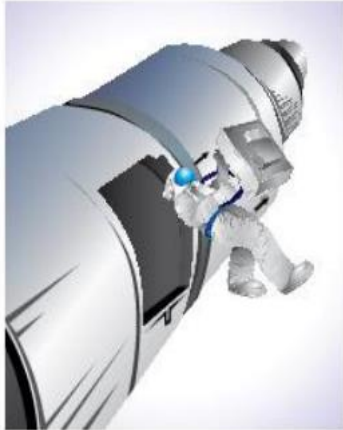
*Figure 5.21 Students observing a demonstration of skills in the laboratory (Textbook A p.17)*

Again, women are portrayed as patients, whilst men are depicted as agents. It is a man who handles scientific equipment and demonstrates scientific activity whilst women observe the process. All these portrayals suggest that women were depicted as subservient to men in the selected textbooks because it is men who are in the driving force, whilst women are depicted as passive onlookers. In the next section, I present and analyse data that evidenced the stereotype of men as creative and independent analytical thinkers.

### **5.5.3 Stereotype of Men as Creative and Independent Analytical Thinkers**

#### **a) Functionalisation and generic pronouns**

Machin and Mayr (2012) regard functionalisation as the tendency of the authors to reduce or promote people to the roles in which they function. It is also used to define what someone does. The following excerpt, Figure 5.22, illustrates the use of functionalisation to elevate a man to a superior and dominant position. Furthermore, the text producer used the generic pronoun “he” to evoke images of a man when the astronaut is used as an example in explaining scientific concepts. Gastil (1990) shows us that using the generic “he” in the text elicits more mental images of a male.



An astronaut of a mass of 75kg carries a mass of 25kg. He accidentally separates from his spacecraft and floats in space to 15m from the craft. The astronaut knows that the only way to get back to the spacecraft is to push away his pack.

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

*Figure 5.22 An astronaut is a man (Textbook C, p.45)*

In the excerpt above, the pronoun ‘he’ and the possessive pronoun ‘his’ reveal that the person depicted, even though unnamed, is a man. He is represented by the functional name “an astronaut”. Choosing generic “he” and “his” to portray an astronaut indicates a gender bias. There are many instances where women were also represented by pronouns such as “she”, “her”, and “hers”. However, the choice of the positions where the generic pronouns that represent the female gender were depicted was not equivalent to that of being an astronaut. It was in either unqualified positions or inferior qualifications.

Furthermore, to represent a man with a functional name, the astronaut reflects and perpetuates patriarchal principles. Gastil (1990) proposes the use of he/she or they (instead of the generic pronoun “he”) as gender-neutral pronouns. This gender bias was also shown in the figure extracted from Textbook B below.



3.1.24 A paediatric surgeon prepares a suture for a surgical procedure at Chris Hani Baragwanath Hospital in Soweto. One doctor in South Africa and one doctor in Germany conducted the surgery using a robotic endoscope

*Figure 5.23 A man paediatrician (Textbook B, p.150)*

Figure 5.23 also depicts a person represented by a functional name, a paediatric surgeon. His face clearly shows that he is a man. He is also portrayed in a highly prestigious science profession. Although in both cases, the author did not use nomination (their real names) to represent men, the positions in which they are portrayed endow honour upon the male gender and is possibly an implicit form of suggesting that only boys and men should pursue such professions. Comparing these portrayals of men to depictions of women in Figures 5.1 to 5.3 (in sub-section 5.3 of this chapter), women seem as though they are students, while men are depicted as examples of specialists who are already in practice. The visual image of the male paediatrician in Figure 5.23 is accompanied by the text that shows that the photograph was taken in Baragwanath Hospital in South Africa. Women were never used as examples of doctors and meteorologists in all three textbooks.

#### **b) Specification**

Additionally, the analysis showed that selected textbooks used specifications to connote that men were agents of power. However, the specification was also used to demote women to science professions of low status in selected textbooks. Machin and Mayr (2012) mention that writers can represent people as specific individuals or as a type. Representing people by specification can be done by mentioning them by their real names. In the excerpts below, men were represented by specific names.



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

Figure 5.24 Friedrich Wohler (Textbook C, p.75)



4.4.1 Michael Faraday

One of the pioneers of electrochemistry was Michael Faraday

Figure 5.25 Faraday (Textbook C, p.328)



The Russian chemist, Dmitri Mendeleev. In 1869 Mendeleev published a periodic table that included 66 elements known at that time.

Figure 5.26 Dmitri Mendeleev (Textbook A, p.69)



1.1.1 Galileo Galilei, 1564–1642. Italian astronomer and physicist.

In early 1600s Galileo Galilei observed that an object cannot move unless a force is applied to it. In 1609 Galilei invented a telescope.


Figure 5.27 Galilei (Textbook B, p.22)

**Case study Newton versus Einstein**

You have now studied in depth the laws of Newton. Apart from formulating the laws of motion and gravitation, Newton also experimented with light and its properties of dispersion and interference. He also invented calculus, a mathematical system of solving equations.

The laws formulated by Newton are referred to as causal laws, in which every effect has a specific cause. We know, for example, that when you drop an object, it falls towards the Earth. Newton stated that the acceleration of an object was a direct cause of the net force acting on it. Motion was predictable. As a result, the universe came to be imagined by scientists and philosophers as a large machine whose parts move in a predetermined way according to natural laws. The Newtonian universe is one of absolutes, where time flows at the same rate, and the mass of an object never changes. Past experiences can be used to predict the future. We now refer to Newton's physics as classical physics.

In the 20th century, however, scientists changed this view of the universe. Einstein laid the foundations for the two pillars of modern physics, his special theory of relativity and quantum mechanics, and created a new theory of gravity. (In 1921, Einstein was awarded the Nobel Prize for his work on the



1.2.14 Isaac Newton

Figure 5.28 Sir Isaac Newton (Textbook B, p.9)

The excerpts above show the specification example because the textbooks did not use pronouns to represent them. Instead, they are called by their names, and their scientific contribution is mentioned. These scientists are easily memorable to the readers because they will remember them by their names and discoveries. For example, Dmitri will be remembered for developing

the periodic table, Galilei for inventing the telescope, and Isaac Newton for being the founder of Newton's Laws. Hence, they are portrayed in a position of superiority.

Furthermore, they are likely to be role models for boys because, in most cases, people want to emulate a person with characteristics like his. This discourse can convey the message that men are the ones who are suitable for Physical Sciences and courses related to it because they are depicted as creative (inventing new things), analytical thinkers and problem solvers. In the case of the female scientist, the authors did not use specification but collectivisation in the excerpt below.

### c) Collectivisation

Collectivisation occurs when social actors in discourse are represented as part of a collective or generic group with homogenous characteristics. In the excerpt below, the woman scientist is concealed by representing her as part of collectivity instead of individualising her.

Hermanus Magnetic Observatory



Accurate observations and measurements are done in the absolute house at the HMO, a room built out of non-magnetic materials. Here a scientist is measuring the magnetic declination and inclination with a D1-flux instrument.

Sir William Hoy, the General Manager of the South African Railways & Harbours in the early 1900s, spent his holidays in Hermanus, a coastal town in the southern Cape. Although a railway station had already been built in the town, Hoy blocked the completion of a railway link from Bot River, 30 km away, 'because it would remind him too much of work'. When the Magnetic Observatory had to be moved from Cape Town due to magnetic interference from the electric urban railway system, Hermanus was chosen as its

This excerpt is depicted as Figure 5.3 in subsection 5.4.2. In the excerpt above, the woman depicted is called a scientist. This excerpt demonstrates that the female scientist was represented as part of collectivity instead of calling her by her real name. This woman scientist is depicted in textbook A. Furthermore, the authors did not use the pronouns "she" or "her" to make it easy for the reader to see that it is the woman who is depicted. The face is also concealed by the instrument she is using. Only the clothing makes us assume that it is a woman who is depicted. This portrait justifies my assumption that the possible motive was to conceal women as qualified scientists from the readers. It is also controversial that the authors depicted men

using a potent cultural symbol in Figure 5.18. On the contrary, the face is concealed when the woman uses a potent cultural symbol in the figure displayed above. This visual is one of the few that could encourage girls to pursue the STEM fields associated with the activity depicted.

The authors also showed bias by using the specification to refer to the man not represented by the photograph in the text alongside the portrait. The picture depicts a female scientist, but more is said about the man who manages South African railways and harbours. This text backgrounds the woman scientist and foregrounds the man who is the manager. On the next page of the textbook, where this figure was extracted, the author mentions Dr Pieter Kotze, who narrates how the Hermanus Magnetic Observatory was founded in 1941. The author again uses specification to refer to the man who is a doctor (possibly of philosophy). However, it was never mentioned who the female scientist was and where she came from, like the other two men. Hence, this representation also shows gender bias against women.

## **5.6 Gendered Entrepreneurship Discourse in Physical Sciences textbooks**

The excerpts below show men as scientists of note and businesspeople.

### **Overlexicalisation**


Machin and Mayr (2012) describe overlexicalisation as repeating the same features in the text as a strategy to persuade the readers to accept the ideology implicated. It occurs when there is excessive or unnecessary overuse of words in the language, resulting in redundancy. In the following excerpt, overlexicalisation was used to foreground men in business.

**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.

The use of DC power requires that the same voltage generated at the power station be used by all users. A power station also has to be built close to the consumers to avoid power losses over long distance transmission. In AC power, the power can be transmitted at higher voltages by the use of transformers. This allows for transmission of AC power over long distances with less power losses than in DC transmission. AC can also be used at different voltages, again through the use of transformers. Electric motors run more efficiently using AC instead of DC.

Who do you think eventually won the great debate about AC vs. DC?



Thomas Alva Edison (1847–1931)



Nikola Tesla (1856–1943)

Figure 5.29 Science entrepreneurs (Textbook C, p. 293)

The authors used specification and functionalisation in the excerpt above to foreground Thomas Edison. He was mentioned by his full name, Thomas Edison (specification), and was also called the inventor, a functional name. However, the text further reveals that he was famous for over a thousand inventions. The authors described Edison as a successful businessman and power station owner. I found that there was overuse of words like “famous, very successful businessman, owned more than a thousand power stations” in the text.

Moreover, no female scientist was depicted as a businesswoman, famous, or successful in a science-related business. Again, this text presupposes that only men can pursue and be successful in science-related business enterprises. In the following excerpt, a photograph of a woman engaged in the music business was extracted from the introductory pages of a textbook.

**Did you know?** boxes provide interesting additional information that will help you relate the concepts that you are learning about to real-life situations.

**Did you know?**

When quicklime is heated to 2 400 °C, it emits an intense glow. This form of illumination is known as a limelight and was used in theatrical productions prior to the invention of electric lighting. We still use the idiom for someone that receives attention from the public.



4.2.10 Miriam Makeba in the limelight


The **Case studies** link science to real-life situations and include a wide variety of people and organisations active in the scientific field. Some cover interesting topics relevant to science and present balanced views on sensitive issues. The Case studies are often linked to activities suitable for assessment.

**Case study Newton versus Einstein**

You have now studied in depth the laws of Newton. Apart from formulating the laws of motion and gravitation, Newton also experimented with light and its properties of dispersion and interference. He also invented calculus, a mathematical system of solving equations.

The laws formulated by Newton are referred to as causal laws, in which every effect has a specific cause. We know, for example, that when you drop an object, it falls towards the Earth. Newton stated that the acceleration of an object was a direct cause of the net force acting on it. Motion was predictable. As a result, the universe came to be imagined by scientists and philosophers as a large machine whose parts move in a predetermined way according to natural laws. The Newtonian universe is one of absolutes, where time flows at the same rate, and the mass of an object never changes. Past experiences can be used to predict the future. We now refer to Newton's physics as classical physics.

In the 20th century, however, scientists changed this view of the universe. Einstein laid the foundations for the two pillars of modern physics, his special theory of relativity and quantum mechanics, and created a new theory of gravity. (In 1921, Einstein was awarded the Nobel Prize for his work on the



1.2.14 Isaac Newton

Figure 5.30 Real-life situations Mirriam Makeba and Isaac Newton (Textbook B, p.9)

Miriam Makeba is a famous South African musician who used her musical talent to do business. Her portrayal in a colourful, nice picture in the introductory pages of the textbook used to teach grade 11 can tell girls that this is the kind of business they must pursue. It is also worth noting that the authors wrote a message on the right-hand side of the photograph that the concepts learnt relate to real-life situations. Below her photograph is a picture of Newton with a case study. Alongside Newton's portrait, there is an accompanying message that the concepts learnt relate to real-life situations. However, it continues to say that the case study must be linked to a suitable assessment.

Therefore, the text-producer balanced the gender by portraying a woman and a man independently on the same page in the introductory section of the textbook. However, the coded message can be received differently by boys and girls. Some girls might think the textbook is

channelling them to a music career because a woman is portrayed singing, and the message alongside might be wrongly interpreted as this is a real-life situation for women. Boys might think the textbook is persuading them to remain in the Physical Sciences class despite the challenges they might encounter. This conclusion can be the case because the message alongside a man's photograph states this is a real-life situation and further states that the case study is linked to activities suitable for assessment. In the next section, I present and analyse findings that confirm the evidence of racism and classism in studied textbooks.

### **5.7 Physical Sciences Textbooks index racism and classism**

In all three studied textbooks, only Western White men were depicted as founders of scientific knowledge. The table 5.5 below attests to this. Additionally, all the scientists featured in the chosen textbooks were White and Western. For instance, Doppler, the founder of the Doppler effect, is Austrian, Emille du Chatelet was a French physicist, the chemist Robert Boyle is from Ireland and so on. Not a single scientist of African or Indian origin was depicted. This indicates that the policies of diversity were not considered. The textbook, therefore, promotes racism.

The authors also depicted scientists from the upper social classes. Women of the lower classes of the community tended to be presented as actively involved in science passive portrayals. For example, the two Black women who were portrayed applying hair relaxers show evidence of women in low-class status. Indian and African women who were depicted as science-active were depicted as students. The evidence is in Figure 5.18, which shows a photograph of students demonstrating laboratory skills. All persons depicted are Africans. Figure 5.14 also indicates women collecting water in the river. Women in African rural environments typically wear their apparel. Except for Marie Curie, who was featured as a student and the discoverer of radioactivity, no White individuals were illustrated as students. The selected textbooks did not depict disabled persons as scientists, science active or science passive. The textbooks selected demonstrate social stratification by portraying only Africans and Indians as students and women in lower-status vocations or as unqualified.

**Table 5.5 Depicting all scientists as Western Whites**

| <b>Name of the scientist</b>   | <b>Country</b> | <b>Total</b> | <b>Gender</b> |
|--|----------------|--------------|---------------|
| Friedrich Wohler, Adolf von Baeyer, Eduard Simon, Fritz Haber, Albert Einstein | German         | 5            | Man           |
| Charles Goodyear, James Wright   | American       | 2            | Man           |
| Earl Warrick   | United States  | 1            | Man           |
| Hendrik Baekeland  | Belgium        | 1            | Man           |
| Bonastre, Le Chatelier   | France         | 2            | Man           |
| A. Doppler   | Austria        | 1            | Man           |
| Arrhenius  | Sweden         | 1            | Man           |
| Bronsted, Soren Sorensen   | Denmark        | 2            | Man           |
| Faraday  | London         | 1            | Man           |
| T M Lowry  | England        | 1            | Man           |
| Thomas Edison  | United States  | 1            | Man           |
| Nikola Tesla   | Europe         | 1            | Man           |

|  |         |   |       |
|--|---------|---|-------|
| Robert Boyle                                   | Ireland | 1 | Man   |
| Emile du Chatelet, Marie Anne Pierrette Paulze | France  | 2 | Woman |

## 5.8 Conclusion

This Chapter analysed data I generated from the three selected textbooks using CDA. My findings show that gender roles for men and women were represented differently. The CDA constructs, such as lexical choices and claim counterclaims, revealed how the texts used discriminatory verbs to portray women scientists. The discourse of studied textbooks showed biases. For example, although women possessed qualifications similar to men, such as being a chemist, being a woman scientist meant an inferior scientific role, whilst men were portrayed in highly prestigious scientific roles.

By drawing on Critical Theory, I show how the text framing portrayed men in positions likely to send messages of men being dominant and women being dominated. This was seen firstly through the overrepresentation of men as producers of scientific knowledge and through depicting women as weak whilst men were depicted as strong. The selected textbooks were also silent about the inventions of women scientists. On the contrary, whenever men as scientists were mentioned, their inventions were also stated and used as an introduction to most topics discussed in these textbooks. Therefore, this was interpreted as positioning men as the superior and women as the inferior.

Accepting the use of these textbooks is likely to promote patriarchal values in the Physical Sciences classroom. Hence, I see the potential of these textbooks as promoting hegemonic masculinity. According to Connell (2005), hegemonic masculinity endorses men's superiority in society and justifies women's subordination.

Conceptually, hegemonic masculinity clarifies why men maintain dominant social roles over women (Connell & Messerschmidt, 2005). This concept was adopted from Gramsci's cultural hegemony, which acknowledges that societies are hierarchically organised into the dominant and the dominated. The dominant is supposedly the ruling class that manipulates society to accept its dominance through disseminating cultural norms or ideology, beliefs, perceptions, and values. Conceptually, cultural hegemony further investigates the power relations among the members of society. In other words, how power is used to privilege while exploiting others. Aspects of the selected textbooks reproduce traditional notions of men as being powerful, compared to women, as they are portrayed in highly prestigious science professions. Much of the representation of women shows them as subordinate in positions that make it seem like they possess incomplete qualifications, are students or rendered as qualified scientists who are dependent on men.

In the next chapter, I present and analyse the findings I generated using interviews to determine the student teachers' pedagogical responses to gender representations in selected Physical Sciences textbooks.

## Chapter 6: Analysis of interview data

### 6.1 Introduction

In this chapter, I present and analyse the findings from interviews with participants. The interviews were conducted after I had analysed the textbooks to generate answers for research questions 1 and 2. The evidence and inferences expounded upon in this particular section pertain to the third and fourth research inquiries, which are:

- What are student teachers' pedagogical responses to the gender representations in selected Physical Sciences textbooks?
- What informs student teachers' pedagogical responses to how gender is represented in selected Physical Sciences textbooks?

Using thematic analysis informed by the Social Construction of Gender, Critical Theory and Feminist Post-Structuralist Discourse Analysis, the following themes emerged from the data.

- Student teachers' understanding of gender
- Student teachers' concerns about gender biases in textbooks
- Sense of efficacy to develop strategies to mediate biases in selected textbooks.
- The potential of learning from gender-sensitive mentors
- Possible strategies to address gender issues in existing science textbooks

### 6.2 Student Teachers' understandings of gender

In this theme, I describe student teachers' understandings of gender. I found them describing gender based on varied understandings. The excerpts below illustrate Yanda and Elelo's descriptions of gender based on biological differences.

*I can say gender is sex... (Elelo)*

*Gender is sex differences, using biological features on the person's body, e.g., sex organs. (Yanda)*

The participants' interpretations in the excerpts above indicate a general understanding of sex and gender as synonymous. For example, Yanda and Elelo (quoted above) stated that gender is based on sex organs. In other words, Elelo and Yanda assumed gender as a construct to categorise people's differences based on sex. However, Snezy's definition, while still based on a binary view of gender, differs slightly in the excerpt below.

*Gender is the characteristics of a male or female. Whether a person is a woman or a man, it is socially constructed... (Snezzy)*

Snezzy's dialogue presents a slightly conflicting perspective on gender, as it defines gender as based on both biological traits of men and women and a societal construct related to expectations of a man or woman. Consequently, as interviews progressed, I used other questions as a probing strategy to get more data about the understanding of gender from each participant. Their interpretations illustrated that some believed that society constructs gender. They also demonstrated that they understood that society shapes being a man or a woman by assigning gender roles and influencing gender performances. The following excerpt attests to this.

*My uncles played the role of a father in my life, and they are the ones who raised me. In our family, we believe that uncles are the ones who make vital decisions... in meeting our needs as a family. So, my uncles filled the gap in my life of not having a father. So, my uncles played the role of a father very well. They headed the family because they were the ones who took care of most of our financial needs. (Ntsiki)*

Ntsiki stated that it is common for men to be the heads of the family. She mentioned that her uncles headed the family as men when her father passed on. She did not mention her mother. It seems as if she accepted society's norm that men should lead the family because, in her dialogue, there are no signs of objections to this belief. Instead, she mentioned that "...uncles played the father's role very well". The phrase "very well" demonstrates that Ntsiki possibly agreed with the norm that men (because uncles are men) must perform these duties. The phrase "very well" is used to agree. She further stated, "*My uncles filled the gap of not having a father...we believe that uncles are the ones who make vital decisions*". This statement illustrates that Ntsiki believed and expected that older men must perform the duties of decision-making and provide for the family because, in her statement, she sternly declared that she "believes". Therefore, Ntsiki's response illustrates that her understanding is that the society within which the family functions shapes gender expectations and gender performances. Yanda's response also demonstrated that he saw differentiated roles as usual in the excerpt below.

*In my family, the roles of women differed from those of men. That is how it is in our society. Roles associated with cleaning, washing clothes and cooking were assigned to women, even currently.*

*Roles associated with physical strength, like cleaning the yard, digging holes and everything that required more power, were assigned to men. (Yanda)*

In one of his statements, he said, "...this is how it was in our society...and even currently...". Yanda's statement implies that he regards the gender performance of men and women as dissimilar. Along with Ntsiki, he recognised the standard view that women are typically responsible for tasks related to home upkeep, such as cleaning, washing, and cooking. Additionally, Yanda stated that gender performances were coined based on the belief that men possessed strength. He mentioned that there was a belief in his society that men were expected to perform duties that required more power, such as cleaning the yard, digging holes, and tending the flock. On the contrary, Snezzy's statement below reinforces the conventional perspective on gender roles, which dictates that men should hold jobs and work outside the home to fulfil their breadwinner duties.

*We grew up believing that the father must go to work to be a breadwinner. Although my mother was educated and had a qualification, she did not use it because she had to remain at home and do house chores as the duties of a mother. (Snezzy)*

Snezzy's dialogue also illustrates that her mother had to remain in domestic settings, being separated from her husband to perform the duties of a woman. Wane also mentioned that it was a norm for society (where she grew up) that men and women had to perform different gender roles. In her dialogue, she mentioned that they "...lived a normal rural life." Elelo's dialogue further illustrates that the mother's role was raising children as a woman.

*"...before my father passed on, I did not notice much of his role as a father. However, I have observed from my society that a father's role is to support the family financially. The role of a mother is to take care of the family, including raising the children. That is the experience that I have from my own home..." (Elelo)*

Moreover, Elelo comprehended and recognised that traditional social standards dictate women's and men's roles and obligations. His statement corroborates Snezzy's stance that the male parent bore the onus of meeting the family's monetary requirements in his capacity as the

patriarch. In simpler terms, the father should secure employment and generate an income. These interpretations indicate that the individuals grew up in conventional gender norms, wherein men were obligated to work outside of the household while women were confined to domestic duties, even though they possessed education and qualifications equivalent to those of men for employment. In the next sub-theme, I provide examples of participants' interpretations that show participants' understanding of the flexibility of gender.

### **6.2.1 Dynamism of Gender Roles**

Participants' interpretations also indicated a deviation from the common belief that certain duties are only appropriate for a specific group of individuals. For example, it became evident that in some societies, particular responsibilities known to be performed by men are sometimes shared with women. The following excerpt attests to this.

*My uncles and my mother raised me. My mother and uncles were the ones who provided us with financial needs. In my family, everybody washes his or her clothes irrespective of whether you are a male or a female. We also clean our bedrooms, but my mother cleans the kitchen. My mother and sisters did cooking, but we do cook when they are not around to prepare meals. Cooking is my mother's responsibility, but we (boys) assist with cooking if she is not around. (Nature)*

*Things changed when my father passed on. My mother had to find a job to assume my father's duties while he was still alive. Luckily, it worked to her advantage that she was qualified. So, she managed to get a job and provided basic needs for us as her children. (Snezzzy)*

*But in cases where all women were not around, we wouldn't go to bed without food. Only then would we cook. So, we would intervene in all duties, even in cleaning, only when the mother and our sisters were not present to perform them. (Yanda)*

As opposed to Ntsiki's scenario, the expectations for gender performances differ in the response exhibited by Nature. From Nature's standpoint, it is typical for men to have a role in raising children alongside women. Additionally, Ntsiki acknowledged that it is customary for boys to assist with domestic responsibilities, including the upkeep and organisation of their living space. This response indicates a deviation from the norm and that the concept of gender is not static but can change over time. Although Nature's mother and sisters were the ones who had to perform the traditional feminine duties of cooking and cleaning the kitchen, he mentioned that as a family, they agreed that when women were not around, men could perform these house

chores. Snezzy's response also shows the shifting in the duties of men and women as necessitated by the family's needs. When Snezzy's father passed on, the mother had to assume the responsibilities that are known to be suitable for a man.

Additionally, her mother had to perform these duties alone as a woman, unlike in the cases of Ntsiki and Nature, where their mothers as women could not perform the breadwinning responsibilities alone when the fathers were no more. Instead, uncles performed such duties as men. The contrasting views of participants demonstrate the flexible nature of gender roles and expressions.

Yanda's response also shows that gender performances for men and women confirm that gender is not static. Yanda's dialogue shows that whenever women were not around to perform their duties as a society's norm, they (men) would assume those duties temporarily to meet their needs as they were not supposed to go to bed without food. In other words, gender roles associated with men and women changed.

### **6.2.2 Gender and women's career choices and opportunities**

Based on the evidence, I concluded that a proportion of the participants acknowledged the unequal gender roles assigned by societies, which primarily benefit men and put women at a disadvantage. The excerpts below reflect this.

*We grew up believing that the father must go to work to be a breadwinner. My mother had to be there for us, do house chores and make sure we were all okay emotionally and physically. Although my mother was learned and had a qualification, she did not use it because she had to remain at home and do house chores as the duties of a mother. (Snezzy)*

In light of the preceding extract, I inferred that Snezzy perceived her mother to be in a less favourable position due to the systemic norms of society. Although she was suitably qualified to find a job like her husband, she was deprived of her right to use her qualifications to find a job. Her response tells us that it was society's norm that women must remain in domestic settings and perform house chores as duties of wives.

The implication from Snezzy's statement suggests that the societal norm in this context is following this belief. Consequently, this assumption is considered a stereotype, as she explicitly mentions that it is a deeply ingrained concept passed down through generations. Which serves as a tangible manifestation of the relentless perpetuation of this ideology throughout society,

leading to its eventual acceptance and conviction. In her opening statement, the pronoun “we” may refer to individuals outside of her immediate family within society. The upcoming passage illustrates how the participant highlights the ongoing obstacles faced by women in the present generation. Based on Ntsiki's account, the cultural norms and values imposed by society functioned as an obstruction in her efforts to pursue her desired occupation.

*Teaching was not my first choice. I wanted to pursue health-related careers in science. However, due to family issues, I had to take teaching, although it was my third option for the career I wanted to pursue. So, I chose to teach physical sciences because I saw male teachers teaching this subject in most schools. Even in our class here at university, more boys than girls study to teach Physical. Sciences. I chose to study it to represent our gender as women. (Ntsiki)*

Ntsiki's conversation above tells us that her profession as a teacher was not her primary selection but the third preference in her list of choices. She mentions that her family hindered her from pursuing the career she had a passion for. Furthermore, Ntsiki highlights that most schools regard Physical Sciences as masculine. Through a deliberate and conscious effort to reinforce her viewpoint, she explicitly underscored the notable aspect that, despite being a student teacher, the number of male students within the university she attends exceeds that of their female counterparts. According to Ntsiki, women have to deal with the pervasive belief that the fields of Physical Sciences and their related occupations belong to men. In response to this widespread misconception, she has expressed her determination to challenge and overturn this deeply ingrained social norm.

In the extract below, another participant also mentioned how the stereotypes from society could hinder the academic achievement of women and girls, which ultimately impedes them from achieving their career goals.

*For example, in grade 11, I was failing, so I had that mentality that only boys could pass Physical Sciences. So, we had low self-esteem and believed we could not make it as girls. (Wane)*

Wane's conviction that only male students possess the necessary aptitude to excel in Physical Sciences significantly contributed to her mediocre performance. In addition, she makes a subtle reference to the prospect of enhancing the academic achievements of young women in the realm of Physical Sciences by amplifying their self-assurance in their capabilities. The ideas conveyed by these statements strongly indicate that the prevailing stereotype, which posits that

only men possess the necessary skills and abilities, has been meticulously constructed by society and thus warrants reform. It is conceivable that other classmates who also held this belief reinforced this stereotype. I reiterate this point as Wane vehemently emphasises their deep-seated conviction that success was beyond their reach. It is readily apparent that there existed occasions in which they (referring to women belonging to the same class) would engage in conversations about Physical Sciences as a discipline and arrive at the consensus that it was exclusively the male gender who possessed the ability to excel in it. The extract provided below further highlights the detrimental oversimplification associated with girls, as they are constantly subjected to the dominance of men, and the attitudes and actions of male teachers continuously reinforce this biased concept.

*My Physical Sciences teacher was a male who always made me feel that the science stream was for men. He would highlight that few female teachers are in the Physical Sciences stream. He would tell us girls must pursue nursing rather than highly prestigious science careers. He would say men must dominate in science. So, he would continue to tell us that girls must do only IsiZulu, Life Orientation. He would say that is where we are to be based. Initially, I wanted to be a pharmacist. (Snezzy)*

It is evident from Snezzy's statement that the male teacher in question espoused the belief that the science stream is primarily suitable for male students while relegating Life Orientation and IsiZulu to the female gender. The dialogue shows that the teacher would implicitly declare that girls are not welcome in the Physical Sciences class, but they were supposed to pursue the nursing profession.

In the last sentence, Snezzy admitted that she wanted to be a pharmacist. However, she eventually changed her mind and pursued the teaching profession because the teacher perpetuated the stereotype that Physical Sciences is for boys and nursing is for girls. Her experience is like Wane's case, who failed Physical Sciences at school because of society's belief that only boys can pass it. In the next section, I provide evidence that student teachers assumed that gendered stereotypes negatively affected girls' academic performance.

### **6.2.3 Student Teachers' Understanding of How Gendered Stereotypes Affect Girls' Efficacy**

The excerpt below reveals a different scenario from Snezzy's case. Snezzy had revealed how the gendered stereotype that the male teacher had perpetuated, that Physical Sciences is for

boys, not girls, hindered her from pursuing her career dreams. In Nature's case, as evidenced below, the teacher welcomed all learners but gendered societal stereotypes destroyed girls' confidence in science as a school subject.

*My teacher never showed favouritism to specific learners whilst neglecting others. No learners were very close to him, whilst others would feel neglected. He was not like that. Anyone could approach him. However, boys did well in Physical Sciences in terms of academic performance. In the middle, one or two girls were close to good performance. But boys were the ones who did exceptionally well. (Nature)*

Nature's discourse shows that the male teacher did not perpetrate the negative stereotype. He emphasises that the teacher welcomed all learners, yet boys still outperformed girls regarding academic achievement in Physical Sciences. He used repetition in the last sentence to emphasise that boys' academic achievement was astounding. Nature's dialogue indicates that the stereotype that Physical Sciences is for boys was possibly from home or other larger society's sub-systems other than the school environment. He alluded to the fact that girls did not do well in Physical Sciences despite all the teachers' efforts to ensure that all learners, irrespective of gender, were afforded equality during teaching and learning. His statement implied that other factors adversely affected girls' efficacy in doing well in Physical Sciences. A similar feeling is also evident in Elelo's dialogue below.

*We were all given the same hours to study Physical Sciences. However, boys always did better than girls. And girls knew that there would never be a time when they could score higher than boys. So this was normal for the whole class. Everyone had accepted that girls would never perform better than boys (academically). (Elelo)*

Elelo's discourse illustrates that despite being given the same time and chance to study Physical Sciences, boys' academic performance surpassed girls'. He shows that it was a norm that girls would never achieve better than boys. His conversation indicates that this ideology was possibly a belief from their (boys' and girls') upbringing. Elelo further showed other indicators of girls' faith in the supremacy of boys in Physical Sciences in the excerpt below.

*However, I never saw girls doing extra work or putting more effort into coming closer to boys to get assistance so they could improve their grades. They only asked for information from boys (implied copying of homework). But they never put more effort into improving themselves. Otherwise, they could get good results. (Elelo)*

In the excerpt above, Elelo's statement shows his belief that girls contributed to being dominated by boys in the academic achievement of Physical Sciences. He demonstrated his belief that girls' positions could change if teachers employ effective strategies to empower them to defeat gendered stereotypes. However, the ideology that science is for boys and not for girls ruled their minds to such an extent that they never sought help so that they would also get scores that would be equivalent to or better than boys'. Elelo believed that girls could pass if they sought help. Elelo's conversation also implies that gendered stereotypes negatively impacted girls' achievement in Physical Sciences. In the excerpt below, Mdu's response shows that the masculinity of Physical Sciences may result from society's expectations, which ultimately influence gender performance.

*Studying physical sciences wasn't that difficult, almost for everyone, even though our IQ levels differed...boys were dominant in the top 10, but we all managed to achieve excellent results...but I explained the last time. Boys were always expected to perform better in physical sciences because only boys in my school were always good at math. I don't know why. (Mdu)*

Mdu sternly declared that boys would always be expected to outperform girls because of the stereotype that only boys were good in Maths. Mdu's conversation shows that this stereotype had possibly been transmitted from one generation to the next because he concluded by stating that he did not know why boys were always better in Maths. Mdu also believed that girls and boys had different IQs, which contradicts his first statement, where he said that Physical Sciences is not a complex subject, though the very sentence shows that he had doubts about what he was saying. This response also demonstrates a norm that boys must pass because he mentioned, "...it was always expected that boys would perform better than girls". What is missing in this statement is who was expecting. Could it be the teacher or other learners? The inclusion of the word 'expected' indicates that this could be from society's belief that Physical Sciences is not for girls, making this belief a stereotype transmitted from generation to generation. Additionally, the interpretations above made me wonder if textbooks could be one factor contributing to girls losing faith in themselves, as Physical Sciences learners, that they were equally capable of passing Physical Sciences as boys.

In this theme, I presented data that illustrated how the student-teachers' conversations showcased a diverse array of understandings and perspectives regarding the concept of gender.

The evidence revealed that some participants understood gender as a social construction, whilst other participants had a misconception of gender as synonymous with sex. The data I generated also showed they understood that society assigns gender roles to men and women. Their conversations also showed that they understood how gendered stereotypes that emanate from norms of society permeate science classrooms and negatively impact girls' efficacy to perform astoundingly in science academic tasks and assessments. In the next theme, I present and analyse the data showing that participants were concerned that gender-biased texts could negatively affect science learning.

### **6.3 Student teachers' concern about gender biases in selected textbooks**

In this section, I first show that student teachers recognised that selected textbooks were prejudiced and then show the effects of the identified biases on learners of Physical Sciences. All participants viewed the selected textbooks as promoting gender inequality. The sub-theme presents the evidence of recognition of biases in texts by student teachers.

#### **6.3.1 Recognition of biases that promote masculinity in science.**

Participants' interpretations showed that they were concerned about how gender representations in selected textbooks could demotivate some learners whilst motivating others. Most participants' interpretations illustrate that they recognised prejudices in Physical Sciences textbooks. The following excerpts attest to this.

*It is unfair; they are showing that women are supposed to be doing housework and chores only. Why is it showing only women applying hair relaxers? Why is it showing only women because men also work in salons? When I grew up, I thought science was for men. These textbooks do not encourage girls to stay in science the way they are portrayed because we only see men. So, we, as girls, think Physical Sciences is a male-dominated industry. These textbooks do not encourage girls. Maybe a teacher can encourage you. But not these textbooks. (Wane)*

Wane identified gender unfairness in the way gender was portrayed in selected textbooks. She mentioned that the selected textbooks show only women in activities associated with being uneducated, such as applying hair relaxers, which implies working in salons. She further pointed out how this could reinforce negative stereotypes in girls, which she observed culminated in early years of socialisation. She stated that as a girl, she grew up believing that science was for men (boys).

This statement shows that she recognised how stereotypes that cast women as suitable for domestic chores and non-scientific activities in selected textbooks possess the potential to reinforce society's norms for girls in learning Physical Sciences. She emphasised that the selected textbooks would not encourage girls. She compared how gender was portrayed in textbooks chosen with society's norms. She illustrated this when she stated that the belief disseminated by society made girls believe that science had to be dominated by men. She concluded that the selected textbooks could discourage girls from continuing with Physical Sciences as a school subject. She repeated this in the last sentence, "The teacher can motivate you, but not these textbooks". Her statement suggested that teachers can use textbooks in ways that challenge and disrupt the biases embedded in the textbooks. Elelo's statements in the excerpt below also indicate that textbooks carry messages that possibly maintain the masculinity of science.

*These textbooks depict gender discrimination...women are poorly represented. The picture shows a woman pushing a 5kg box so hard... No one can apply that amount of force to a 5kg box. That is a form of undermining women, that they have no power because...it is impossible for a grown person to be equivalent to a 5 kg box. Women will be discouraged from continuing with Physical Sciences by checking these textbooks. Men will still have more scientific qualifications because they are motivated by the(se) textbooks... (Elelo)*

Elelo regarded how women and men were depicted differently in illustrating scientific activities in selected textbooks as gender discriminatory. He regarded the women's representations as bad compared to those of men. He endorsed his dispute by stating that authors had undermined the status of women. He elaborated on how a woman was being ridiculed by depicting her as exerting great power over a small object of 5kg. From Elelo's point of view, the person depicted was not a girl but an adult woman. He endorsed his point of argument by stating that "... a grown person cannot be equivalent to a 5kg box...". Elelo regarded this as dehumanising other women. He regarded the women depicted as representing all other women because when referring to a woman depicted in a visual, he used the singular form "a woman". However, he used the plural "women" when he proposed what the visual suggests. Furthermore, Elelo emphasised his full persuasion about how the visual mocked the woman when he described her even when he was no longer looking at the photograph that depicted her. He used the words "...even looking at the picture....".

These words show that the picture remained in his mind, and he was still describing her precisely as the picture depicted her. He further mentioned that the height of the box the woman was pushing was equivalent to the woman's height, yet it was labelled as weighing 5kg. This dialogue shows how depictions from selected textbooks could bring divisions in science classrooms. He pointed out that textbook depictions had demoting messages that could hinder women from pursuing science careers. He emphasised this point when he stated that the women would be discouraged from continuing with Physical Sciences. His last sentence suggests that men will still dominate in STEM fields because he mentioned, "...men will still have more academic qualifications in science because they are motivated by the(se) textbooks". The following excerpt also shows the participant indicating that the selected textbooks promote masculinised science.

*There was gender unfairness, for example, a woman pushing a child in a stroller... There will be more men than women who pursue STEM subjects during schooling and at the tertiary level if future textbooks maintain these portrayals. (Pro)*

Pro also contended with the size of objects that selected textbooks used to portray women as incapable of handling heavy objects. She mentioned that depicting women pushing a child in a stroller was unfair. However, she did not continue to explain why she was rejecting the act of depicting women pushing a child, possibly indicating that she noticed that women were, in most cases, depicted in a manner that suggested that they were not capable of handling heavy objects. In other words, textbook depictions showed women as weak. She further indicated that such portrayals send the wrong message to girls that science is not for them. She points out that these portrayals indicate the possibility of fewer girls choosing physical sciences as a subject at school and tertiary institutions.

On the contrary, she pointed out that selected textbooks empower only boys because she stated that "...there will be more men than women...". His argument indicates a leak of women from the STEM pipeline during and beyond schooling. Mon's and Elelo's dialogue below also demonstrates how textbook portrayals evoked feelings of activism in student teachers.

*From what I have seen, it portrays that women were always there to help the men. But men were the driving force; women were only there to be translators. I think people who are in the wrong are authors...Men dominate, mainly when showing scientists. Only men were seen to be in science. It just sends a message that for a woman to succeed, there must be a man...Boys*

*have more role models...So, it is natural that if you see someone of your gender doing something, you may be motivated to be like them. I think it is our duty as teachers to encourage girls. (Mon)*

Mon argued that most textbook portrayals depicted women as lacking critical thinking skills. He mentioned that studied textbooks depicted women as helpers of men. A helper generally refers to someone unskilled who assists the skilled by manual labour. Helpers only take orders from their bosses; they never invent. In other words, according to Mon's response, women were portrayed as either unqualified or qualified with lower proficiency than men. He regarded women's portrayals as lacking creative and critical thinking skills. Mon further highlighted that the selected textbooks conveyed that for a woman to be successful, there had to be a man. Mon's argument is an indication of women's subordination. He used the verb "dominate" to indicate that textbooks positioned men in power and women in subordination. Mon stressed the evidence of the dominance of men when he stated, "It is obvious that men dominate....". Notably, he recognised the potential for teachers and teaching to disrupt the gender stereotypes that position girls as deficient and to motivate them to excel in STEM-related subjects. In the following excerpt, Elelo's conversation also supports Mon's argument.

*All textbooks suggest that men are still dominating in science ...checking from the first book, the texts depicted only male scientists...In the second book, women are represented as scientists but under men. Even in the third textbook, when women have achieved something, like doing their research, the credit still goes to men, like when a male was a professor and a student was a female. So, all in all, they are saying the professor is the one who did the work and was able to help that female think about those things. (Elelo)*

Elelo concurred with Mon by mentioning, "...all textbooks suggest that men are still dominating". Elelo's response shows logical reasoning. He mentioned that the dominance of men was evident in the first textbook that depicted men only as scientists. He further mentioned that men dominated women when they were given credit for what was achieved by women. He mentioned that the professor was depicted as a man in the third textbook, while the same excerpt depicted a woman as a student. Therefore, he claimed that although the text mentioned the woman as the founder of the term radioactivity, text framing made it sound as if it was because the male professor assisted her in thinking. He, therefore, regarded selected textbooks as promoting masculinity. He also felt that only boys had role models. He concluded by indicating the teacher's duty to mediate media that indicated ideological subversion.

In this sub-theme, I analysed how gender representations in selected Physical Sciences textbooks evoked feelings of activism in participants. I also showed how student teachers regarded selected textbooks as possessing the potential to create divisions between boys and girls in learning science. In the next sub-theme, I present recognition of the possible effects of the marginalisation of women through the failure of authors to include their scientific contribution to science.

### **6.3.2 Omission of women's inventions in textbooks - an epistemological omission**

Student teachers also recognised that textbook portrayals omitted women as producers of scientific knowledge in selected textbooks. Almost all participants of this study considered the absence of women's contribution to the production of scientific knowledge in textbooks studied as a form of gender discrimination against women. The omission of women as producers of science marginalises and deprives them of their human rights of being treated equally to men. The excerpts below show examples of their interpretations that indicate how they felt that visuals and texts devalued, dehumanised and sidelined women. This act of discrimination against women could ultimately push them to the margin of STEM streams. The analysis of each participant's extract starts by showing recognition of omission, followed by the possible effects of marginalisation through omission.

*... But she was a chemist, right? (she paused) So she was qualified (participant paused) but was only there to assist, and textbooks did not show her work! Why is that? (participant paused) She should be doing the real work and not become someone's doormat. So, I think it is unfair for her to be qualified and not seen...and have someone else (husband) in the front line. So, she was discriminated against, and she is supposed to be getting the real fame, not the husband... Maybe the men take women's work and portray it as theirs... (Wane)*

Wane also disputed the act of sidelining a woman the textbook depicted as a chemist but did not show what she discovered or produced or how she contributed to scientific knowledge. She used the words "...and textbooks did not show her work". She sounded convinced that, like other (male) chemists that the textbooks depicted as scientific producers; there should be something that women chemists must also have discovered or produced. She concluded that the authors chose not to show it.

Wane expressed her feelings of anger when she mentioned that textbooks reduced women's status to resemble the "doormat". Instead of calling the woman depicted an assistant, the text

producer's word, she said the woman must refrain from being used as "...someone's doormat...". She said the woman "should be doing the real work..." because she was a qualified chemist. This statement implies that the participant regarded how the text portrayed the woman as being demoted, devalued and dehumanised. She regarded being the laboratory assistant as not real work, considering that the woman was a chemist by qualification. Portraying her as a laboratory assistant typifies demotion from being a qualified chemist to a laboratory assistant. In other words, Wane was questioning why female chemists were qualified as male chemists, yet the textbook did not portray female chemists the same way it depicted male chemists. She stressed that such portrayal brought evidence of discrimination against women. In the following excerpt, Wane showed the possible effects of depicting only men as producers of scientific knowledge.

*"...in our class, there are few women, which shows that we (women) are discouraged from home while at school. So, we can't continue with Physics ...I was encouraged by my teacher because he studied here at this University, and he is a male because textbooks discouraged us as girls..." (Wane)*

Wane further indicated that textbooks could cause girls to drop out of the Physical Sciences stream whilst at school, resulting in fewer women in science streams at the tertiary level. She endorsed that Physical Sciences textbooks contained messages that were discouraging girls from continuing with the subject. She clarified her point by showing that, at some point, messages from Physical Sciences also demotivated her as a learner. She continued to state that she was only encouraged by her teacher to remain a student of science. She indicated that she considered dropping out of the science class. In one of her discourses earlier, she had stated that they asked the teacher, "...why is it that all that time when we have to learn a new topic from the textbook, we would hear 'the male scientist discovered this...the male scientist discovered that...' all the time?"

Furthermore, in the extract above, she also mentioned that in her current class, i.e. in university, "... there are few women". This discourse shows that she recognised the possible effects of women's omission from studied textbooks. She considered demotivating messages from textbooks as one factor that could contribute to the fact that there were few girls in her Physical Sciences class at the tertiary institution.

In the following excerpt, another participant highlights that he also noticed the omission of women's scientific contributions.

*I see that the work done by women is not shown in the textbooks you have shown me; for example, there is a picture of them in the salon. So, to do hair has nothing to do with science, so they are showing that women are not supposed to do science. Remember the picture that showed a woman pushing her baby, which had nothing to do with science and the other photo that showed fem? Cycling is not part of doing science. So, they did not show women as scientists but as students doing something else. (Phiwo)*

Phiwo also outlined that textbook portrayals did not feature the work of female scientists. He showed that, instead, the same textbooks portrayed women in activities that channelled them away from science. He repeatedly stated the areas where the textbooks depicted women as examples in illustration of scientific concepts but that "...had nothing to do with science...". He mentioned working in a salon, engaging in cycling activities and caring for babies as things that cannot motivate girls to remain in the science stream. Hence, he regarded failure to show women's scientific contribution as coequal with rendering them invisible. In the last sentence in the excerpt above, he opposed his first sentence. He concluded by stating that "...in fact, they did not show women as scientists ...". Yet in the first sentence, he claimed that textbook portrayals depicted female scientists. It is only their work that textbooks do not show. In the following excerpt, Phiwo shows the possible effects of marginalising women by omitting their scientific contribution.

*These textbooks can demotivate women because the illustrations and the inventions portrayed are for men. So, a female learner might say, why should I continue with Physical Sciences because if I do, I will "end up doing" nothing? There is a female who was a scientist but was assisting her husband. There was also a female scientist who was translating Newton's work. So, women might think they are useless and consider leaving science. (Phiwo)*

Although Phiwo is also a male student, the discourse above illustrates that he empathised with the girls' who will learn from this textbook. He showed three stages preceding girls' decision to drop out of Physical Sciences classes. First, he indicated that the messages from selected textbooks could lower girls' self-esteem. It is also evident in his first sentence, where he states, "...These textbooks can demotivate women."

He then used the language that indicates stepping into the shoes of women by stating, "...So a female learner might say, why should I continue with Physical Sciences because if I do, I will end up doing nothing." He demonstrated by using the pronoun "I", which indicates the second stage, information processing. For example, he enumerated the list of such information to include illustrations that use men as examples and inventors, depicting women as translators of men and as assistants of husbands. The processing of all this information occurs internally without the teacher being aware of the damage the textbook might have caused. In the last sentence, he showed the previous stage where a girl might decide to drop out. He demonstrated this in his statement, "...might end up leaving science". Therefore, Phiwo also believed that the textbooks that sidelined women through omission could contribute to women leaving from the science pipeline. Other participants anticipated that the authors decided to credit men for what had been discovered by female scientists. The following excerpt attests to this.

*Even in the cases where there was something scientific that women discovered, they showed it as if it was found by male scientists and as if women were working under them...So, if girls see that from textbooks used to teach Physical Sciences, most photographs depict men as scientists and women only follow them. (Snezzy)*

Snezzy also noted that selected textbooks did not reveal women's scientific discoveries and concluded that the motive was to promote male superiority whilst depicting women as subordinates. Her concern made her anticipate that authors used women's discoveries as men's. She also alluded to the fact that studied textbooks depicted women as servants of men. In the last sentence, she mentioned that textbooks' photographs depicted men in positions of power "as scientists" and women as subordinates who "...only follow them...". In the next excerpt, Snezzy also showed the effects of the bias of marginalising women by depicting only men as scientists who contributed to scientific knowledge.

*So, if girls see that from textbooks used to teach Physical Sciences, most photographs depict men as scientists and women only follow them, they can change their minds...textbooks can harm girls. First, when we teach Physical Sciences at schools during practice teaching, I noted that there is a belief that Physical Sciences is difficult for girls...They will start to believe that this thing is difficult. The absence of female scientists from Physical Sciences textbooks could be interpreted by the girls as that they have no role models in science.*

*So, they might have doubts about their choice to include Physical Sciences in their subject package in the first place. I have noticed that if you are a girl in Physical Sciences class, it calls for you to be tough or refuse to be shaken... (laughing). (Snezzy)*

Snezzy stated that textbooks that depict men only as producers of scientific knowledge can harm girls. She mentioned that she had evidenced the impact as a student teacher during practice teaching. She said that firstly, it would reinforce the stereotype that Physical Sciences is complex for girls. Then, it would introduce doubts to girls who had conquered society's norm that Physical Sciences is for boys. The fact that girls included Physical Sciences in their subject package in the first place suggests that they had ignored society's norm that science is for boys. Snezzy predicted that girls might change their minds about including it if they were not resilient. She also put herself in the shoes of other girls by telling us how she also experienced the pressure of being regarded as a misfit in science. From her tone, it seemed like a girl lacking resilience could not stay in the science stream. This statement reinforces her earlier argument that girls who experience marginalisation from selected textbooks might feel they have no role models and ultimately consider dropping the subject.

In this sub-theme, I presented the findings that reveal participants' concern about the effects of marginalisation of women through omission. All participants anticipated that girls who have chosen Physical Sciences in their subject package might consider dropping out if masculinity continues to permeate science classrooms through textbooks. In the next sub-theme, I present the findings that show that participants identified the stereotypical language and their effects on learners as readers of the selected textbooks.

### **6.3.3 Influence of stereotypical discourse in texts**

Participants also noted the evidence of language that had the potential to reinforce stereotypes, which could contribute to girls' doubt about remaining in the science stream. In the following excerpt, the student teacher was concerned about the text producer's choice of words to cast a man as superior and a woman as dependent.

*For example, when a male was a professor, and a student was a female, they are saying that the work was done by the professor, who was the one who was able to help that female think about those things. Women are (will be) discouraged to continue by checking the(se) textbooks. Men will still have more qualifications in science because they are motivated... (Elelo).*

Elelo disputed the author's choice to cast a woman who is the founder of radioactivity as a student and foregrounded a man as a professor. He was not worried that the text mentioned the professor but rather that the professor was being used to conceal the woman's reputation. He argued that the message sent to the readers was that the woman could not have thought about the term if it weren't for the professor. In other words, according to Elelo, the female scientist was depicted as lacking creative thinking skills. Although the textbook had revealed the student's name, Marie Curie, Elelo was concerned that the text producer chose to mention her with the man. He provided his interpretation that "... all they are saying is that it was the male professor who helped that female...". His concern was that such discourse could demotivate girls in the course of learning science, and he felt that this could be the cause for fewer women attaining STEM qualifications. Mdu raised a similar argument in the excerpt below.

*.... In my head, there is full of Albert Einstein, Tesla, Thomas Edison, all those male scientists...We used to be the top students as boys...Maybe we are motivated because we can see that science is depicted in texts as if it is for boys...The girls used to say Physical Sciences is for men, maybe because of their laziness. But also, because we see scientists as men, we boys believe we will be like them one day. So that drives us to work very hard. The same thing goes for girls. As they cannot see a woman who is a scientist, it will be hard for them to believe in science...It results in them failing grade 12. So, they cannot attend the university and take Physical Sciences if they do not pass it. (Mdu)*

Although Mdu is a male student teacher, he also put himself in girls' shoes. He mentioned that the text producer's choice to mention the male scientists by their names had made him "...full of Albert Einstein, Tesla, Faraday...". He stated that seeing male scientists in textbooks motivated them as boys to work very hard, believing that one day they would be like the scientists depicted. He endorsed that this reinforced the stereotype that science is for boys. He mentioned that even girls believed this norm in sentence 4, "girls used to say Physical Sciences is for men". Mdu argued that such depictions contributed to the factors that hinder women's careers. He emphasised his argument in the sentence where he stated that if girls had failed in high school, they could not pursue the careers of their dreams because it meant they could not continue their tertiary studies. He mentioned that girls' failure to pass the subject had made boys label them as lazy. However, he also emphasised that excluding female scientists from textbooks used to teach Physical Sciences could sideline girls and demotivate them from continuing with Physical Sciences as a school subject.

Most importantly, he stated that it could cause girls to fail, which would hinder them from pursuing their studies at the tertiary level. Elelo also agreed with Mdu and further argued that selected textbooks depict only men as "...too smart...". The following excerpt attests to this.

*...when examples are made about men, they make examples of too-intelligent men, like the astronaut and the one who was using that thing of...for the Doppler effect. That shows that men are analytical thinkers. Checking at the paragraph where they quoted the astronaut, they say, "...he knew already that to be back in space he needs to push..." So, a man always knows something better than a woman. Women are not represented well... Men will still have more qualifications in science because they are motivated, time after time, by these textbooks. (Elelo)*

Elelo also highlighted that the textbook language reinforces the stereotype that men are wise, depicting women as "...making mistakes". He clarified his argument by quoting words from the textbook that used a man as an example of an astronaut, "...the man knew already that to be back in space, he needs to push". He emphasised that this reinforces the stereotype that men are analytical thinkers and more knowledgeable than women. He concluded by stating that this implied that men would continue to dominate in science because the language used in textbooks reinforces stereotypes that motivate them whilst demotivating girls and demoting them by representing them poorly.

In this sub-theme, I analysed how student teachers' interpretations demonstrated that selected Physical Sciences textbooks could potentially reinforce stereotypes in learners who learn from them. In the section below, I present the analysis of the findings that confirm the student teacher's sense of efficacy in mediating gender issues in the classroom while learning Physical Sciences.

#### **6.4 Student Teachers' sense of efficacy to mediate media assaults.**

Teacher efficacy has been defined as the teacher's certainty that they can successfully achieve the desired outcome for their students (Tejeda-Delgado, 2009). In this theme, I analyse the student teachers' discussions about their capacity to use the textbooks in empowering ways.

The participants' discourses demonstrated that many were confident that they could address textbook biases in Physical Sciences classrooms. Some of the participants indicated that their experiences as learners have taught them how to deal with media assaults. The following excerpt attests to this.

*As a teacher, I am responsible for encouraging everyone who wants to learn Physical Sciences, even if textbooks discourage them. My Physical Sciences teacher was my role model. He did not display favouritism to some learners but would treat us the same way as learners. Hence, I chose to be a physical sciences teacher because I found it in my heart that I could develop and help other learners who were coming behind me so that they could become essential aspects of scientific thinking and understand the nature of science. (Pro)*

Pro's response illustrates that having a good teacher impacts effective learning. She demonstrated that she had an experience of observing good qualities from a man and what it means to be an effective Physical Sciences teacher who retains learners until they finish, irrespective of their gender. She also tells us that what she observed from her teacher instilled in her a passion for pursuing a teaching career and Physical Sciences so that she would make a difference to other girls in the future. She mentioned that, from what she learned by observation, she aspired to develop herself to help others. She explained that she trained to become a Physical Sciences teacher to achieve this goal. In addition, she displayed a strong sense of assurance in her belief that her future pupils will ultimately serve as vital components in the cultivation of scientific thought and comprehension of the essence of science. Although female, she was able to assist other learners during her schooling years to be like her. So, as a woman, she regarded herself as a future role model for girls. In line 1, she regarded herself as a teacher, although she was still in training and demonstrated that she has all it takes to encourage all learners by herself. She first demonstrated a high level of efficacy when she stated that it was her responsibility to encourage learners who might be discouraged by textbooks.

*During the times when we were supposed to clean the class, he would make all of us clean the classroom. Irrespective of whether you were a boy or girl, you would clean. (Pro)*

Pro's discourse further illustrates that she had an experience of gender equality. She was treated equally to boys. Furthermore, she observed the teacher disrupting society's gender norms because the teacher would make boys and girls clean the classroom. She stated that it was never a duty that the teacher solely assigned to girls. This dialogue demonstrates that if Physical Sciences textbooks continue to present domestic roles as suitable for women only, Pro will be able to guide her learners as an equipped teacher. In the following excerpt, Snezy also demonstrated that she was confident that she could assist girls in remaining in the science stream, irrespective of gender biases presented by textbooks.

*“In most cases, during my teaching practice, I encourage girls. For example, I used to make an example about myself. What drove me to be a teacher was that no one forced me because I had no other options. I was motivated by my physical sciences teacher, who is a male, who always made me feel that science is for men. ... So, I made up my mind that I would never allow a male person to dictate to me that I cannot do Physical Sciences just because he believes it is for men. If you believe that this is what you want to pursue, you can do it. That is precisely how I encourage my learners during practice teaching. I have noticed that if you are a girl in Physical Sciences class, it calls for you to be tough or refuse to be shaken. (Snezzy).*

Snezzy’s dialogue shows that she conducted self-evaluation and concluded that because she overcame stereotypical language from a school teacher, other girls can also overcome it. She quoted the instances from teaching practice experience. Her dialogue shows us that she exemplified herself when she encouraged girls. Again, this statement shows that Snezzy regards herself as a role model for other girls. Furthermore, her discourse displays that she had an experience of invalidating negative stereotypes from her schoolteacher. She tells us how the male teacher made nasty comments that girls were not welcome in the Physical Sciences classroom. Her full persuasion was evident when she stated that she decided not to follow the male’s sabotaging strategy. Hence, she managed to pass with good grades that enabled her to further her education at the tertiary level to be a Physical Sciences teacher. She put her foot down that anyone could pursue her dreams amid opposition. She regarded this experience as valuable evidence that she used to encourage other learners to learn Physical Sciences (during practice teaching) irrespective of how textbooks portray gender. In the last sentence, she demonstrates the ambition to reproduce girls of her kind. She stated, “What I have noticed is that, if you are a girl and you are in Physical Sciences class, it calls for you to be tough...”.

Hence, Snezzy was also confident she would be a valuable resource in disrupting problematic gender identities presented by Physical Sciences textbooks. In the following excerpt, Mon also demonstrated his readiness to assist learners in overcoming media assaults.

*Boys have more role models because all these textbooks show male scientists. So, it is natural that if you see someone of your gender doing something, you may be motivated to be like them. I think it's our duty as teachers to encourage girls. From a young age, I have always been fascinated by the wonders of the physical world and was naturally curious to understand how things work. Throughout my studies, I constantly shared my knowledge and explained scientific concepts to my peers, which sparked a realisation that I had a natural inclination for teaching.*

*Combining my love for science and desire to educate others, I tended to education. I ultimately decided that becoming a Physical Sciences teacher was the perfect career choice for me, and it was also my first choice. (Mon)*

Mon's discourse shows that he can, first of all, identify the problem and use his capabilities to provide a solution. The first sentence shows that he recognised that only boys had role models. He then showed his processing and then concluded that boys would be motivated by the selected textbooks. Furthermore, he demonstrated his leadership qualities by indicating that the selected textbooks had role models for girls. He then concluded by recognising the availability of the solution that included himself in sentence 3: "...for girls, it's our duty as teachers to motivate them". His statement demonstrated a high level of efficacy because he did not regard the textbook that contains valuable information as useless. Instead, he firmly stated that he would keep using any Physical Sciences textbook, regardless of gender representations, and would also make an effort to encourage girls who might feel demotivated by such representations. His high level of efficacy is also evident in his ability to draw from his innate qualities. His dialogue demonstrates his passion and commitment to the subject and teaching profession. He stated that he had a love for science and a desire to educate others. Hence, passion is one factor that will make him do what he deems helpful to ensure that all his learners come out as high-quality products of Physical Sciences teaching and learning.

*For learners like me, I review all the pages and look at the pictures before using a textbook. If I see anything that I disagree with, I switch it off. I will not even pay attention to what the teacher is saying because I am troubled by what I have seen.*

*So, I think it may be the same case with some girls. Most will be discouraged by how textbook portrays men and women. Currently, I am the coach for ladies' soccer. The reason is that I believe that girls can do what everybody else believes can be done by men only. I did this to prove that no sport is for men only. Everyone with two legs is capable. Therefore, before I use the textbook with learners, I will go through it to check its possibility of demotivating girls and boys. Then, I will motivate learners first so no one will feel like dominating others. Even if there could be a learner who could have seen biases and switched off, she would switch on again because I would have said it as a male. (Yanda)*

Yanda also believed, without a shadow of a doubt, that he was capable of mediating assaults presented by Physical textbooks, particularly those that are gender related. He also shows high

efficacy by drawing from his strengths and weaknesses. Drawing from his shortcomings, Yanda's conversation shows us how girls may be negatively affected by the gender biases in textbooks. Yanda stated that before he used a textbook, he scanned through it, and if there was anything offensive, he would naturally switch off during teaching and learning. In other words, Yanda regarded such a textbook as demotivating. He believed that it was the same case with girls. Yanda empathised with girls and put himself in their shoes. Drawing from his strengths, he exemplified how he empowered girls as a coach for ladies' soccer. His conversation shows that he started the ladies' soccer team to demonstrate to his society that girls can also play soccer because they have two legs. This example shows his understanding of how he can deconstruct society's norms that hinder girls' academic performance in Physical Sciences classrooms. He also demonstrated his confidence in himself by stating that girls would disregard the textbook's assault and believed him as a male as he motivated them.

In this theme, I presented and analysed the findings that show student teachers' sense of competence to disrupt gender biases that textbooks might present in future. All student teachers who participated in the study drew from their experiences to validate their readiness to address gender biases that physical science textbooks may present. These experiences included learning by observation, overcoming negative stereotypes during schooling, passion and commitment to the subject and teaching profession, and their past strengths and weaknesses. In the next theme, I present the findings about resources that student teachers recognised as effective means to address gender biases.

### **6.5 Potential of Learning from Gender-sensitive Mentors**

All study participants recognised that they were novices in teaching and demonstrated a willingness to learn from senior educators. Their discourses display that they observed (unconsciously) effective teaching methods from their high school Physical Sciences teachers, lecturers as teacher trainees, and senior teachers during practice teaching.

The participants' discussion exhibits how their schoolteachers, who welcomed all learners irrespective of their gender, served as tools to retain girls in the Physical Sciences stream, although they considered it as masculinised. Most participants regarded their previous schoolteachers as role models. Additionally, they felt that the teaching practice experience afforded them opportunities to meet other senior teachers in the field whom they regarded as examples of valuable resources in deconstructing gender stereotypes in textbooks. In the following excerpt, Wane's conversation illustrates this.

*My Physical Sciences teacher was a male but was an outstanding teacher. I liked that he explained Physical Sciences very clearly and gave examples of things happening in our everyday lives. For example, when explaining the acceleration principle, he would not just focus on the textbook but use the car to clarify the concept. He was very gentle. If you didn't understand, he would be there for you to explain until you understood. He also inspired me. As a future teacher, I want to be like him because he lives what he teaches. (Wane)*

Although Wane is a female student teacher, she tells us that, whilst she was a learner (during her high school years), the male teacher imparted the good qualities that she reckoned desirable for a gender-sensitive Physical Sciences teacher. She highlighted that the teacher's methods were gender-neutral because he would essentially make examples of objects rather than persons when explaining scientific concepts. Wane argued that she learned from her teacher that if the textbook was stereotypical or gender-biased, it was better to use non-human examples to ensure a welcoming environment for all learners.

She also emphasised that the teacher's human skills enhanced learning for all in the Physical Sciences classroom, such as being gentle when communicating with learners. This point foregrounds an essential aspect of learning that puts learners at ease and boosts their confidence such that they can even ask questions where they feel they don't understand scientific concepts.

Wane's earlier conversation also demonstrated this argument, whereby girls confidently sought help from the teacher when textbooks seemed to demotivate them. She said they asked the same teacher, "...why is it that whenever they were learning a new topic, the textbook would say, ...A male scientist discovered this?... a male scientist discovered that? all the time?" Learners could only ask such questions from the teacher if he was approachable and gentle. In other words, he would not ridicule girls or make them feel they were asking stupid questions. The teacher explained scientific concepts clearly. In the following excerpt, Mon's conversation also corroborates this.

*My physical sciences teacher incorporated various instructional strategies for diverse learning styles. She would often use visual aids, demonstrations, and hands-on activities to ensure that all students fully grasped the concepts being taught. Her explanations were clear and concise, and she was always willing to go the extra mile to ensure everyone understood the material. Furthermore, she encouraged active participation and engagement in the classroom. She fostered an inclusive and collaborative environment where students felt at ease asking*

*questions and sharing their insights. She often initiated discussions and encouraged us to think critically and express our opinions. (Mon)*

Mon's focus of attention is on the gender-inclusive strategies that the female teacher used during his schooling. He tells us that she (the teacher) was conscious of the different genders of learners, hence, her teaching strategies catered to diverse learning styles. This statement indicates gender inclusivity. Mon's discussion also points out that the teacher brought her visual aids to foster learning. His conversation suggests that this gender-sensitive teacher was conscious of stereotypical messages in Physical Sciences textbooks. Hence, he would use other methods to illustrate concepts to ground learners on the content taught rather than on the founder of the knowledge. Mon further used the word "all" to emphasise that the teacher wanted to ensure that Physical Sciences is for all, i.e. boys and girls. He also underscored the acknowledgement of gender-inclusive methods from the teacher in sentence five, where he stated that the teacher "...fostered inclusive and collaborative environment". The teacher's methods also promoted critical thinking instead of rote learning. In the following excerpt, Mdu's conversation tells us how teaching practice mentored him to acquire skills and strategies that he could employ as a future teacher to cater to all learners' needs in learning science.

*"...Being in teaching practice was a great experience. What I loved the most was having a female teacher as a mentor, welcoming and allowing gender balance in the classroom. She used gender-neutral language when teaching Physical Sciences, such as saying students instead of boys and girls. She also used diverse role models in examples and case studies, including men and women. She promoted equal participation and dialogue between all students, regardless of gender. (Mdu)*

Mdu said that during teaching practice, he learnt from a female teacher. He indicated that he was also gender inclusive, as he learned from a female, although he was a male. He continued to tell us that the teacher that he observed used gender-neutral language in the Physical Sciences classroom to be welcoming to all learners. He made an example of using the word "students" instead of boys and girls. He also acknowledged that the teacher provided learners with diverse role models. Mdu indicated that if textbooks provided only boys with role models, the teacher could strike a balance by including female role models.

Furthermore, she provided a classroom environment where all learners experienced gender equality because Mdu reckoned that *"...she promoted equal participation...between all*

students". Therefore, according to Mdu's dialogue, gender discrimination and marginalisation were highly reduced by the teacher's methods. In the following excerpt, Phiwo also regarded a Physical Sciences teacher who mentored her during practice teaching as a venerated resource she would use as a frame of reference when deconstructing gender biases presented by textbooks.

*During teaching practice, my Physical Science mentor would point to everyone in the class when asking questions so that all learners would feel the teacher treated them equally. However, when he realised that there was one gender that was dominating in numbers in terms of responding to questions, he would encourage the other gender by pointing them out even when no one of their gender raised the question. He tried to make his class equal. He would do this interchangeably. If girls were not participating, he would encourage them by pointing at them even when they don't indicate by raising their hand that they know the answer and vice versa. No one "was left behind" during the lesson. Even when doing demonstrations, he would use boys and girls to make examples. (Phiwo)*

Phiwo also believed he could help all his learners deal with gender issues that Physical Sciences textbooks could present. During his teaching practice, he observed how the teacher handled situations that represented dominant norms in Physical Sciences education.

He stated that when there was one gender that would dominate by showing to be more knowledgeable than the other, the teacher would focus on the gender that looked powerless by lacking relevant answers during the verbal assessment. In other words, Phiwo's dialogue tells us that by using probing techniques to get answers from the learners of the gender that ran short of ideas, the teacher was lifting them to eliminate all forms of gender inequality. Phiwo stressed that the teacher's techniques ensured all learners felt welcome in science class.

Snezzy also felt empowered by senior Physical Sciences teachers to work with learners to address gender biases. However, her discourse not only focuses on teaching practice but also pinpoints how the university lecturer allowed her to learn good qualities.

*What I admired the most about my Physical Sciences mentor during teaching practice was that he was patient and approachable to all his learners. My Physical Sciences lecturer loved her work. She treated us as boys and girls the same. She instilled in us the winning spirit. In contrast, my male lecturer believes his concern is only about male students. He only picks the*

*male students even when he hires the laboratory demonstrators. I think we all need equal opportunities as them. (Snezzy)*

Firstly, Snezzy conversation shows that her mentor during teaching practice also drilled gender equality in his teaching methods. She further indicated that her female university lecturer employed gender-inclusive techniques for all her students. However, Snezzy felt that the male University lecturer demonstrated masculinised science. She said that girls were side-lined and marginalised because the male lecturer used only male students as demonstrators during practical investigations. Therefore, he demonstrated gender inequality by showing a preference for male students. Wane also got the opportunity to learn from the senior teacher during teaching practice. The following excerpt attests to this.

*“...the teacher who mentored me during teaching practice greatly inspired me. She knew all learners by name. I saw that this was one of the reasons that made her learners interested in the content taught because they felt welcome and accepted. The examples she used also fascinated me. For example, when teaching acceleration. We use cars when explaining the acceleration concept, yet only boys are familiar with cars. This teacher would first explain the car's parts to everyone, like pedals, accelerator and their functions.*

*So that even girls will not switch off. Her teaching methods would captivate the learners' concentration throughout the lesson. When teaching about acids and bases, girls would, for example, mention that soap as a base is used to wash dishes and our bodies. Girls felt part of the content because they mentioned examples that the teacher regarded useful in understanding scientific concepts. (Wane)*

Wane's argument highlights that her mentor knew all her learners and called them by name when communicating. She acknowledged that this made learners feel important and ultimately loved the subject. She also stated that the teacher provided a gender-sensitive environment when teaching Physical Sciences. She made an example of the time the teacher would teach girls about the parts of the car and their functions before he taught the principle of acceleration. Snezzy said that the teacher knew that boys were more familiar with cars, so she wanted to make girls feel welcome in the subject matter by pulling them to the same level of understanding as boys so that they would not feel the subject matter marginalised them and probably switch off. Snezzy became even more fascinated when the teacher asked girls for examples to empower them while teaching acids and bases. So, the teacher would plan the

lessons to be mindful of stereotypes and come to class well-prepared to limit their effects on boys and girls. The teacher did this because she believed no one would feel science was only for boys.

### **6.6 Possible strategies to address gender issues in existing science textbooks.**

According to the student teachers, the mentoring process adequately equipped them to support learners in tackling the gender bias in specific Physical Sciences textbooks. The following extracts present the proposed strategies to help teachers reduce the effects of stereotypical messages in physical sciences textbooks.

#### **a) Teaching methods that promote gender equality**

In the subsequent passage, the participant affirms his determination to thwart the effects of stereotyping that stem from the studied textbook(s) to achieve gender equality by utilising examples of both girls and boys.

*When making examples using humans, I will not use boys only since they dominate even in textbooks; I will do this to represent both genders. For example, when they are holding a rope when teaching about tension forces, the boy will hold the rope on one side, and on the other side, it will be a girl. Even when demonstrating it in class, I will use both a girl and a boy.*  
(Mdu)

Mdu contended that a critical tactic for promoting gender equality is to ensure equal utilisation of female and male learners in demonstrative roles during science-related tasks. His science lessons would not only feature examples of boys, as he has explicitly stated his intention to include a diverse representation of students due to the overrepresentation of boys in Physical Sciences textbooks. Instead, he aimed to feature both a boy and a girl to represent both genders accurately. He demonstrated the feasibility of this strategy by illustrating a specific instance wherein he imparted knowledge on tension forces through teaching. To demonstrate the practicality of tension forces, he planned to involve a young boy and a girl who would both be assigned to pull a rope in opposing directions. Mdu was convinced that this would defeat the stereotype that science is for boys only. Wane's argument also emphasised the significance of instilling principles of gender equality while learning science. The subsequent passage exemplifies her aspirations in attaining this objective.

*I will apply equality in my teaching. But I am not focusing more on scientists. They are not necessary, and they are not part of the assessment. We can have peer tutorials with my learners. For example, if a boy understands the mechanics module while other learners are struggling, and if a girl is doing exceptionally well in kinematics, I will give the platform to both of them (a girl and a boy) to teach other learners. In that way, my teaching methods will boost both genders. In most instances, there will be learners who understand the topic or portions of a subject while others struggle. (Wane)*

In her first sentence, I note that Wane recognised the value of implementing teaching techniques that support the ideals of gender equality in the teaching and learning of Physical Sciences. She believed that one way of achieving gender equality was to identify girls and boys who excel in specific Physical Sciences content and equally allow them to teach other learners. She drew from her experience that some students would comprehend the subject or certain aspects in most instances while others would face difficulties. Hence, she was confident that implementing this strategy would considerably enhance self-esteem and performance for both girls and boys. Wane desired that this would pave the way for the realisation of the goal of science for all.

#### **b) Raising awareness among students about the partiality within texts**

Some participants stressed the importance of raising awareness among learners about biases found in texts and supporting them in managing the adverse effects of stereotyped messages. The following excerpts attest to this.

*I will first study how the textbook portrays gender that I will use to teach, and then I will start by making all learners aware of the biases in texts and then address them. In other words, I plan to motivate the gender that can be discouraged by how the textbook depicts it. I will ensure no one feels unwelcome by how gender is portrayed before I start with the content. (Yanda)*

Yanda argued that teachers had a responsibility to educate students about gender biases found in Physical Sciences textbooks and take steps to empower the gender that is often disregarded or underrepresented in these materials. By adopting this strategy, he had a firm conviction that the science classroom would become a more welcoming environment for all learners, breaking down the stereotype that science is solely for male students.

However, Mdu did not fully agree with Yanda about exposing learners to gender bias in texts. The following excerpt demonstrates this.

*Explaining to girls that this book is biased will mix up their minds. They will keep looking and checking the textbook and not focus on the content. (Mdu)*

Mdu held a perspective contrasting with Yanda's, as he maintained that it was conceivable for some students to overlook the gender biases present in a Physical Sciences textbook. He firmly emphasised that when the teacher conscientiously informs learners about the presence of gender biases, it could result in a disruption of their attentiveness while engaging in the act of instructing and acquiring knowledge. He believed the problematic aspects he would have shown would continue to rule their minds. Wane also highlighted that teachers should not focus on scientists depicted in textbooks when teaching Physical Sciences content. The excerpt below attests to this.

*“...not focusing more on scientists, they are not necessary, and they are not part of assessment. They are just there, so we know they were there. “Wane*

In other words, Wane also believed learners should not be conscientised about scientists. Instead, the teacher should defeat the effects of stereotypic messages through teaching methods that embrace diversity and inclusivity.

### **c) Enhancing girls' self-efficacy to grasp scientific knowledge**

Through the provision of opportunities to conquer challenging tasks, teachers have the potential to enhance girls' self-efficacy, as revealed by participants' interpretations. For example, Ntsiki's excerpt illustrates that she planned to encourage girls to engage in practical investigations to support girls' confidence and growth in scientific thinking. The excerpt below illustrates this.

*I will encourage girls to study to do better in the Physical Sciences. I will tell them not to lose hope and that they must believe in themselves and can do things. That will boost their self-esteem. They must not allow men to dominate them. During practical laboratory lessons, I will tell girls not to stand at the back and say, “...I am afraid of touching chemicals...” and watch boys being hands-on in conducting experiments. No! They must be hands-on so that they will understand and might find themselves inventing something while trying to find solutions for assessment purposes. I will ensure that I engage them a lot. Even in those that have to do with*

*electricity, if they want to pursue electrical engineering, I will engage them so that they will be motivated to pursue electrical engineering and other science fields. I will ensure that I engage both men and women. (Ntsiki)*

According to Ntsiki, starting by inspiring girls who would be disheartened by textbook portrayals that subtly discourage them from pursuing science was crucial. She stressed that she would encourage girls to have faith in themselves. In Ntsiki's opinion, involving girls in hands-on activities during practical investigations could trigger their intellectual curiosity. She was confident they could begin searching for answers to what they learned and ultimately provide solutions for global issues. She maintained that hands-on involvement in practical investigations or projects related to electricity was crucial for girls aspiring to enter the field of electrical engineering. She strongly emphasised the necessity of including learners of both genders in conducting practical investigations. Through the insights provided by the participants, it was apparent that science teachers can improve girls' self-efficacy by also incorporating science peer role models in the classroom. The following excerpts illustrates this.

*We can have peer tutorials with my learners. For example, if a boy understands the mechanics module while other learners are struggling, and if a girl is doing exceptionally well in kinematics, I will give the platform to both of them (a girl and a boy) to teach other learners. (Wane)*

Wane proclaimed her intention to meticulously pinpoint boys and girls who displayed remarkable proficiency and aptitude in diverse areas of science learning and make it her mission to inspire them to assist their fellow learners grappling with academic challenges by imparting their knowledge and expertise. Wane believed this would make science's goal for all come true. In the excerpt below, Elelo's and Yanda's statements are similar to Wane's, emphasising the importance of motivating learners whom gender representations in Physical Sciences textbooks may dishearten. The following excerpts demonstrate this.

*"...I will also invite women who have done exceptionally well in Physical Sciences like...to come and motivate girls." (Elelo)*

*In other words, I will motivate the gender that can be discouraged by how the textbook depicts it. I will ensure no one feels unwelcome by gender portrayals before I start with the content. (Yanda)*

Elelo was sure that exposing girls to other female scientists who excelled in the science industry would boost girls' confidence that science is also for them. Although Elelo's response is compared differently to Wane's, it does not contradict what she had contemplated. Instead, it clarifies and extends the argument of removing the focus of learners from male scientists portrayed in textbooks. Elelo emphasised that bringing female science role models to science classrooms to motivate girls will enhance girls' efficacy to be inventive and critical problem solvers. Yanda also believed that as a teacher, he had to plan to encourage girls who could be discouraged by textbook messages. His argument shows the importance of incorporating gender when planning lesson presentations.

#### **d) Incorporation of pedagogic strategies that enhance cooperative learning among learners**

Some participants suggested teaching strategies that promote cooperation rather than competition during science lessons. The following excerpt attests to this:

*The seating plan of the class must allow girls to share a desk or sit next to the boys so they can help one another. The teacher should avoid the seating arrangement where a girl shares a desk with another girl or boy next to a boy as they don't help each other. (Mdu)*

Mdu highlighted the importance of promoting cooperation between boys and girls in learning to promote mutual support among students. Through his observations, he noted that seating arrangements that allowed homogenous individuals to share a desk in a science classroom could make them shy away from helping each other. Nevertheless, he contended that if the teachers pair learners with complementary partners, they would be more inclined to assist each other.

#### **e) Integration of gender-inclusive images, graphics, and written resources**

*When teaching, I will use sketches of boys and girls when making examples. I will also bring examples of other female scientists not in the textbook. I can create a link with what they are learning on the topic I teach. For instance, this guy Mendeleev, I can bring a female scientist who also used that Law, the periodic law. I will show the learners how the female scientist agreed with Mendeleev. (Mdu)*

According to Mdu, representing men and women when illustrating certain concepts is recommended to shift learners' minds from gendered representations in science textbooks. He further suggested that each time a male scientist is portrayed in the content section taught, the teacher should incorporate female scientists who are not in the textbook but agree with, for example, the laws studied. He believed it is crucial to incorporate both men's and women's sketches, images, and illustrations to shift learners' attention away from masculine depictions and exclusively male text materials, which can negatively impact girls' self-esteem. Mon stated this, believing it can be an effective strategy to degender masculinised or gender-marked professionals such as doctors, nurses, and engineers as examples in science learning. Mon was of a similar view, and the following excerpt attests to this.

*I will then take them through to show them women who discovered crucial scientific knowledge, mainly if it is similar to what we will be learning. I will say, Sir, so, and so came with chemical bonding, but another female came with a similar theory but is not in the textbook. So, learners will see that women also come with scientific knowledge, but it's just that the authors did not include it in the textbook. (Mon)*

Mon emphasised that teachers should plan their lessons to integrate female scientists who are not in the textbook to make science lessons welcoming to all learners, not just boys.

#### **f) Give priority to girls without overlooking the needs of boys**

Elelo's argument outlines his plan to prioritise girls in science education while providing equal attention to boys.

*I will help girls come up with their ideas. I can organise private sponsors to help them with their inventions so they can improve their science. I can even organise a visit to Sasol company to get sponsors for their scientific projects and invite women who have done exceptionally well in Physical Sciences, like our Physics lecturer, to come and motivate girls. (Elelo)*

Elelo explicitly emphasised his unwavering commitment to implementing thorough measures to elevate young girls' self-esteem to equal that of their male counterparts. Given the prevalent trend of male-centric textbook content, he underscored the importance of prioritising girl learners, who could be disenfranchised and disregarded in academia. Nevertheless, he maintained that this did not entail suppressing the educational needs of boys. Additionally, he proposed organising educational outings to business establishments where students could

participate in scientific initiatives, ultimately honing their ingenuity and ability to solve complex problems. In Elelo's estimation, implementing this strategy would inevitably lead to girls developing a greater sense of ingenuity. Furthermore, he advanced that including women scientists as invited speakers in Physical Sciences classes could potentially catalyse the encouragement and empowerment of young girls to pursue scientific fields.

In addition, Snezzy effectively demonstrated that young girls have the potential to reach the same level of academic success as boys, given proper guidance and support from educators who encourage the cultivation of solid self-confidence and self-worth.

*In most cases, during my teaching practice, I do encourage girls. I used to make an example of myself.... So, I made up my mind that I would never allow a male person to dictate to me that I cannot do Physical Sciences just because he believes it is for men. If you think that this is what you want to pursue, you can do it. That is precisely how I encourage my learners during practice teaching. (Snezzy)*

Snezzy insisted that teachers can educate young girls about the importance of self-belief and standing up for themselves, regardless of any limitations imposed by men, particularly those in positions of authority such as teachers.

In this theme, I presented and analysed student teachers' interpretations and pedagogical responses on how they could mediate the media assaults presented by Physical Sciences in the classroom. All participants believed that the teaching methods that promote gender equality can limit the effects of gendered stereotypes in learning science. These included using both genders to demonstrate scientific concepts, engaging learners, particularly girls, in scientific projects to stimulate critical and creative thinking skills, encouraging girls to be hands-on during scientific investigations, and showcasing female scientists whose scientific knowledge corroborated with male scientists' hypotheses in textbooks.

## **6.7 The Conclusion**

In this chapter, I analysed data I generated by interviewing the student teachers. The interviews aimed to generate data to respond to research questions 3 and 4, outlined in the introduction. Their understanding of gender implied that delineations of the society of what it is to be a man and a woman led to the hierarchical order in society. In other words, the gender roles that are assigned legitimate status. Their interpretations showed that this results in one gender being privileged whilst the other is disadvantaged and oppressed.

The participants were concerned about how Physical Sciences textbooks portrayed gender representations. They believed that selected textbooks promoted masculinity and other societal stereotypes that demotivated, dehumanised and devalued women, which could lead to girls dropping out of the Physical Sciences stream.

Student teachers also demonstrated that they believed they were competent to deal with ideological messages that could be implicit in Physical Sciences textbooks. All of them mentioned that their experiences from schooling and being mentored at the tertiary level and during practice teaching have empowered them to use any textbook rich in scientific knowledge, irrespective of how it may also possess gender biases. I have outlined The strategies they suggested to address textbook assaults in section 6.6 of this chapter.

## **Chapter 7: Discussion of the findings.**

### **7.1 Introduction**

In this chapter, I discuss the findings presented in chapters 5 and 6. The reason for combining the findings of the two chapters into one chapter was to evaluate if the responses of student teachers aligned with or differed from my analyses. Initially, the discussion focuses on the findings detailed in Chapter 5, setting the foundation for a thorough analysis. This is then followed by a detailed examination of the reactions elicited from student teachers in response to the findings. Consequently, this Chapter begins by delving into the research question research 1 which pertains to how gender representations within selected Physical Sciences textbooks were perceived by me, the researcher. Simultaneously, it delves into research question 3, which was aimed at eliciting insights into the responses of student teachers towards the gender portrayals that I had identified and shared with them. Therefore, the focal point of this chapter revolves around presenting an in-depth discussion of the findings obtained from the application of Critical Discourse Analysis (CDA) and the significant revelations gleaned from the series of interviews. The literature I reviewed in Chapter 2 and my theoretical framework discussed in Chapter 3 underpin the interpretations and discussions in this chapter.

I presented and discussed the findings in themes. For the sake of coherence, I discuss most of the themes I developed in chapters 5 and 6 except for one theme, Student teachers' concern about gender biases in textbooks. The discussion of this theme was merged with another theme called Gender inequalities disseminated through Physical Sciences textbooks in subsection 7.2. This was done because the participants were directly responding to my analysis of the textbooks. The discussion below begins with the theme: Gender inequality being disseminated through textbooks

### **7.2 Gender inequality being disseminated through textbooks**

The findings of three textbooks illustrated a concerning trend of promoting gender inequality through the representation of men and women in science active and science passive roles, respectively. One way in which chosen textbooks manifested gender inequality was by overrepresenting men as scientists. Numerous studies attest that the underrepresentation of women in Physical Sciences textbooks is not a novel phenomenon but echoes the findings of many other studies in other parts of the world. Women tend to be disproportionately

underrepresented, for example, in History, Business Studies, and English as a Second Language (ESL) textbooks (Hutchinson, 2020; Pillay, 2017 & Chiponda & Wassermann, 2015). My findings corresponded to the findings of Pillay and Maistry (2018), who determined that Business Studies textbooks employed in SADC countries had a dearth of positive female role models and thus considered the language of the text to be non-inclusive of gender.

Most student teachers who participated in the study recognised the disparity in the representation of female and male individuals in the sampled textbooks. The student teachers predicted that if the depictions of scientists in textbooks remain the same, girls could drop out and pursue non-STEM subjects and careers. They were concerned that portraying this could reinforce the notion of male dominance in Physical Sciences courses. Their delineations align with the idea proposed by Lee and Chin (2021), who contend that the dearth of female representation in texts can affect girls' capacities, wishes, behaviour, information management and memory recall. They emphasise that it could also impede their growth, ambitions, and choices concerning their studies and careers.

The introductory section of textbook C excluded women and only highlighted men who had published scientific papers, laying the foundations for scientific Laws and methods. There was a notable absence of women in the publishing of scientific literature. This occurrence was construed as discourse marginalisation, as it excluded the participation of a specific discourse group, namely female scientific publishers. The textbook's introductory section orientates and welcomes all learners to the textbook. As proposed by Supardi (2016), opening statements are used in language communication to influence the listener or reader with persuasive ideas and arguments. He emphasises that they are the initial impressions that can arouse interest and persuade the reader to take a particular course of action. Presenting men as the sole creators of scientific knowledge can give an erroneous impression that only men can succeed in science-related professions.

Girls might conclude that it is not rewarding to pursue science-related careers. Furthermore, it may introduce barriers to science learning because once girls are discouraged by what they see in textbooks, they are less likely to concentrate on the content taught. The literature suggests that this trend is not something new. The study by Murray et al. (2022) also found the selected textbooks used to teach chemistry in the UK and Ireland represent more male scientists than women. Similarly, in Becker and Nilsson's (2021) finding in the US, men were present in every four pages of chemistry textbooks, whereas women were present in every 250 pages of the

same books. The findings quoted above are from recent studies. So, this signals that selected textbooks discriminate against women.

Despite the slight rise in women's visibility, evident in the similarities between men and women in scientific passive roles, how textbook depictions represented them still promoted gender differentiation. The analysis indicated that men were in the majority in both science active and science passive roles. This finding aligns with Lee and Chin's (2021) research, which found that children's books depicted only male characters as active and playing significant roles. They are of the view that if textbooks consistently expose young children to stereotypical roles in educational materials that are rooted in traditional social orders, they may internalise gender-related stereotypes. Therefore, learners can internalise the overrepresentation of men in active science roles in selected Physical Sciences textbooks as reality. Lee and Chin (2021) point out that textbook functions include constructing children's gender beliefs and expectations. They assert that images in textbooks act as a platform to display societal values and role models to vulnerable young children, making an essential contribution to early gender role socialisation. Hence, the overrepresentation of men in both science passive and science active roles suggests that learners who read from these textbooks do not have female science role models.

The gender roles and power relations of gender in these textbooks can shape learners' perceptions about careers they intend to pursue. Boys may be more likely to pursue STEM courses and careers because studied textbooks primarily depicted their gender as science-active. Girls are more likely to be discouraged from pursuing STEM subjects and courses because textbooks depict characters of their gender more in non-scientific activities.

Confirming Foroutan's (2012) research, which disproportionately found many images dedicated to the male gender, with the female gender consequently representing a conspicuously lower portion of the total, my research found a greater prevalence of men's imagery representation in all studied textbooks. Besides the lower numbers, the pictures of women were also inferior in quality. The student teachers in the study viewed these biased depictions of women and men in visual images as gender unfair. They described images representing women as shades and sketches that can be drawn by crèche kids. Foroutan (2012) concluded that social and ideological elements were the predominant causes of the gender representations favouring men. Phillips and Clarke (2012) acknowledge that images in textbooks supply learners with visual points of reference for career decisions.

The dominance of boys and men conducting experiments in selected Physical Science textbooks was interpreted as reinforcing gender stereotypes and can hinder achieving goals of fostering diversity in science classrooms. These findings, therefore, suggest that girls are still victims of patriarchal forms of oppression presented by science textbooks. Although women are still underrepresented in STEM (Toolo, 2018), many women have graduated and are practitioners in various STEM fields (Cubas et al., 2022). The authors only sourced the scientists from as early as the 1860s. Given that in South Africa, after 1994, the Department of Education implemented new policies which conscientise text producers about the significance of gender equality in educational material, it remains questionable why forms of gender inequality continue to permeate the school curriculum. For example, the South African Schools Act 1996 empowered educational institutions to identify and address school gender inequalities. CAPS grades R to 12 commits to addressing gender inequalities in schools by improving the manner and the context in which knowledge and skills are acquired (DBE, 2011), but research suggests that little has been put into practice (Maistry & Pillay, 2014; Ndlovu, 2019; Schoeman, 2009).

Depictions of men and women in group photographs also suggested messages of gender discrimination against women. The male gender was more prevalent compared to women, and the pictures of women presented them in a sideways or rearward angle. The student teachers firmly believed this was a purposeful act to make women unnoticeable in texts.

These results do not demonstrate adherence to the ideals of gender inclusivity and gender equality mandated by the South African Schools Act (SASA) of 1996, even though these textbooks have been in use for more than a decade since the implementation of SASA. These textbooks, as highlighted in Lee and Chin's (2021) study, can serve as a vehicle for communicating cultural values of men as the leaders who must be visible and women as subordinates who must not be seen.

The higher representation of men as scientists, compared to women scientists in science passive and science active roles, could be reflective of South Africa's patriarchal roots. Similarly, Cairns and Inglis (1989) asserted that the lack of female representation in 9 out of 10 textbooks analysed was caused by authors and publishers being swayed by the patriarchal society in which they lived. Apple (2014) stated that textbooks are authored, crafted, and composed by individuals with agendas. This argument was evident in Taki's (2008) study, which, through the application of Critical Discourse Analysis (CDA), discovered that the Iranian textbooks

utilised for instructing English as a Second Language (ESL) depicted the discourse of the Western economy and consumer society. His observations revealed that the textbooks examined had a dual agenda, specifically economic and political. Depictions of studied textbooks reinforce the ideology of science as masculine (Annie Chiponda & Wassermann, 2015; Mudau & Obadire, 2017). Al Ghazali (2007) posits that educators should evaluate the content to gauge the consequences of textbook representations to strategise how to protect students against deep-seated convictions and doctrines pushed by authors consciously or inadvertently.

Despite being CAPS aligned (as indicated in the sampling section in Chapter 4), the selected textbooks' failure to represent women adequately suggests a discrepancy between the prescribed materials used in schools and the CAPS goal of eliminating gender biases in education material. Hence, there exists an incompatibility between the governmental directive for gender inclusivity in educational programming and its implementation, resulting in the perpetuation of gender prejudices within instructional materials. In the next section, I discuss how the selected Physical Sciences textbooks index differentiated gender roles.

### **7.3 Physical Sciences textbooks index differentiated gender roles.**

The selected physical sciences textbooks also reflected gender inequality by depicting female scientists in inferior scientific roles, such as laboratory assistants or document translators. On the contrary, men were depicted as inventors and producers of scientific knowledge. The study by Doughman et al. (2021) shows that gendered roles in texts indicate gendered occupational bias, which occurs when "...an occupation or role is generalised onto a specific gender" (p.39). For example, they mention that when the word 'assistant' is used to refer to a woman more often than her real name, it indicates a gendered role and is used to highlight a woman's inferior role. They also mention that occupational bias in the text is evident when men are referred to as scientists but women as secretaries. It can be inferred from their research that specific jobs subtly reinforce gender-specific occupational boundaries. Therefore, the manifestation of gendered scientific roles in the selected textbooks can index boys and girls who read from these textbooks to different roles in STEM-related fields. The notion of women being portrayed as less qualified chemists and as translators or laboratory assistants could suggest (to readers of these textbooks) that women are more suitable for such roles than chemists or physicists.

The use of vocabulary like "married", "assisted him", and "wife" to describe the women, although they were scientists, can index the women to domestic settings. Furthermore, text

framing that positions these words (lexical choices) before scientific qualifications suggests that marriage and wife commitments are more important than being qualified scientists such as chemists (Milgram, 2011; Mkuchu, 2004; UNICEF, 2020b). These renderings can direct women to subordinate scientific roles where women can work in science disciplines but under men and imply that marriage was the most meaningful thing for women. Machin and Mayr (2012) regarded this as backgrounding women and foregrounding men. They regard the elements mentioned after the others as inferior. Similarly, Huckin (1997) is also of the view that whatever is put first in the text is regarded by the readers as the most important. Thus, the text structuring at the sentence level implies that these scientific roles are gender-specific because when depicting a female scientist, the text emphasises being married more significantly than being a proficient chemist.

Lexical choices the text used to describe men also indexed men into different gender roles compared to women. In academia, men were the patriarchs of knowledge, including the father of stoichiometry and pioneers of scientific laws, to name a few. Such lexical choices connote men's scientific achievements, and the text accentuates scientific feats associated with their credentials as the originators of scientific knowledge, elevating the capacity and status of men.

Furthermore, I noticed textbooks did not illustrate men as exhibiting a stronger devotion to their duties as husbands or parents, aside from their role as knowledge bearers. Consequently, for learners using the textbook, portraying a man (with the same qualification as a woman) as more proficient can reinforce gendered stereotypes in science classrooms. Boys can receive messages that elevate their self-esteem while discouraging that of girls. I concur with Wang et al. (2023, p. 471) that gendered scientific roles in texts "...affect in subtle ways the students' learning outcomes, career choices and how they perceive science." Textbooks may give girls the impression that selecting Physical Sciences as a school subject will not bring worthwhile outcomes, making it seem unappealing.

The student teachers who were participants in the study also realised that textbooks subjected women to gender segregation by portraying them as chemists or physicists who had not made any advancements, whereas when the same textbooks mentioned men, it was always in terms of their inventions or successes. For example, some participants stated that the textbook depictions undermined the status of women. They queried the justification for representing women primarily as inadequate while portraying men as skilled science professionals. In this way, chosen textbooks echo traditional views of men as powerful compared to women, as

observed in highly esteemed science professions. Kamasak et al. (2019) posit that hidden curricula may subtly embody or introduce stereotypes and sustain cultural, gender and racial prejudice. They alert us that sometimes, even educators may not recognise what the curriculum implies, or they may view stereotyping as innocuous. Depicting men as highly skilled and women as less proficient was an act of prejudice against women. Unless teachers are acquainted with these inconspicuous examples of bias in science textbooks, students may unintentionally adopt them as truth. (UNICEF, 2020b).

The participants also felt that women's portrayals connoted women objectification (Machin & Mayr, 2012). A particular participant in the study expressed that Paulze, the female scientist, was characterised as a 'doormat' for her husband, implying that she was subjected to contempt and considered insignificant. As a result, they considered the chosen textbooks as prejudicial, favouring masculinity and capable of demotivating girl learners. These findings are comparable to those of Lee and Mahmoudi-Gahrouei (2020), who used interviews to understand gender representation in Iranian English textbooks with schoolteachers as participants. The study's participants indicated that the authors of the chosen English textbooks were conscious of gender concerns, as they frequently employed gender-neutral language. However, depictions of women confined them to only family and school contexts, as noted by Lee and Mahmoudi-Gahrouei (2020). They also observed that textbook portrayals portrayed women in stereotypical jobs.

Thus, authors' word choices to typically portray women as occupying less meaningful scientific roles and men in more highly esteemed roles in selected Physical Sciences textbooks is likely to perpetuate hegemonic masculinity. As Connell (2015) posited, hegemonic masculinity promotes men's supremacy in society and validates women's inferiority. Hegemonic masculinity normalises the unequal power dynamics between men and women, thus causing power disparities. Connell (2015) opines that in such scenarios, men are the ones who reap the rewards of inequitable gender relations. In the next theme, I discuss how portrayals of selected textbooks marginalised women. They were, for example, omitted when displaying the scientists' discoveries and publications, depicted as scientists but not named, and represented in visuals in a biased manner.

#### **7.4 Marginalisation of Women Scientists**

The sub-section below discusses the findings indicating women's marginalisation through the non-inclusion of their discoveries.

#### **7.4.1 Silences about women's scientific contribution to knowledge**

None of the three textbooks included women's scientific discoveries, inventions and publications. On the other hand, men were illustrated as producers of scientific knowledge and publishers of science papers. Based on Huckin (1997), teachers must carefully analyse texts to determine the underlying purpose for the author's selective inclusion and exclusion of certain aspects. He elaborated that analysts ought to be aware that the text type which excludes what is usually included signifies that the author intentionally left it out. Correspondingly, Lorber (1994) asserts that women are not fully recognised in their professional roles due to the predetermined expectations of their gender. According to Ceglie and Olivares (2012), authors skew the representation of women in the sciences in preference of the male point of view to adopt societal and social expectations of who does science. My research findings confirm the notion that the invisibility of women as scientific producers of knowledge in selected textbooks can perpetuate a hidden sexist agenda, subtly suggesting that their role is traditional domestic duties. Furthermore, considering the crucial role of textbooks in inculcating values among secondary school learners, the contents of these books may significantly impact their future career aspirations.

Despite the constant portrayal of men as the originators and disseminators of scientific knowledge in the text, it failed to acknowledge the role of women in contributing to scientific advancement. According to Chiponda and Wassermann (2015) and Fitzgibbon (2013), those viewed as weak in social and economic standing are habitually denied recognition and obstructed from having their knowledge featured in textbooks. Therefore, I deem the text to be gender unjust, perpetuating the norm of women as weak and silent members of society and invisible textbook discourse. Girls can opt out of STEM fields because of the transmission of disconcerting messages. Critical Theory scholars argue that all communication channels support the power struggle between oppressed and oppressors (Pillay & Maistry, 2018). They see oppression as any instance in which a specific collective is disadvantaged. They also view the privileged as those who are not subject to the drawbacks of the oppressed (Rezende & Ostermann, 2020). I share this point of view, and I consider the selected textbooks to have the capability to spread the ideology that can result in the oppression of women.

Analysis of the chosen textbooks also revealed many male scientists as publishers, but there were no female scientists among the publishers listed in the preface of textbook C. It was

peculiar that female scientists were not present among inventors of physical objects and could not even publish articles or papers despite having the same qualifications as men.

Critical Theorists such as Winkle-Wagner et al. (2019) assert that when disadvantaged groups gain insight into the purpose of text framing, they can be relieved from the influence of the ideology of the dominant, which could be intended or unintentional. They regard the critical theory as a component of social change used by society to deconstruct oppressive structures that side-line and sabotage particular groups of people and render them powerless.

Student teachers acknowledged the lack of female involvement in producing scientific knowledge during my interviews. Participants queried the intention behind the authors' characterisation of a woman as a chemist without disclosing what she invented or created to further scientific knowledge. Applying words like "...but her work was not exposed..." indicates that they distrust the portrayals that disregard women. They were confident that, in the same way, men as chemists were honoured for their scientific contributions, women who were depicted as chemists must also have made discoveries or created something. They assumed that the authors had chosen not to illustrate women's work. Other participants declared that they expected to see women's scientific work. Their displeasure made it clear that they were not against the inclusion of men's original scientific contributions, but they anticipated observing proof of gender equality by additionally featuring women's primary input to scientific knowledge. Like Lorber's (2000) and Baehr's (2007) findings, I agree that the present surroundings fail to adequately acknowledge and showcase women's interests, accomplishments, and demands, neglecting their existence. Lorber (2000) lists these representations of women that are not well reflected as women prime ministers, CEOs, astronauts, winners of science Nobel prizes, and many more.

Most participants emphatically asserted that leaving out women as discoverers of scientific knowledge in textbooks indicated gender inequality propagated by text producers. Some of them felt that the exclusion of female scientists was deliberate. They mentioned that if someone looked further, he could locate the discoveries of female scientists. Other participants determined that the authors had opted to award credit to men for what had been achieved by female scientists. Their conversations showed that they thought writers deliberately concealed women's work to undermine them. In other words, the sentiment was that the authors acted as if women had created nothing to hurt them. This finding aligns with Butler's (2011, p.18) assertion that sexism is the prime cause of women's oppression and that discourse has

incorrectly portrayed women. Butler (2011) regards depicting women in a manner that belittles and demeans their status as another form of gender discrimination.

Controversies concerning the representations of femininity and masculinity heightened tensions, and student teachers feared this could lead to separation in science classrooms. Most participants regarded the visuals depicting men and women as reflecting gender imbalance. Thus, participants opined that selected textbooks promoted gender inequality s by omitting to reveal what women had accomplished as scientists whilst portraying men as inventors and producers of scientific knowledge. Brugelles and Cromer (2009) elaborate that excluding girls from textbooks contributes to their lack of confidence and low self-esteem in science. Consequently, these results align with Brugelles and Cromer's (2009) conclusion that current textbook portrayals about women are insufficient to persuade readers that science is for all.

Findings from the research indicate that, despite efforts to update the curriculum, the incorporation of gender-sensitive components in learning materials, mainly science textbooks, remains a hurdle due to the ongoing marginalisation of women's scientific contributions. In the next sub-theme, I discuss how my analysis and student interpretations found that the selected textbook portrayals suggest women's marginalisation through not naming.

#### **7.4.2 Not naming marginalises women scientists**

The visuals that represented men and women in all three selected textbooks carried messages that suggested gender segregation. In this study, one form in which authors displayed gender segregation was by using a person's real name when referring to male scientists but using collectivisation, such as a scientist, when referring to female scientists. Furthermore, women depicted as science active i.e. portrayed as participating in scientific activity, looked like learners or tertiary students rather than science specialists. Surprisingly, none of the male scientists were depicted wearing laboratory coats. Writers portrayed most of them in their formal suits, indicating gender segregation. Hence, the study participants regarded these women working with chemicals as students. They noted that no male scientists wore lab coats in depictions from chosen textbooks. Ceglie and Olivares (2012) mention that depicting the ideal scientist as an adult White male in textbooks persuades teachers and students as to who should do science.

Other scholarly investigations have confirmed the marginalisation of women through the omission of their names in educational materials. For instance, Mboyonga's (2021) study found

that history textbooks in Zambia's secondary schools depict more men with identifiable names and roles than women. Through a meticulous study of a particular book, he thoroughly analysed every single illustration of historical personalities who were specifically mentioned and discovered that every last one of them was depicted as a man, without a single woman character being acknowledged as such.

In the second textbook, out of the thirteen images of the named people, there were twelve male characters and only one identifiable female figure, Joyce Banda, the former president of Malawi. He observed that the visual imagery in the two textbooks features only one female leader, in contrast to the 63 images of male political figures. Through thorough analysis and contemplation, it was his final judgment that textbooks persist in reinforcing gender stereotypes through the use of images, text, and the topics chosen for inclusion. In a unique approach, Mboyonga (2021) did not concentrate on female scientists but on the textbooks used to teach history. Nevertheless, the corroboration between my study and his suggests that secondary school learners lack exposure to the contribution of women leaders (in History textbooks) and women scientists (in Physical Sciences textbooks). While the recognition of Marie Curie as a pioneer in radioactivity is a significant milestone in acknowledging women's achievements in science, as she is the only woman scientist in the textbook with evidence of contribution to scientific knowledge, men alongside her overshadowed her portrayal. A noticeable trend was the absence of female African scientists in the reviewed texts.

Besides scientists, women who were science-active in studied textbooks were also not named. For example, in one visual, a woman who was depicted wearing laboratory clothing and working with chemicals was not named. Teachers could use such portrayals to motivate girls; however, not naming the persons depicted implied that they (women as represented participants) would be less memorable to the readers. On the contrary, in almost all science activities that used men to illustrate scientific concepts, they were either named or depicted in high-status professions such as meteorologists, astronauts and paediatric surgeons. There were no cases where portrayals of men aroused participants' doubts about whether the person was a qualified scientist or a student.

These findings align with the conclusion of Dawar and Anand (2017) and Huyer (2015) that despite UNESCO's prescriptions and recommendations that nation-states should revise textbooks to remove prejudices and introduce reforms that promote gender equality,

extraordinarily little progress has been achieved. Textbooks still render women invisible in texts and visuals. The participants mentioned that the failure to name women as scientists whilst naming men depicted as scientists in the same textbook implicitly reinforces gender inequality. For example, when referring to scientists portrayed in the selected textbooks, some would refer to female scientists as women but refer to male scientists using their names, such as Tesla, Faraday, Albert Einstein, and others. Additionally, some participants considered female scientists who lacked autobiographies as students. Therefore, the participants considered the motive behind not naming female participants to render women invisible in texts. Zhang (2020, p. 797) observed that gender inequality emanating from the learning environment (which could be how gender is portrayed in a textbook) has proven to negatively affect the achievement of learning outcomes by boys and girls.

The participants also acknowledged that text framing about gender roles presented ambiguity. The reason for ambiguity was naming male scientists depicted but portraying female scientists as unknown because of not naming them. All the participants' statements confirmed that they recognised the harm brought about by messages of gender differentiation coded in texts. The student teachers' interpretations echo Lorber's (2000) assertion that the pervasive categorisation of men and women into unequal groups reinforces gender inequality. She elaborated that women are devalued and dehumanised in workplaces. She proposes that the binary gender division be challenged and done away with using feminist principles. By neglecting to acknowledge female scientists and their research, these textbooks perpetuated the devaluation and dehumanisation of women. In the next section, I discuss how decoding the visuals of men and women portrayed in selected textbooks exposed gender biases.

#### **7.4.3 Biased visual representations of men and women**

I used the camera's angle as a semiotic tool to elucidate the visual discrepancies between women and men engaged in science activities and their potential to convey empowerment or disempowerment. (Kress & van Leeuwen, 2020). The evidence suggested that photographs of women were likely to disempower learners of the female gender because their pictures were either small, which implied that they were likely to be forgotten by the readers of the selected textbooks, or large in size, like the photographs of men but accompanied by messages that dehumanised and devalued the status of women.

The study conducted by Acheson et al. (2020) on 'The Representation of Women in the Photographs of Introductory Human Geography Textbooks' put forth a unique finding. There was a noticeable improvement in how women were depicted in visuals because the number of photographs of women increased. However, they were primarily in traditional passive roles. My study also found women depicted by the large pictures and closer to the viewers, but the text that accompanied the pictures promoted masculinity. For example, the woman was a physicist, but the text endorsed her function as a translator of documents for the male physicist. Doughman et al. (2021) regard text framing similar to these findings as perpetuating occupational bias. They refer to occupational bias as occurring when men are hired in specific jobs of high prestige. Conversely, jobs reserved for women include being secretaries, laboratory assistants, and others that denote inferior positions to those assigned to men. The women's photographs carried a self-contradictory message that is likely to discourage girls.

Moreover, the images featuring male scientists close to the viewers were likely to send messages that primarily inspire boys. The accompanying text enumerated their scientific discoveries. For example, Gay-Lussac was depicted as one of the founders of Avogadro's Law. The evidence suggests that women in science were either visually represented in a limited manner or mentioned without corresponding visual elements. Holmes and Mathews (2010) assert that imagery analysts should evaluate the text accompanying the photograph to ascertain if it was designed to yield an offensive or benign meaning. They also state that using visual images with ambiguous or negative messages can evoke feelings of anxiety in the readers. They further posit that visuals are powerful tools that can trigger certain emotions rather than language-based representations. They emphasise this argument by stating that images can be cues for reactivating related episodic memories.

Consequently, I assert that text creators possibly depicted men in this manner to uphold prevailing societal norms and beliefs about women's involvement in scientific fields. Gaze was also used to evaluate images of men and women as examples in explaining scientific concepts. According to the data, a few of the women's photographs showed them while facing away from the camera. On the contrary, none of the men's visual images showed them from the rear. Although most radiographs are generally taken from the back, I found it unacceptable that only women were chosen to depict photographs taken from the back, which concealed the women's faces. Therefore, a lack of gaze implies that the interactive participants or viewers might not emulate the represented participant (Machin & Mayr, 2012). Hence, learners, as viewers, can

forget them quickly. Fitzgibbon (2013) argues that the lack of an optimistic gaze reduces the possibility of emotional attachment, which is a detrimental factor in the retention of knowledge learned.

Student teachers were also concerned that authors used freehand sketches that seemed to mock women. They also noticed that the large and colourful photographs that depicted women showed women in inferior roles. They stated that the visuals that represented women were humiliating and demoting the prestige of women. They felt the selected textbooks could discourage girls from continuing with Physical Sciences as a school subject. Hence, they concluded that learners who read from these selected textbooks do not have female science role models. As van Leeuwen (2005) stated, individuals often look to high-status individuals as role models and emulate their actions in pursuit of best practices. He added that people can admire role models in media, including textbooks. Therefore, these selected textbooks reinforce patriarchal principles, which support the notion of men pursuing high-status professions in science (Chambers, 2005; Schiebinger, 2000). The following section looks into the results that point to specific textbooks propagating stereotypes that could lead to a gender power imbalance in Physical Sciences classrooms.

### **7.5 Stereotypes that perpetuate gender power imbalance.**

I exposed the underlying meaning in portraying men and women by utilising hyperbole, presupposition, indexical signs, iconic signs, and potent cultural symbols as CDA constructs.

#### **7.5.1 Stereotypes of women as weak**

The results showed that authors used hyperbolic statements further to demote the status of women in selected textbooks. In some instances, textbooks portrayed women as able to manage very lightweight items while presenting men as able to handle very hefty weights in the same module. The representation of men in the text was contentious, not simply exhibiting that they could take on large volumes of work but also suggesting that their vigour made them ideal for roles such as astronauts. In this way, the textbook sustains the stereotype of women as weak and men as strong. Burgers et al. (2016) regard this type of hyperbole as quantitative hyperbole because it shows an exaggerated difference between the quantity that a woman and a man handle. Therefore, I regard the studied textbooks perpetuating gender differentiation in science classrooms, which, if not addressed, oppose principles of gender equality envisaged by the South African Constitution and other education policies.

This finding strikes a chord with the outcomes obtained in other comparable research projects, such as that of Hamidah (2017), who found men in activities emphasising physical strength, competitive attitude, sportsmanship, aggressiveness, liveliness, courage, and problem-solving. On the other hand, women participated in activities that emphasised forming cooperative, uncompetitive, and passive relationships. The visuals that featured women tended to relate to parenting activities. Regarding ideals or ambitions, men showed that they had ambitions in work that required physical strength, challenge, and intellectual strength. These examples of representations caused participants to conclude that textbook portrayals could heighten tension among learners in science classrooms.

Participants also contended with visuals that depicted women carrying lightweight objects compared to men in mechanics' modules. They regarded this as an act of gender unfairness. They elaborated that such textbook portrayals could reinforce negative stereotypes in girls, which culminated in early years of socialisation. Student teachers insisted that girls may be disinclined to continue with Physical Sciences if textbooks display representations as selected textbooks showed them. One participant's reaction also demonstrated this: "...men will still possess more scientific qualifications because of the(se) textbooks." These representations corroborate social constructivists' perspective that "gender roles are learned and enacted" rather than innately existing (J. Baxter, 2015; Butler, 2013). Therefore, social convictions that women are suitable for activities and jobs that require little human energy can rule the learners' minds, leading to women's marginalisation in the Physical Sciences stream. The mechanics module orientates learners to professions such as mechanical engineering. Consequently, compared to men's, the intent of depicting a woman handling tiny objects was highly likely to demonstrate that women were unsuitable for mechanical engineering and related fields due to their little power.

In the next section, I discuss the stereotype that perpetuates the notion of women in low-paying jobs.

### **7.5.2 Stereotypes that perpetuate the notion of women in low-paying jobs.**

A meticulous examination of both men and women in science passive and science active roles further uncovered the portrayal of women in the selected textbooks, implying that they must go for jobs which do not demand a tertiary credential. These jobs are poorly compensated and fail to raise the status of women in the public eye. From the composition of the text, it is evident

that the authors chose women primarily for illustrations of low-status non-STEM professions. Though including the significance of indigenous knowledge (such as collecting water in the river) in science teaching and learning is beneficial, the textbook did not depict men in similar roles or settings. The implication can suggest that only women should be involved in non-STEM occupations. These outcomes reaffirm the second-class status of women, denoting them as trivial and insignificant (Hutchinson, 2020).

The authors opted to show only women as applying hair relaxers in salons in textbook C. Such depiction reinforces gender-based discrimination against women since men also work as employees in salons. However, the authors projected a perspective that can make readers assume that the implication is that women are assumed to be suitable for such roles. Consequently, these textbook depictions can cause the learners to believe that salon work is the exclusive domain of girls. Ceglie and Olivares (2012) observed that, despite progress made in female engagement in scientific endeavours, there are still unequal representations in science-related occupations. They assert that beliefs about gender and race can affect the amount of enthusiasm and success in science and math areas.

Participants observed that the stereotypes featured in selected textbooks, portraying women as apt for domestic chores and non-scientific activities, could validate society's expectations about girls during the learning process of Physical Sciences. They concluded that only boys are being encouraged by the selected textbooks. Schiebinger (2000) highlighted the influence of gender role stereotypes on children's career choices. She emphasised that the stereotype of scientists has a negative impact not just on women but also on students from diverse backgrounds, particularly students of colour. Therefore, these gendered stereotypes can affect how learners perform on science assessments and how likely they are to pursue science-based careers. By using stereotypes in texts, it is evident that the aim is possibly to segregate girls in science classrooms. Menegatti and Rubini confirm this claim, stating that language abstraction in texts makes women's representations disappear in implicit forms (Menegatti & Rubini, 2017).

In the following sub-section, I discuss the results that showed women cast in domestic settings.

### **7.5.3 Stereotype of women in domestic settings**

Textbook portrayals can index women to nurturing roles in domestic settings. For example, only women were depicted as mothers, fetching water from the river, perpetuating the idea that women are responsible for nurturing children. The selected textbooks did not feature any icon

of a father, suggesting that men should not take part in parenting. Machin and Mayr (2012) indicate that Critical Discourse Analysts should examine the text to determine why women are usually considered wives and mothers. The findings yielded by this study correspond impeccably with the prevailing literature that has been meticulously examined and assessed for this research, specifically in connection with instructional materials geared towards facilitating the learning of English as a second language, as well as textbooks encompassing a broad spectrum of additional academic topics. For example, Hamidah (2017) found (elementary school textbooks of Turkish and life sciences) that women prominently featured engaging in domestic duties, childcare, promoting nutrition, securing familial medical coverage, and maintaining environmental cleanliness. Pillay (2017)), Chiponda and Wassermann (2015), and Hutchinson (2020) established similar findings to provide a mere glimpse into the vast array of literature that has been meticulously examined concerning this subject.

Following this, the textbook representations perpetuating the notion of women as nurturers may convey to students that girls must stay at home and look after children. They strengthen femininity and masculinity as produced by society and its institutions. The discoveries of this study are akin to those of the Zittleman and Sadker (2015) research, which identified disparate forms of gender bias, such as the wilful disregard of men in parenting roles. Earlier studies, such as that of Blumberg (2008), also observed that not only were textbooks filled with stereotypes of female roles in care and homemaking, but there was also an absence of portrayals of women in the workplace. He elaborates that women were also portrayed as shrewd mothers, confused or incapable.

Therefore, I concur with students teachers' response that these textbooks, as also posited by Finkel (1993), have the potential to create hierarchical segregation in science classrooms, with boys being more likely to ascend to higher levels of power in the workforce, and girls more likely to be directed towards low-paying jobs. These results can reinforce the patriarchal view of Physical Sciences as a school subject and can reinforce the stereotype that science is not for girls.

In the following section, I discuss the findings that evidenced women are represented as onlookers in scientific experiments while men were running the show, manipulating scientific tools during practical work.

#### **7.5.4 Stereotype that Physical Sciences is not an option for girls.**

In group photographs, women and girls were also excluded or presented in a discriminatory manner, such as showing only one woman among a group of men in a picture that shows learners conducting scientific experiments. According to Machin and Mayr (2012), potent cultural symbols represent the particular practice and the cultural values of a specific group of people. Consequently, depicting just men using scientific instruments as a potent cultural symbol in a group photo was another kind of gender prejudice against women. These kinds of depictions may be the cause of why girls shy away from using chemicals in laboratory experiments. Moreover, they could imply that science is not for girls as the images in the textbook welcoming learners show only boys working with equipment and in the majority. Baehr (2007) viewed gender stereotypes as learned in people's early lives as they grow up in society. He further explains that gender stereotypes give a framework for action. According to West and Zimmerman (2009), people establish gender stereotypes through the observation of the behaviour of people in society. Hence, when learners observe gendered stereotypes modelled by textbooks, they are likely to imitate them as they might regard them as a reflection of society's norms.

The student teachers also pointed out that viewing women depicted poorly in images brought back memories of the negative representations they witnessed in the Physical Sciences textbooks during their schooling years. Female student teachers mentioned that they used to be discouraged by similar textbook depictions and would also believe that Physical Science(s) was difficult and not for them. Thus, these findings are consistent with Winkle-Wagner et al.'s (2019) view that societal disparities can impede an individual's freedom. Girls may be hindered and discouraged by messages from these textbooks. Participants also noted that the selected textbooks would likely send misleading messages to girls.

According to Croucher and Cronn-Mills (2014), people can use the Critical Theory to defend the marginalised and dispute the replication of inequalities and preminent discourses in educational material. Thus, the stance taken by Croucher and Cronn-Mills (2014) regarding the imperative need to disrupt and oppose the hegemonic practices prevalent in texts is crucial to emancipate and empower those subjugated and marginalised by the societal conventions designed to maintain the dominance and superiority of the privileged few.

The representation of Marie Curie as a female scientist was also questionable. Student teachers felt that the text creators did not give her enough credit despite being portrayed as the originator

of radioactivity. Her portrayal lacked a visual image. However, each depiction of a male scientist also included an accompanying image. Surprisingly, Murray et al. (2022) found only one female scientist in one of the chemistry textbooks they analysed in the UK and Ireland. It was the photograph of Marie Curie with her husband. So, if the text producers had wanted Marie Curie's photograph, they would have found it. Hence, this portrayal (lacking visual image) renders Marie Curie invisible. Villar and Guppy (2015) stress role models' impact on young people constructing their identities. Omitting Marie Curie from textbook A thus denies grade 10 students who read from this textbook access to female role models.

Student teachers further challenged the authors' option to mention Marie Curie after Becquerel and underscored that Becquerel was the professor. They felt that the text was foregrounding Becquerel as a man scientist and backgrounding Marie Curie as a woman. They said the text presupposed that she remained a student because it did not mention that she graduated later. Rezende and Ostermann (2020) contend that all communication channels contribute to the power struggle between the sabotaged and the powerful. In this instance, Becquerel is positioned in power as the professor and Marie Curie is positioned as the oppressed and as the student. Hence, these portrayals promote patriarchal principles which support the notion of men in power and dominating over women. The motive may be to sideline girls and women from science subjects.

The consistent marginalisation of women scientists in all three studied textbooks does not depict working towards gender equality that the Curriculum and Assessment Policy Statements and Constitution of South Africa envisage. Instead, it appears as if the authors wanted to maintain the status quo.

These findings imply that women are still marginalised and treated as second-class citizens, as had been indicated by the earlier studies about South Africa after it had attained its independence from Apartheid policies (Healy-Clancy, 2017; Maringe & Prew, 2015; Mbeki, 2001). These textbooks still expose girls to science curriculum that prepare them to occupy inferior positions in society as women, while boys are schooled to be dominant in the economic, social and political fields in society (De Wet, 2011; Keddie, 2012; Mbeki, 2001; Simpson, 2004; Volovitz, Vichyanond, & Zhong, 2004). Despite the democratic principles of gender equality having been in place for over 15 years, the Physical Sciences textbooks have yet to reflect this. In the following sub-section, I discuss how the selected textbooks reflected the subservient positioning of women.

### 7.5.5 Subservient positioning of women

Although Marie Curie is the female scientist who founded the term radioactivity, she was not presented as a self-reliant thinker by the authors of the text. Instead, she was reduced to a subordinate scientific role. Student teachers viewed this as an indication of the norm that women are incapable of thought and consequently reliant on men. Similarly, Barton and Sakwa (2012) found that the textbooks used to teach in Uganda sustained negative gender stereotypes. Ultimately, they concluded that the author/s of the studied textbooks overlooked the principles of equity and inclusivity that the Ugandan government holds dear. Instead, they reinforced the gender gap derived from Uganda's origins in a patriarchal culture. They regarded the studied textbooks as promoting a negative construction of gender with women as second-class citizens after men. Therefore, women characters in selected textbooks endorse the idea that women should conform to submissive and docile behaviours in comparison to the authoritative and forceful conduct of men, thereby sustaining and perpetuating the patriarchal hierarchy in educational materials. In addition, the female scientists in Textbook B were portrayed as men's servants. Although the woman scientists were qualified as men, the text presupposes that when they completed their qualifications equivalent to men's, they had to work for men as translators and laboratory assistants. Conversely, men progressed and became pioneers of knowledge. These depictions can explain why women tend to avoid STEM fields despite the well-known gender disparity in these fields (Villar & Guppy, 2015).

Women who thrive in the disciplines of mathematics and scientific studies, thereby undeniably proving their cognitive ability to make significant impacts in the areas of science, technology, engineering, and mathematics, frequently do not pursue those fields beyond high school. Villar and Guppy (2015) assert that younger women are more likely to be attracted to other areas where they can create identities that better fit their understanding of themselves and their aspirations. So, lacking a visual image, Marie Curie's portrayal cannot attract girls to emulate her.

The participants also argued that the portrayal of gender in specific textbooks stifled girls' critical thinking and problem-solving aptitudes. They thought depicting women as having no creative aptitude but relying on men could make girls lose confidence and not succeed in Physical Sciences. One participant also observed that when girls take note of female representation in some textbooks, it can spark a lack of enthusiasm during Physical Sciences lesson presentations. They anticipated that girls might fail the subject due to their lack of

attentiveness, missing out on the material discussed during their scatterbrainedness. This finding resonates with Chiponda and Wassermann's (2015) view that if young children continually observe stereotypical characters or roles in educational materials, it may negatively influence their capabilities, interests, information processing and memory recall.

The other participant reckoned that the stereotypical messages in specific textbooks can be a hurdle for girls wanting to pursue STEM courses at the tertiary level since they will not be eligible to apply for tertiary classes if they do not succeed at the school level. Thus, these textbooks create a disadvantage for girls in a multitude of ways (Cubas et al., 2022). The other participants observed that the writers of the text had taken a stance that suggested that men in scientific positions were wise and women were inept and making mistakes. They surmise that men will remain the primary force in science due to the language used in educational materials, which boosts their confidence while disheartening and undermining female students. Thus, the analysed textbooks can display major impediments restricting girls from succeeding in STEM across various stages of their lives (UNICEF, 2020a). As per the UNICEF report, girls who choose to use computers or the internet over gendered textbooks show similar cognitive and behavioural capabilities to boys (p.9). Therefore, teachers must become aware of the prejudiced content in Physical Sciences textbooks and work with learners to spot and confront the stereotypes expressed by printed materials. In the following sub-section, I discuss how studied textbooks depicted men as imaginative and autonomous analytical thinkers.

#### **7.5.6 Stereotype of men as creative and independent analytical thinkers**

Functionalisation was employed to investigate how textbooks portrayed men in a privileged position. These results were indicative of the conventional view of male superiority and further endorsing traditional patriarchal values. For example, textbooks featured only men in depictions of esteemed occupations, such as astronauts, doctors, and meteorologists. Correspondingly, Hamidah's (2017) investigation in Indonesian textbooks highlighted a substantial percentage of men in prestigious careers related to productivity and the public sphere. He observed that the prestigious professions showcased only male individuals as doctors, soldiers, and journalists. His findings differed slightly from my study, as he did not identify any male meteorologists or astronauts in his research. Hence, I concur with social constructionists' view that the construction of gender roles can result in hierarchical segregation where men dominate in higher ranks of power and prestige (Lindsey, 2015). Possibly, the intentions of these portrayals were deliberate to appropriate divisions between

boys and girls in science classrooms. This notion is in agreement with West and Zimmerman's (2009) viewpoint, which asserts that social powers manipulate gender to create deep-seated divisions within society.

Textbooks did not feature women in highly esteemed occupations like astronauts. There were instances where women were referred to by pronouns such as she, her, and hers, as men were represented by male pronouns such as he or his. Yet they weren't given the same opportunity for the role of an astronaut. The roles the author assigned to the men endow honour upon the male gender, which could be interpreted as a suggestion that only boys and men should pursue such professions. West and Zimmerman (2009) tell us that professional roles are gender-marked and aim to legitimate power and inequality. How high-status professions are portrayed in these textbooks connotes gender marking. For example, depicting only men as astronauts and doctors was possibly meant to send a message that only boys must pursue such careers.

When looking at how men and women are portrayed, the women seemed to be still learning, while the men were portrayed as professionals already established in their fields. The paediatric surgeon's photograph was sourced from Baragwanath Hospital in South Africa, which is commendable given the contribution of South Africans to the textbook content. Amazingly, no women were used as examples in such positions across all three textbooks, which is particularly contentious. Numerous photographs of female doctors in South Africa are available as examples to showcase. Thus, it is gender discriminatory to depict only men in these scientific roles. These representations confirm what Lorber (1994) mentions, that the sex category discredits women from displaying excellence in their professional duties solely because of what society expects of them. West and Zimmerman (2009) tell us that the social subordination of women by men influences the division of labour. In light of this, my analysis is consistent with the argument by O'Neill et al. (2016) that women are not assigned positions based on their abilities but rather on societal norms and expectations. In other words, being a woman means being assigned a job inferior to that assigned to a man because of the stigma of being seen as a weaker human resource (Buford, 2018).

The analysis further demonstrated that in specific textbooks, authors used specification to portray men as having power while relegating women to science fields of lower esteem. Machin and Mayr (2012) mention that writers can represent people as specific individuals or a type to elevate or demote. Representing people by specification can be done by mentioning them by their real names. As an illustration, readers of these textbooks will remember Dmitri

for creating the periodic table, Galilei for his invention of the telescope and Isaac Newton for formulating Newton's Laws. Consequently, their portrayals position them as being in a superior position. Furthermore, they are likely to be seen as a source of inspiration for boys as usually, people strive to copy the qualities of a person they respect (van Leeuwen, 2005).

Selecting only men as suitable examples in these scientific roles validates Bussey and Bandura's (1999) viewpoint that people see men as possessing more desirable, effective, and prestigious attributes and roles. This discourse can mislead learners that only men are suitable for Physical Sciences and related courses because the textbook discourse projected them as creative (inventing new things), analytical and able to solve problems. In the next section, I discuss how selected textbooks indicated the gendered entrepreneurship discourse, which further marginalised women and girls.

### **7.6 Gendered Entrepreneurship Discourse in Physical Sciences Textbooks**

The authors utilised specification and functionalisation to increase Thomas Edison's prominence. The text referred to him using his complete name, Thomas Edison, and by his functional name, the inventor. The text further supports that he was renowned for inventing more than a thousand scientific objects. It also portrayed Edison as a highly successful entrepreneur and owner of several power stations. Upon meticulous inspection, I noticed that the text overused expressions like "famous, very successful businessman, owned more than a thousand power stations".

Additionally, the text did not feature female scientists as businesswomen or very celebrated or successful in a science-related business. Textbook C presupposes that only men can be successful in science-related industries. Creamer (2018) found that although the number of human participants in STEM fields has grown enormously in South Africa, it remains skewed towards men. As has been previously highlighted in the literature and reiterated by the esteemed Natural Sciences and Engineering Research Council (NSERC), there exists a dearth of female figures within the fields of science and engineering, which is often identified as a significant contributing factor (NSERC, 2010, p. 13). NSERC conjectured that children develop a negative attitude towards STEM during early life due to a lack of role models. Villar and Guppy (2015) also emphasise the significance of role models in shaping the identities of young individuals. Failure to exhibit women who have become successful in STEM careers and businesses thus denies students who refer to this textbook access to female role models.

Instead, the introductory portion of Textbook B featured Miriam Makeba, who has achieved a successful career in music. I regarded this as a subtle strategy to steer young girls into music-related vocations, compared to young boys whom the text channels into science-related professions and businesses. Additionally, the textbook visuals depicted women working in salons. No photographs depicted men in low-income businesses.

Although Hutchinson's (2020) study is unique to mine as the phenomenon she investigated was entrepreneurship, while I investigated gender. Our findings are similar; she also found that only men were portrayed in highly prestigious businesses. On the contrary, women were found in slum areas pursuing low-profit businesses. Consequently, readers can misinterpret the chosen textbooks as encouraging girls towards low-profit-making businesses. I noted that there was no mention of a successful business run by women in all three studied textbooks. Although Miriam Makeba uses her musical talent to do business, the text does not use words like successful or famous businesswoman to portray her. Thus, how the selected textbooks presented women can persuade students to believe that women's role is meant to be inferior despite being given the same educational opportunities as boys which is mandated by the Constitution of South Africa. In the following section, I expound upon and analyse the findings pertinent to the interdependence of class, race and gender.

### **7.7 Physical Sciences Textbooks index racism and classism**

The intersection of race, class and gender was also evident in the sampled textbooks. All male scientists in all three sampled textbooks were White. Analysing the data showed how male power is linked to class, race, and other forms of inequality. The sampled textbooks evinced a demonstration of racial prejudice, with the scientists depicted as Whites from the Western domain and White men taking on preeminent scientific positions. This finding is consistent with Ceglie and Olivares's (2012) study, which found that the science discipline was initially designed "...for and by White men" (p.50). They mention that this is evident in the overrepresentation of men working in the science professions, teaching in colleges, and writing and designing science curricula. Possibly, these textbook depictions intended to endorse the notion that science is for White men. All scientists depicted in studied textbooks as White men constituted a significant percentage. The EFA Global Monitoring Report also highlights that recent studies on gender bias in texts in the USA still show the underrepresentation of women (Blumberg, 2015). Blumberg (2015) interpreted this as "...reinforcing... gender patriarchal system" (p.4).

Taki (2008) also observed that English Language Teaching (ELT) textbooks produced globally exhibit a dialogue analogous to Western economies within the Iranian framework. Significantly, of the three sampled textbooks in this study, only 3 White female scientists were portrayed, while male scientists surpassed 20. I argue that White women were also marginalised in sampled textbooks I studied because their contribution to the production of scientific knowledge was not featured or acknowledged.

Additionally, women of colour were examples in science-related roles as students, and textbooks depicted them in lower-echelon occupations as unskilled or illiterate. Gottfried (2008) tells us that intersectionality examines the relationship between gender, class and race and is rooted in perspectives derived from Western contexts. He perceives class and gender as intertwined but representing two distinct social dynamics. He explains that there are no ungendered class relations and no gender without class dimensions. Gramsci's social theory also proposes that how we act is determined by our perceptions of gender, race and class (Bates, 1975). Gramsci believed that the dominant beliefs of any era have invariably been the perspectives of its ruling class. The overwhelming presence of White men in the three textbooks assessed was a result of the intersection of gender, social class, and racial identity. Classism intersected with racial and gender concerns, as women were often portrayed in subordinate roles within the scientific and social spheres.

Therefore, these textbooks are used as cultural tools to disseminate the ideas of White supremacy despite South Africa having attained its democracy. Their depictions consistently confirmed that they were not in line with the tenets of democracy. Instead, they promote the view of White men as the dominant group. According to the research conducted by Shah and Pathan (2016), Iranian textbooks featured a preponderance of English language lessons that deal with Western culture, including ideology, religion, and social customs. They concluded that the authors neglected learners' culture, religion, and traditions to implicitly persuade them (learners) to take their heritage as the universally unacceptable norm. I agree with Shah and Pathan (2016) and regard these textbooks as carrying a hidden agenda: to westernise the learners and entice them to accept Western culture as an acceptable norm.

From the literature review, it was interesting to learn that Marie Anne Pierrette Paulze, depicted in Figure 5.7, was a female scientist of the noble class. According to Eagle and Sloan (1998), she translated some of Lavoisier's work as textbook A presupposed but edited and published some of it. As a couple, she and Lavoisier, in their marital union, advanced their chemistry

research together (Eagle & Sloan, 1998). However, in textbook A, Paulze is portrayed as a less proficient chemist who only translated what Lavoisier had produced. Textbook C depicted only Lavoisier as the publisher of scientific documents. As attested by Masland (1994), female learners in American educational institutions remain disadvantaged by traditional practices that continue to solidify their position as second-class citizens. These findings show that Marie Paulze's portrayal was also gendered. The authors sabotaged her, showing her only as a translator of documents because she was a woman. Although the selected textbooks portrayed her as a White female scientist, she was depicted with a tiny photograph and in an inferior role as a laboratory assistant. Authors likely presented her in this manner to reinforce the ideology that women are second-class citizens after men.

The texts in all three textbooks did not feature scientists from Africa. Considering South Africa's former status as a British colony and the fact that Cambridge University has published the three studied textbooks in the United Kingdom, it is reasonable to assume that the authors may have had the intent to promote a Western-centric ideology to South African students. Shah and Pathan's (2016) analysis demonstrated that English language textbooks published by Oxford University Press, an international publication service for English educational content, propagated Western culture. They claimed Western Capitalism utilises textbooks to market their commodities in non-Western regions. Similarly, Taki's (2008) research on ELT Iranian textbooks established that the global prevalence of the English language can be linked to the historical traces of colonialism and the economic and political globalisation of capitalism (p.139). The depictions in selected Physical Sciences can detrimentally affect pupils' aptitude for analysing and synthesising facts, particularly when they experience difficulty in understanding the topics being taught (Rahman, 2002). It could result in African learners' inclination to drop out of science classes, falsely concluding that only Western White men will benefit from taking Physical Sciences subjects at school and tertiary.

No depictions of individuals with disabilities as active participants in science or passive examples to illustrate scientific concepts were found in the analysed textbooks. My prior research on Gender Representations in selected science textbooks yielded that a sampled Natural Sciences textbook portrayed disabled persons as actively participating in science, which aligned with the goals of inclusive education outlined in White Paper 6 of South Africa (DoE, 2001). All learners who learn Physical Sciences from this Natural Sciences textbook in their early education have the same opportunity to pursue science courses, regardless of physical restrictions. Leaving out disabled persons from Physical Sciences textbooks can

ostracise disabled students from science classes. It can also create the perception among learners that having a disability implies being of a lower social status than other South African citizens.

As such, these textbooks propagate gender segregation, racism, and classism. Unless children are taught and conditioned to challenge the orthodoxy of educational materials, they are more likely to rely upon textbooks for authoritative knowledge (Apple and Apple, 2004). They can accept that these textbooks embody an unchangeable truth that must not be questioned (Blumberg, 2015). Apple and Apple (2004) assert that textbooks construct worldviews. They assert that schools play a significant role in reproducing an unequal society.

Consequently, Physical Sciences textbooks (that I analysed) socialised learners to attach themselves to the Western cultural ideology of White superiority. Whites are presented as symbols of progress and prestige. These textbooks reflect racial discrimination against Africans as they are either represented as unqualified or in inferior occupations, such as working in salons. In the next theme, I discuss student-teacher proficiency in working with learners to disrupt gender-based representations and stereotypes in Physical Sciences textbooks.

## **7.8 Student Teachers' understandings of gender**

The discussions among the participants revealed a variety of interpretations and viewpoints when it came to grasping the intricate concept of gender. The evidence brought to light the fact that a portion of the participants comprehended gender to be a social construct, whereas another portion of the participants held a belief that gender and sex were interchangeable terms. Some held a viewpoint that slightly contradicts itself regarding gender, as it encompassed both the biological characteristics of men and women and the societal norms and expectations associated with being a man or a woman. For example, when asked the question that sought answers on what is their understanding of gender, some simply answered, “...*gender is sex differences, using biological features on a person's body*”, while others said, “... *it refers to whether a person is a woman or a man and it is socially constructed*”. Cohen and Harvey (2007) acknowledge that more often than not, individuals tend to use the term "gender" to denote the biologically established "sex" (namely, either male or female), a definition that is insufficient in capturing the intricate essence of a construct like gender. Nyaluga (2007) also points out that the notion of gender is frequently employed in various contexts, yet it is a

concept that is prone to misconceptions and misinterpretations by many individuals. While, Hannan's (2000) definition shows that gender pertains to a complex web of attributes and possibilities associated with one's identification as either male or female, encompassing not only individual traits but also the intricate interplay of societal norms and expectations shaping the relationships between women and men, as well as girls and boys.

The data I generated and presented also demonstrated that most student teachers understood and grasped the notion that society categorises and assigns distinct roles and expectations according to gender for those categorised as either male or female individuals. Furthermore, a small subset of participants displayed responses that implied that the construct of gender is not rigid, rather fluid and capable of transforming as time progresses. For example, the dialogues of most participants pointed towards a reconfiguration in the obligations expected from men and women, driven by the evolving demands of the family dynamic. Some articulated their beliefs that following the father's passing on, who held the primary role in the family hierarchy, the mother was required to take on the tasks and responsibilities typically designated for a man. Hannan (2000) concedes the notion that traits ascribed to individuals based on their gender are indeed transmitted across generations, yet he emphasises that these characteristics are not fixed, but rather exhibit a fluid and evolving nature over time. My findings are also in alignment with the research conducted by Tabassum and Nayak (2021), which indicates that even though there has been a gradual decrease in many gender-related obstacles and prejudices that have historically hindered the progress of women in different sectors, it is clear that enduring gender stereotypes continue to present substantial obstacles and impediments to the professional growth of women.

The conversations among student teachers further underscored the fact that ingrained gendered stereotypes can impede the progress and self-assurance of young girls as they navigate the realm of studying Physical Sciences. One participant recounted an experience where a male teacher reinforced the gendered stereotype that the field of Physical Sciences is predominantly for boys and not girls, acting as a significant barrier in deterring her from chasing after her aspirations in a science career path. A perspective held by certain participants suggested that, throughout their time in school, it became evident that boys tended to excel over girls in tasks related to Physical Sciences, showcasing a noticeable disparity in performance. A small number of participants expressed the view that this conviction was nurtured and developed

within the intimate setting of their family homes, rather than being fostered through formal education in a school setting.

### **7.9 Student Teachers' sense of efficacy to mediate media assaults.**

The participants' deliberations showed they were confident they could tackle textbook biases in Physical Sciences classrooms without any impediment. They noted the following as wisdom they had obtained:

- Unconscious learning by observation
- Observing high school teachers
- Self-evaluation
- Input-processing-output stages of the problem-solving process

#### **a) Unconscious learning by observation**

It was apparent from the participants' talks that they had taken information from their high school teachers, University instructors, and mentors during their practice teaching. They declared that they observed previous schoolteachers' approaches to maintaining pupils in science classrooms until they completed schooling, regardless of gender. As Bell et al. (2019) noted, mentoring results in a heightened comprehension of teaching, learning, and the art of teaching.

Some student teachers avowed that they had realised from their former Physical Sciences school teachers the necessity of just and impartial treatment to all learners. They maintained that this was a successful tactic for preserving boys and girls in science classes until the end of their schooling journey. Hardt et al. (2022) substantiate that teaching mentorship allows pre-service teachers to form relationships with their schooling environment, boosting their growth and development.

The fact that the prior schoolteachers did not prearrange this mentoring (observing teachers during schooling years), as they had not been apprised of their student's eventual plans to become teachers, validates Fairbanks et al.'s (2000) idea that a favourable and encouraging rapport between mentors and pre-service teachers guarantees mentors as exemplary models for learning. Acknowledging the teacher's implementation of gender equality and observing the

beneficial effects of learners staying on in science indicates the student teachers' mental growth and development, as Hardt et al. (2022) suggested.

The student teachers' statements further authenticated the growth seen, where they declared that their past gender-sensitive mentors instilled in them an enthusiasm for teaching and vowed to be a positive model for boys and girls who would follow them to become significant contributors to the area of scientific thinking and comprehending the essentials of science. These statements show strong student teachers' conviction that what they will model to learners will bring about the outcomes they desire in their learners, specifically, to retain learners in science disciplines. According to Tejeda-Delgado (2009), teachers' beliefs and assurance in their abilities to facilitate student improvement constitute teacher efficacy.

By declaring their confidence in being able to encourage students who may be discouraged by science textbooks, student teachers exhibited a high level of proficiency without dismissing the value of a textbook rich in science content. Tejeda-Delgado (2009) shows that teachers with high levels of efficacy feel confident both in their teaching and in the effects of teaching in general to retain students with problems. Female student teachers considered themselves a potential source of inspiration for young women. They guaranteed their experiences of disregarding stereotypic messages from gendered Physical Sciences classrooms as a frame of reference to inspire learners to thrive and remain in science classes to achieve their dreams in scientific endeavours despite textbooks' assaults.

Some female student teachers asserted that they observed male teachers dismissing conventional gender norms by having both boys and girls take part in cleaning the classroom, not just the girls. Therefore, they believed they could leverage such experience to enable learners to challenge the stereotypical messages that textbooks as print media can present. For example, the studied textbooks had shown women in stereotypical roles as nurturers and men advancing in science.

Alshehri (2019) stresses that when novice teachers observe experienced teachers regarded as experts, they gain experience, learn from their mistakes and improve them. In this way, effective mentoring results in improved teaching quality. So, the discourses of female student teachers who participated in the study showed that they had gained experience in making all learners believe that gender norms change. Moving from simple by making all learners believe that both boys and girls can clean the classroom, amid the norm that girls have to clean, will

help the student teachers move to complex, changing their minds about how to challenge and disregard discriminating stereotypic messages.

### **b) Teaching practice as a mentoring strategy to defy gender stereotypes.**

Female student teachers as mentees were fascinated by observing experienced teachers during practice teaching, disrupting the stereotype that “only boys are familiar with cars”. According to Killpack and Melón (2016), diverse students can be hindered in their efforts to thrive and remain in STEM fields by prejudice in institutional culture. Student teachers noted the teachers’ efforts to maximise opportunities for diverse learners (boys and girls) to thrive during science lessons. In agreement with Killpack and Melón (2016), in this way, individual educators were granted the opportunity and the obligation to fortify the retention and tenacity of diverse students in STEM. Which also fosters an environment of acceptance and appreciation of student diversity while still achieving science learning goals (Casad et al., 2021).

### **c) Self-evaluation**

Some participants showed the notable capability to challenge textbook stereotypes by expressing that they would take from the experience of self-assessment and employ their strong and weak points to help learners go beyond obstacles or unfavourable messages from textbooks.

One participant divulged that he habitually turns off when he reads a textbook and comes across dejecting depictions. He professed that he would use this experience to review the textbook for teaching Physical Sciences.

He then planned to make the learners aware of the texts' disturbing message and prompt them to disregard the textbook prejudices. Utilising his aptitudes, he sets a precedent for how he encourages girls as a soccer trainer for female teams. He explains that he established the female soccer team to confirm to his community that girls can also play soccer. This exemplification illustrates his understanding of how he can deconstruct the social mores that interfere with girls' academic performance in Physical Sciences classrooms. Showing his faith in himself, he states that the girls will overlook the textbook's assault and put their trust in him as a man as he motivates them. Bandura's (1977) theory of efficacy postulates that when individuals set

incentives for themselves upon meeting certain performance levels, individuals are motivated to continue striving until they reach the goals they have set for themselves.

Other participants highlighted that they had gleaned an understanding of how to appraise themselves to benefit from their inborn aptitude to confront gender prejudice. For example, a participant talked about how the schoolteacher would make them feel unwelcome in the Physical Sciences classroom, emphasising that it should be male-dominated. The teacher would point the girls to classes specialising in general subjects and languages. Masland's (1994) research corroborates this claim and alludes to the fact that teachers obstruct students' ability to procure and construct self-confidence. He points out that their actions suggest they greatly regard their male pupils. However, Snezzy (the participant) was determined not to abandon her Physical Sciences class, and she said that she worked hard to prove her teacher wrong. She proved that other girls can also succeed in dispelling textbook stereotypes by triumphing over the teacher's prejudiced language.

She resolutely maintained that anyone should be able to chase their dreams despite opposition. She regards this event as valuable proof that she gives to other pupils studying Physical Sciences (during practice teaching) regardless of how textbooks present gender. Thus, she was sure she would be a valuable asset to challenge problematic gender identities presented in Physical Sciences textbooks. Literature proves that these student teachers' expectations are attainable. For example, according to Bandura (1977), it is possible to alter behavioural functioning through therapeutic approaches that involve reconceptualisation of human learning and cognition. Given that the participant quoted above is a female, learners she will teach will likely follow her as an example in disregarding discouraging messages from texts.

#### **d) Input-processing-output stages of problem-solving process**

Other participants highlighted that they would first diagnose the science textbooks to identify the problems related to gendered stereotypes. I regard this as an input stage. For example, Mon stated that he will first analyse the book he will use to teach Physical Sciences to determine if it has demotivating messages for both genders. He persisted in bringing up the idea that if the textbook has male role models only (problem identification phase), he will then formulate the plan (processing stage) for motivating the girls (solution stage). He felt that it was the responsibility of educators to inspire those of the gender that media attacks could let down. His discussion shows a high level of efficacy since he did not consider the textbook (with valuable

information) irrelevant because of the potential of presenting media assaults. Instead, he was confident that he would persist in utilising any Physical Sciences textbook, no matter the gender portrayals, and then find time to motivate girls whom such representations might demotivate. His proficiency was noticeable in his capability to access his inherent qualities.

These findings align with the findings of Monsalve Lorente et al. (2018), which illustrate that UNESCO has also worked to identify and tackle gender gaps in science. Their work is similar to that of Muralidharan and Sheth (2016), who propose that female educators should be encouraged to teach science as examples for girls and lessen gender disparities. According to Power (2014) and UNESCO (2017), during the 1980s, UNESCO and non-governmental organisations collaborated to construct an agenda to encourage science for all. Gaps were also identified in science teaching methods. They discussed potential solutions for adjusting science and technology education to suit the requirements of society. Hence, I also believe that student teachers who participated in this study have acquired an awareness of how Physical Sciences can empower or disempower learners. Therefore, they will likely change Physical Sciences classrooms where they will work as teachers. Power (2014) reports that through the efforts of UNESCO, a remarkable number of girls and women in underprivileged slum areas of the world are being educated, equipped and empowered with the abilities to live with self-respect and to strive against adversity and give priority to secondary chemistry, physics, biology and earth science curricula.

#### **7.10 Possible strategies to address gender issues in existing science textbooks**

Student teachers thought they were fully prepared to awaken learners' awareness in addressing the gender issues observed in selected Physical Sciences textbooks. The student teachers suggested the following strategies to deconstruct gendered messages from Physical Sciences textbooks. As per Baxter's (2018) perspective, implementing reflexive strategies, including familiar deconstructionist methods, can assist teachers in interpreting a text in a subversive manner, along with supplementary reconstructive measures. Baxter (2018) states that this will enable readers to reconstruct the gendered text and generate a broader range of positive perspectives.

### **a) Employ teaching methods that promote gender equality**

Student teachers' interpretations to gender inequalities, as revealed by CDA, demonstrated their potential as agents of transformation and change in science classrooms, in line with the beliefs of Critical Theorists. Winkle-Wagner et al. (2019) pointed out that Critical Theory has two purposes: to critique society while transforming it by integrating insights from multiple social sciences. The data from participants' input indicated that by applying their proposed strategies, it is possible to promote gender equality in science classrooms despite using gendered textbooks as sources of content knowledge. Participants suggested that incorporating both girls and boys as examples of active roles in scientific demonstrations may counter the notion that science is exclusively for boys. By implementing this strategy, we may be able to confront the gendered norms that perpetuate power imbalances and inequities (Garfinkel, 2005) between boys and girls, potentially causing division in science classrooms.

Furthermore, participants recommended equal opportunities for both male and female students who demonstrate proficiency in particular subject areas to teach their peers who may experience difficulty comprehending the material. By adopting these teaching strategies, the teacher can potentially guarantee that the course of science learning addresses the rights, roles, and needs of both girls and boys equally (Leal Filho et al., 2023; Okoli, 2012).

### **b) Raising awareness among students about the partiality within texts**

Participants further proposed that the science teacher should make pupils aware of gender inclinations in Physical Sciences textbooks and then deal with them by invigorating the gender that will be ignored or put down by gender representations in textbooks. In line with feminists' tactics of overcoming the gender binary, they flagged that collaboration between teachers and learners could help in destabilising dominant gender normativity and ideology (Butler, 2011).

As emphatically asserted by Butler (2011), concerted actions and collaborations are crucial in challenging the pervasive influence of normative standards. When science teachers and learners work collectively to identify and address gendered stereotypes in science textbooks, biased textbooks' effects are overcome. Following the assertions of distinguished Critical Theorists, including Winkle-Wagner et al. (2019), marginalised groups, when cognisant of the purpose of text framing, can liberate themselves from the grip of the dominant ideology, which could be intended or unintentional. Similarly, Fairclough (2013) underscores the crucial nature

of heightening awareness among learners regarding media assaults, as he maintains that the underlying assumptions and biases may not be readily discernible to individuals lacking specialised knowledge.

Flowerdew (2008) contends that the individuals portrayed within instructional materials may lack awareness of their potency or lack thereof within discourse. To address this, participants recommended that educators engage in professional development to learn to enhance written texts' clarity and coherence and combat discriminatory language. Raising awareness among learners about the repercussions of using sexist language and other forms of discrimination can aid in diminishing the impact of hostile ideologies in textual and visual learning materials (Huckin, 1997).

### **c) Enhancing girls' Self-Efficacy**

Considering the perspectives offered by the participants, it was apparent that science teachers have the potential to boost girls' self-efficacy by incorporating science peer role models in the classroom setting. The study participants disapproved of teachers' tendency to overemphasise male scientists' contributions to Physical Sciences as the primary source of scientific knowledge. They stated that this could contribute to factors that hinder girls from being efficacious in tackling science knowledge. Some hypothesised that girls could be dissuaded from focusing on subject content if they are only exposed to male scientists as the primary source of scientific knowledge. They proposed in its place that the teachers carry out research to find female scientists who apply the scientific knowledge that male scientists crafted and show it to learners, mainly what will be comparable to the content they learn. Karten (2015) proposed that teachers must conduct a diagnosis and focus on learners' strengths rather than weaknesses.

Participants were sure that displaying female scientists who have accomplished scientific advancements but are not in textbooks would make boys and girls believe that science is for everyone. Following the notion advocated by Letourneau and Bennett (2020), learners should be exposed to counter-stereotypical exemplars to diversify their educational experience. These exemplars serve to counteract the ingrained stereotype often perpetuated in conventional textbooks. As stated in Huckin's (1997) publication, it is incumbent upon teachers to illustrate to their pupils, through discourse, the various techniques successful individuals utilise to convey facts in a manner that elicits positive cognitive processes.

The participants recommended that an effective approach to engaging girls in scientific exploration would be through motivation and encouragement. The underlying assumption was that this approach could spark a flame of interest and ambition within girls' minds, impelling them to actively seek solutions to their acquired knowledge and ultimately devise practical solutions to global issues. Matete's (2021) research (conducted in Tanzania) also acknowledges that "...lack of confidence among female students themselves regarding performance in science subjects hinders them from participating in STEM fields". However, his proposition to address this is unique to my findings. According to his assertion, it is incumbent upon the government to guide and direct young girls to pursue STEM fields from the onset of their primary school education. He ardently believes this would catalyse a profound curiosity in individuals, motivating them to pursue academic fields within the scientific realm until they complete their tertiary studies. On the contrary, my findings suggest that teachers, as agents of curriculum change, should work on motivating learners to aspire to pursue STEM subjects.

Consequently, it is significant that educators proactively assist their pupils in amplifying their self-efficacy levels, as it has a strong positive correlation with academic success, given that self-efficacious learners are inclined to be more inventive and self-reflective (Hayat et al., 2020).

#### **d) Incorporation of pedagogic strategies that enhance cooperation**

The participants vocalised their objectives to comprehensively incorporate measures that enhance teamwork and facilitate knowledge exchange between boys and girls. They deemed that teachers can accomplish this by expertly organising opportunities for them to conceive and collaboratively refine ideas jointly. This approach aims to combat the oppressive messages commonly found in texts that reinforce the subjugation of women and the superiority of men, as argued by critical theorists (Fuschs, 2021). Student teachers envisaged that this would foster creative and analytical thinking and create a sense of belonging for all learners in the science classroom.

#### **e) Integration of gender-inclusive graphics and text materials**

Participants proposed that to counter stereotypical visuals of only men as scientists and producers of scientific knowledge, teachers should use sketches of both men and women when illustrating scientific concepts. According to Okoli (2021), students must identify with the

curriculum and feel validated by the visual representations on classroom walls. They also suggested that teachers give due recognition to women in the scientific field within the context of the subject matter that learners learn. By employing this strategy, teachers would successfully fulfil the recommended aim posited by Post-Structuralist feminists, which is to aptly embody the perspectives and narratives of women who have been overlooked, oppressed, and muted in discourse, to duly acknowledge and embody their existence and impact (Baxter, 2016).

#### **f) Give priority to girls without overlooking the needs of boys**

To overcome the effects of textbooks that show a preference for boys as an intended audience whilst neglecting girls, participants proposed that educational trips to enterprises that involve students in scientific pursuits that cultivate creative and critical-thinking abilities would be beneficial, as this would spark ingenuity in girls (Sullivan, 2019).

Inviting female scientists to physical science classes was put forward to motivate girls. Student teachers also brought up that they will be able to foster gender equality by removing the emphasis of learners from scientists illustrated in Physical Sciences textbooks, as these are not assessed (Casad et al., 2021). Although girls may be the focus since educational materials usually leave them out, they emphasised that teachers should ensure they don't neglect boys. Cheryan et al. (2017) affirm this notion and propose tackling entrenched masculine norms may improve female representation in engineering and physics. Based on their findings, it can be conjectured that addressing entrenched masculine norms and practices within these fields may lead to equal support and motivation for girls and boys to strive for success in these fields.

By implementing these measures, teachers can counteract the harmful effects of hegemonic masculinity, as outlined by Connell (2015), which perpetuates male hegemony and legitimises the subjugation of women. Connell proposes that men are the beneficiaries of such an inequitable gender arrangement. Hence, adopting strategies that promote giving priority to girls will neutralise the traditional patriarchal principles that advocate for men to strive for high-status careers in science (Chambers, 2005; Schiebinger, 2000). Baxter (2002) postulates that for students, the school classroom is one of the most influential settings for forming their identities and subjectivity.

### **7.11 Conclusion**

In this chapter, I synthesised the findings presented in Chapters 5 and 6. I concluded that overrepresenting men in selected textbooks would likely strengthen society's standards and stereotypes of male dominance in science classrooms. Perhaps by portraying men as the only originators of scientific knowledge, the aim was to give a false impression that only men can succeed in science-related occupations. Depicting only boys and men handling scientific equipment in group photographs was interpreted as suggesting that girls are still victims of patriarchal forms of oppression presented by science textbooks. These results do not demonstrate adherence to the ideals of gender inclusivity and gender equality mandated by the South African Schools Act (SASA) 1996. Depicting women in low-status non-STEM professions was interpreted as possibly meant to point girls to such professions while indexing boys to highly prestigious STEM professions such as becoming astronauts, meteorologists and doctors. In the next section, I summarise the findings, the study's implication for the teaching practice, the study's contribution to the body of knowledge and concluding remarks.

## **Chapter 8: Summary of the findings and conclusion**

### **8.1 The Introduction**

The previous chapter discussed the CDA and interview findings in depth. In this Chapter, I provide the summary of the study and the summary of interpretations of the research questions. I also highlight the study's contribution to the existing body of knowledge, suggestions to empower Physical Sciences teachers to expose hidden curriculum, research limitations, implications and suggestions for future research. I have also provided a discussion on the reflection of the study, first methodologically and then from a personal and professional standpoint.

### **8.2 Overview of chapters**

In Chapter 1, I introduced the study, provided the background of South African education, and outlined the rationale and background of the study. After that, I discussed my position as a researcher. I also discussed the importance of the study, explicating how it will benefit teachers, learners, textbook authors, policymakers and staff from tertiary institutions. I also outlined the objectives and critical research questions to demonstrate the aim of the study. I outlined the overview of the research methodology, which comprises the research design, paradigm, sampling strategies, data generation methods, data analysis, principles of trustworthiness, and ethical considerations. I also provided the structure of the thesis.

In Chapter 2, I reviewed and evaluated the extant literature on the phenomenon to explain the tensions in the field and discover aspects of the field that required further investigation. I found numerous studies that had conducted textbook investigations with gender as a primary factor. Some studies used content analysis, while others used CDA to generate and analyse data. Informed by my previous study on gender representations in science textbooks, where I recommended that future research consider including human participants to get diversified insights on the phenomenon, I further reviewed the literature to locate a niche for my study.

I discovered that several scholars have conducted studies to critique gender representations internationally and locally, particularly in English First Language (EFL) and English Second Language (ESL). I also found that recent studies that sought to understand gender manifestations in textbooks had been conducted in History and Business Studies in SADC countries. In all the studies I located, the researcher was the principal researcher and the only

participant. I did not find a study that engaged student teachers as participants to corroborate the researcher's findings. In addition, I endeavoured to ascertain if teacher training institutions empowered student teachers to detect, confront and deal with stereotypic messages from science texts to foster a conducive learning atmosphere that optimises inclusivity and gender equality. I noted a scarcity of studies that engaged student teachers through interviews to explore gender representations in Physical Sciences textbooks in the South African context. I identified this as a gap and purposed to further the study by conducting the CDA first and then showing the findings to student teachers to interview them to get diversified opinions.

In Chapter 3, I discussed my theoretical framework underpinned by Critical Theory, the theory on Social Construction of Gender and Feminist Post-Structural Discourse Analysis. Each selected theory offered a unique perspective on interpreting textbook depictions and student teachers' dialogues. Critical Theory provided insights into how hierarchical social divisions are constructed for legitimate power and inequality (Fuchs, 2021; Horkheimer, 1972). Drawing from the ideas of Fuchs (2021), I justified interpretations of how textbook representations elevated men to power whilst demoting women to powerlessness through depictions in inferior roles as weak, incompetent or in low-status businesses. The Critical Theory on capitalistic ideology effectively detected the depictions that connoted hierarchical divisions through the ruling class and working-class statuses of men and women. The theory on the Social Construction of Gender guided me to see that gender was constructed as binary in selected textbooks and to interpret student teachers' interpretations as they connoted that selected textbooks were laden with stereotypes that marginalised women. The FPDA enabled me to justify my criticism of omissions of women's scientific achievements, drawing from the ideas of Butler (2011). Connell's theory of masculinity enabled criticism of the depictions that showed that gender in selected textbooks was constructed around femininity and masculinity (Connell, 2005).

In Chapter 4, I discussed the methodology I employed to generate data. The methodology section employed was segmented into two phases that the study undertook. Firstly, the CDA was employed to generate data on gender representation in selected Physical Sciences textbooks. Secondly, interviews were employed to generate data from student teachers to acquire insights into their pedagogical interpretations on gender representations in selected textbooks. The mode of interviews was first face-to-face and then through WhatsApp instant messaging. The qualitative study was located within the critical paradigm that seeks to emancipate groups and individuals in society in line with Critical Theory. The sampling

techniques that I employed were also explicated. I used purposive sampling to select 3 Physical Sciences textbooks that are used to teach grades 10 to 12 in South African schools. I also used purposive sampling to recruit student teachers from a selected university in South Africa in the Kwa-Zulu Natal province.

I employed The CDA constructs outlined in Table 4.3 of Chapter 4 to analyse gender constructions in selected Physical Sciences textbooks. Thematic analysis informed the analysis of participants' interview transcripts. I employed principles of trustworthiness to achieve rigour in research, which I have detailed in sub-section 4.8 of Chapter 4. In section 4.9, I provide a discussion on ethical considerations.

In Chapter 5, I presented and analysed the findings I generated using CDA. I organised the findings into themes. The theories of the study outlined in Chapter 3 informed the analysis. It became evident that women were underrepresented in all the studied textbooks. This underrepresentation of women was evident in the number and gender of scientists and representations by visual images in active and passive science roles. The discourse of the textbooks further marginalised women through not naming, biased visual representation and qualified scientists who worked as translators of men's scientific documents. I further identified stereotypical messages, such as the stereotypes of women as weak versus men as strong, women as nurturers and in domestic roles versus men in highly prestigious roles such as paediatricians, meteorologists and astronauts. I also identified Gendered entrepreneurship discourse with men presented as successful businessmen and famous. Conversely, women were indexed to non-STEM businesses.

The selected textbooks also showed evidence of racism and classism linked to gender, and this analysis is outlined in section 5.7 of Chapter 5 and interpreted and discussed in section 7.7 of Chapter 7. I also uncovered evidence of contradictory messages that textbook discourse conveys in subtle forms, using CDA constructs such as claim-counterclaims, functionalisation, collectivisation, specification, indexical signs, and iconic signs, to name a few.

In Chapter 6, I presented findings from interviews. Through thematic analysis, I organised the findings into themes. The findings illustrated that student teachers became cognisant of biases from textbooks that I analysed. For example, in Chapter 6, I presented data from interviews that evidence student teachers referring to selected textbooks as gender unfair, gender discriminatory and promoting gender inequality. Student teachers concluded that the overrepresentation of men may reinforce society's standards and stereotypes of male

dominance in science classrooms. Through the lenses of the theories of the Social Construction of Gender and FPDA, it became evident that their interpretations were informed by their understanding of gender and the constructions of gender roles in their societies. All student teachers who engaged in the study felt that studied textbooks were prejudiced and feared that the messages coded in texts and visuals could lead to divisions during science learning, which could ultimately lead to the withdrawal of girls from science classrooms. They then explained the processes that helped develop them to be proficient in disrupting norms and stereotypes that future Physical Sciences textbooks could possess. For example, they mentioned that whilst they were scholars of Physical Sciences, they observed their teachers disrupting stereotypes and hegemonic norms in the classroom. They also highlighted that they drew from their innate abilities to resist forms of gender discrimination from men while learning science and believed they were proficient role models for future learners. Student teachers also noted that gender-sensitive mentor teachers whom they observed during practice teaching became the sources of professional growth and development. Thus, they were confident that they were ready (working with learners) to identify, confront, and deal with assaults that future Physical Sciences textbooks may present.

They articulated strategies that they would employ, as future teachers, to deconstruct gender in science textbooks. For example, they proposed that teachers should employ teaching methods that promote equality, make learners aware of the gendered stereotypes in Physical Sciences textbooks, enhance girls' self-efficacy, incorporate strategies that promote cooperative learning, integrate gender-inclusive graphics and text materials during teaching as well as giving priority to girls without overlooking the needs of boys. Student teachers anticipated that the revelation of gender-specific stereotypes found within textbooks, coupled with instruction to pupils on effectively resisting these stereotypes, would ultimately counteract any detrimental effects they may have on the student's knowledge acquisition.

In Chapter 7, I discussed the findings I presented in Chapters 5 and 6. The same themes I developed in these chapters were used in the discussion Chapter. The findings were discussed with extant literature to show the relationship between the findings and the literature. I concluded that selected textbooks propagated power inequalities that stemmed from the patriarchal roots of South African education (Engelbrecht, 2006). It also concluded that presenting men as the sole creators of scientific knowledge can give an erroneous impression that only boys and men can succeed in science-related professions. Girls might conclude that it is not rewarding to pursue science-related careers.

Furthermore, it may introduce barriers to science learning because once girls are discouraged by what they see in textbooks, they are less likely to concentrate on the content taught. The dominance of boys and men conducting experiments in selected physical science textbooks was interpreted as reinforcing gender stereotypes, which can hinder achieving the goals of fostering diversity in science classrooms. It was anticipated that these underlying assumptions suggested that girls are still victims of patriarchal forms of oppression presented by science textbooks. These results did not demonstrate adherence to the ideals of gender inclusivity and gender equality mandated by the SASA, even though these textbooks were published more than ten years after the SASA had been in place.

The higher representation of men than women as scientists, as well as in science passive and active roles, was interpreted as reinforcing the ideology of science as masculine (Chiponda & Wassermann, 2015; Mudau & Obadire, 2017). In agreement with Cairns and Inglis (1989), I deduced that selected textbooks possibly reflect society's cultural values and beliefs regarding appropriate gender roles. As suggested by Doughman et al. (2021), gendered roles in texts indexed gendered occupational bias, which occurs when "...an occupation or role is generalised onto a specific gender" (p.39). The manifestation of gendered scientific roles in the selected textbooks can index men and women to different roles in STEM-related fields. As Connell (2009) posited, selected textbooks reflected hegemonic masculinity, which promotes men's supremacy in society and validates women's inferiority to normalise the unequal power dynamics between men and women.

Physical Sciences textbooks (that I analysed) socialised learners to attach themselves to the Western cultural ideology of White superiority. Whites were presented as symbols of progress and prestige. The selected textbooks also reflected racial discrimination against Africans as they were either represented as unqualified or in inferior occupations such as working in salons.

The interview findings indicated that student teachers were proficient in working with learners to confront and deal with stereotypical messages from science texts. They mentioned that practice teaching had provided them with opportunities for professional growth and development by observing how mentor teachers disrupt gendered stereotypes in science curricula. Furthermore, they mentioned that they were confident that they could draw from their innate abilities, strengths, and weaknesses to deconstruct norms from science textbooks (Bandura, 1977; Power, 2014).

They also proposed strategies that science teachers could employ to reduce the effects of stereotypical messages from texts. They proposed using instructional methods that foster gender equality, educational trips to enterprises that involve students in scientific pursuits that cultivate creative and critical-thinking abilities, exposing learners to female scientists to provide female science role models and encouraging cooperative learning between boys and girls so that they could conceive ideas together.

### **8.3 Responding to the Research Questions.**

#### **8.3.1 Research question 1**

*Question:* How is gender represented in selected Physical Sciences textbooks?

Using lenses such as the theory of the Social Construction of Gender, I found that gender roles for men and women were represented differently. The CDA constructs, such as lexical choices and claim counter-claims (Al Ghazali, 2007; Machin & Mayr, 2012), uncovered how the texts used discriminatory verbs to portray women scientists. The discourse of studied textbooks showed gender biases. For example, although women possessed similar qualifications as men, such as being a chemist, being a woman meant an inferior scientific role, whilst men were portrayed in highly prestigious scientific roles (Baxter, 2008).

Drawing on Critical Theory, I demonstrated how the text framing portrayed men in positions likely to send messages of men being dominant and women being dominated (Fuchs, 2021). This was seen firstly through the overrepresentation of men as producers of scientific knowledge and through depicting women as weak, whilst men were depicted as strong (Flores, Gómez, Roa, & Whitson, 2020). The selected textbooks were also silent about the inventions of women scientists. On the contrary, whenever male scientists were mentioned, their inventions were also stated and used as an introduction to most topics discussed in these textbooks. Therefore, it is likely that the motive was to position men as the superior and women as the inferior (Fuchs, 2021). Through FPDA, I uncovered the marginalisation of women scientists through not naming and only men were depicted as successful entrepreneurs in science-related businesses. Women were channelled to non-STEM businesses (Baxter, 2008). I used the following themes to present the findings in Chapter 5.

- *Gender inequality being disseminated through the overrepresentation of men*

- *Physical Sciences textbooks index differentiated gender roles*
- *Marginalisation of women scientists*
- *Stereotypes that perpetuate gender power imbalance*
- *Stereotypes of women as weak*
- *Subservient positioning of women*
- *The stereotype of men as Creative and independent analytical thinkers*
- *Gendered Entrepreneurship discourse in physical science textbooks*
- *Physical Sciences Textbooks index racism and classism*

Janks (2010) argues that the perceptions and beliefs that society collectively constructs and accepts as truths are often portrayed as inherent and unchangeable, despite being products of human interpretation and consensus. How gender is depicted in the textbooks under examination appears to contribute to the reinforcement of the prevailing notion that women are situated at a lower rung of the social hierarchy, with specific emphasis on their perceived lack of literacy, competence, and their confinement to household duties. Exclusively African women were depicted engaging in household tasks or participating in endeavours linked to domestic environments, such as collecting water from the river or tending to children. These depictions have the potential to perpetuate social stratifications based on economic status and may inaccurately portray a woman's professional capabilities, particularly in remote rural regions where students have limited exposure to successful women in the field of science. Some learners are likely to accept these representations as reality.

While there were isolated instances of men being shown partaking in activities traditionally associated with individuals lacking literacy skills, such as bricklaying or construction work, women were markedly more prevalent in depictions of tasks commonly performed in domestic environments. Additionally, it should be pointed out that the activities related to occupations that are deemed to have low pay and social standing were exclusively illustrated using portraits of African women and men. No white man or women were depicted in low prestigious jobs. Consequently, these portrayals serve to perpetuate and strengthen existing racist attitudes.

### **8.3.2 Research Question 2**

Question: Why is gender represented in the ways it is in selected Physical Sciences textbooks?

After meticulously analysing the three selected textbooks, I concluded the following reasons for representing gender in the ways it is in selected Physical Sciences textbooks. They include uneven and inordinate bestowal of power; Physical Sciences continue to be gendered masculine, South Africa's roots of patriarchy and inadequate severing of the curriculum from colonial and Apartheid roots. Each of these reasons is presented and discussed as themes below.

#### **a) Uneven and inordinate bestowal of power**

I found studied textbooks to echo traditional views of men as powerful by depicting men as astronauts, meteorologists and medical professionals while showcasing women as laboratory assistants and document translators for men. Kamasak et al. (2019) posit that hidden curricula could slyly instil or propagate stereotypes, thus sustaining cultural, gender and racial prejudice. Social stereotypes are generally viewed as affecting social power (West & Zimmerman, 2009). Individuals with special knowledge or control of resources are endowed with power. Disparate expectations regarding rank and power often characterise interactions between men and women because sex is closely linked to prestige and position in daily life (Butler, 2011). Villar and Guppy (2015) argue that the dearth of female involvement in financially rewarding positions is a critical factor in the wage gap between men and women and helps to explain why women are comparatively underrepresented in positions of influence and authority. The articulation and elaboration of power relations in selected textbooks are likely to misguide learners and bolster the idea that women are not suited for scientific roles traditionally held by men.

The potential cause for the underrepresentation of female scientists in Physical Sciences textbooks could be connected to the notion proposed by Wassermann et al. (2015) that the knowledge featured in textbooks is the consequence of intricate power dynamics and conflicts between dissimilar social groups based on class, race, gender and religion. It seems to be a persistent representation, as was also noted by Lawlor and Niiler (2020), across the entirety of the United States, spanning an immense array of esteemed educational establishments, a dismally small number of only 75 individuals, amidst the vast assemblage of college physics and astronomy faculty, can be identified as belonging to both the African American or Hispanic community and the female gender. Recent studies such as that of Pillion and Bergin (2022) on Irish physics textbooks found that analysing the language used to describe characters mentioned in the books compounded gender inequalities.

According to Fairclough (2013), discourse has the potential to be exploited by social structures to perpetuate culture and its values for successive generations. Correspondingly, Bourdieu (2003) corroborates this view by suggesting that social establishments, particularly schools, can propagate cultural notions that reinforce the dominant group's supremacy in the culture, thereby accomplishing cultural reproduction. Consequently, it is reasonable to suggest that the writings in the chosen textbooks have been created in a highly politicised milieu, in which certain information is widely regarded as necessary above other forms of knowledge.

I concur with Fairclough (2013) that the strength of the ruling elites is founded upon economic and political power, and consequently, they strive determinedly to uphold their authority using their symbolic production, including discourse. The hierarchy of authority and power present in discourse practice limits and dictates what is presented in textbooks. Additionally, before being granted approval to be read in classrooms, textbooks must first pass through the meticulous examination of department personnel to ensure they satisfy the necessary standards, one of which is gender equality. Some textbooks are selected, and some are rejected (Maistry & David, 2017). It remains questionable why textbook writers continue to depict textbooks that do not align with the prescriptions of South African education policies. It is reasonable to anticipate that publishers would fabricate documents to secure approval from state regulatory entities. Consequently, publishers may unknowingly disseminate state ideologies through their textbooks by selecting information to complement content topics outlined in standard curriculum guidelines.

Writers probably opted to portray gender in this manner as they are cognisant that the vast majority show partiality to men leading the way in most aspects of society. Nyangweso (2020) reports that Martha Karua, a Kenyan woman, bid for the presidency in the 2013 and 2017 elections. According to analysts, the chances of victory were slim due to the African machismo and the myth that women could not play hardball politics. Similarly, here in South Africa, we have never had a female president.

This is also the case in Africa, with most religions preferring men leading the way. The textbook depictions might be connected to the diverse religious roots of Africans. In Africa, most religious principles generally stipulate that men should be leaders (Nyangweso, 2020), which is also reflected in the framework of our governmental portfolios (Warnes, 2023). Despite the South African Constitution's emphasis on gender equality, Warnes (2023) shows

that the election results of the past two decades (and beyond) since the establishment of democracy have demonstrated a preference for male leadership. He shows that the 1994, 1999, 2004, 2009, 2014 and 2019 elections have all resulted in the leadership of men as the country's presidents. Heretofore, we have never had a female president. The research of Merkle and Wong (2020) in Ghana, Nigeria, Rwanda, South Africa and Zimbabwe found that "...people agree that men are better political leaders than women, regardless of their gender..." (p.353).

According to their research, the societal expectation for male leadership is influenced by patriarchal norms. Similarly, female principals are scarcely seen in schools. The voices of female teachers echo the persuasion for men's leadership due to the conviction that men possess an inherent aptitude for leadership (Zikhali & Smit, 2019). Through their research, Zikhali and Smit (2019) found that the female school principals in the study conducted in Gauteng resigned from their positions in response to the various impediments established against women's leadership. These included the repudiation of female authority, absence of backing from peers, absence of role models, seclusion, prejudice, and ostracisation.

Accordingly, one can conclude that the chosen textbooks reflect South Africa's societal and cultural norms from diverse backgrounds. Ojong (2017) observe that due to the patriarchal nature of both society and religious establishments, women have continued to be marginalised in terms of church leadership, with only a few outlier women being prominent at the zenith of such hierarchies. Sharify-Funk and Haddad (2012, p. 1) also found that a considerable number of Muslim women are striving for empowerment by engaging in communal life despite the historical prevalence of male dominance in Sunni and Shi'ite denominations." Similarly, Shah and Sobehart (2008) note that patriarchal traditional leadership has forced Muslim women into places of invisibility and overemphasised the women's domestic role, which belittles the status of women. This literature shows diverse cultures and religious beliefs forming part of the South African nation. Therefore, it is reasonable to assume that textbook portrayals depict what will be acceptable to people's diverse cultural and religious norms to ensure that the textbooks will be approved to be read in South African schools.

Baxter (2015) mentions that FPDA illustrates how children and adults can construct various subjectivities, depending on the discourse, in which they may be in a position of power or a state of vulnerability. Authors should make both male and female scientists visible in texts in an 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 the number of images depicting boys and girls conducting experiments and investigations.

**b) Physical Sciences continue to be gendered masculine.**

Portrayals of selected Physical Sciences textbooks also demonstrated evidence of hegemonic masculinity. Only male scientists were depicted as founders of scientific knowledge. Despite the three women represented as scientists, their contributions were omitted. Ceglie and Olivares (2012) are of the view that the science discipline was “...originally designed for and by White men” (p.50). They mention that depicting the ideal scientist as an adult White male in textbooks persuades teachers and students as to who should do science. Hence, textbook portrayals sideline women and girls in STEM fields. As Connell (2009) posited, hegemonic masculinity promotes men's supremacy in society and validates women's inferiority. It normalises the unequal power dynamics between men and women, thus causing power disparities. Connell (2009) opines that in such scenarios, men are the ones who reap the rewards of inequitable gender relations. Mirembe and Davies (2001) elaborate that messages of the official curriculum promote male domination and power imbalances. Correspondingly, Butler (2011, p.18) agrees that sexism is the prime cause of women's oppression and that discourse has incorrectly portrayed women. Baxter (2015) asserts that feminist post-structuralists consider gender differentiation to be a particularly influential subject matter in several cultures due to its capacity to differentiate among people in terms of gender and sexual orientation. These textbooks will likely bring division in science classrooms and ultimately affirm the stereotype that science is for boys only.

Showing only a male as a doctor referred to as a paediatrician in textbook B illustrates that science is still a gendered subject. Literature reveals that some women, like Margaret Bulkley, had to disguise themselves as men to be admitted to medical schools in the 1800s (Du Preez, 2012). She took the name of his uncle James Barry to study medicine in Edinburgh and concealed herself for 46 years, serving as a doctor in the British army. It was only after her death that a post-mortem was done that it was discovered that she was a female (Du Preez, 2012; Holmes, 2020). Research has uncovered that female medical practitioners in the 1800s were more likely than their male counterparts to apply precautionary measures (e.g., mammograms, Pap smears, and cancer screenings.) and advance overall health and wellness (Walsh, 2009). It is, therefore, surprising that authors did not find these women from literature

sources to feature them in studied texts. Taking all factors into account, I can only conclude that the textbooks selected have a clear bias towards masculinity. I concur with Baxter (2008) and consider these textbooks enacting gendered science.

Textbooks ought to depict both men and women as active contributors to the generation of scientific knowledge and as individuals who have created various scientific innovations (Mudaly & van Wyk, 2015). This approach has the potential to counteract the dominance of male-centric science that is typically presented from a patriarchal perspective. The authors of science textbooks should also depict equal numbers of men alongside women in nurturing roles such as caring for children and the 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 controversially portraying women (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).

### **c) Inadequate severing of the curriculum from colonial and Apartheid roots**

The sampled textbooks suggested a manifestation of racial discrimination, with the scientists exemplified as Whites from the Western world. Combined with patriarchy, it represented White men in the most eminent scientific positions. Taki (2008) also observed that English Language Teaching (ELT) textbooks produced globally exhibit a dialogue analogous to Western economies within the Iranian framework. Women of colour were depicted in science-related roles as students. Furthermore, they were represented in lower-echelon occupations as unskilled or illiterate. Gottfried (2008) tells us that intersectionality examines the relationship between gender, class and race and is rooted in perspectives derived from Western contexts. He perceives class and gender as intertwined but represents two distinct social dynamics. These findings reinforce tenets of the Apartheid regime, which promoted the supremacy of Whites and all women treated as second-class citizens.

White representations are dominant in all three textbooks. Textbooks are used as cultural tools (Engelbrecht, 2006; Medina, 2008) to disseminate the ideas of White supremacy despite South Africa having attained its democracy. It had been acknowledged by Engelbrecht (2006) that the consequences of Apartheid had resulted in curricula in South African schools becoming entrenched in prejudice, stigmatisation and stereotyping. He highlighted that textbooks were

used to transmit and reinforce cultural values in learners. These textbooks are not in line with the tenets of democracy but rather promote the view of White men as the dominant group (Pillay, 2017). According to the research conducted by Shah and Pathan (2016), Iranian textbooks feature a preponderance of English language content that deals with Western culture, including ideology, religion, and social customs. They concluded that the authors neglected learners' culture, religion, and traditions to implicitly persuade them (learners) to take their heritage as the universally unacceptable norm. I agree with Shah and Pathan (2016) and regard these textbooks as carrying a hidden agenda: to westernise the learners and entice them to accept Western culture as an acceptable norm.

Scientists from Africa were not included in all three textbooks. Considering South Africa's former status as a British colony and the fact that Cambridge University has published the three studied textbooks in the United Kingdom, it is reasonable to assume that the authors may have had the intent to promote a Western-centric ideology to South African students. Shah and Pathan's (2016) analysis demonstrated that English language textbooks published by Oxford University Press, an international publication service for English educational content, propagated Western culture. They claimed Western Capitalism utilises textbooks to market their commodities in non-Western regions. In the same vein, Taki's (2008) research on Iranian ELT textbooks revealed that the English language's global dominance can be linked to the remnants of colonialism and the economic and political spread of capitalism (p.139). The depictions in selected Physical Sciences can detrimentally affect pupils' aptitude for analysing and synthesising facts, particularly when they experience difficulty understanding the topics being taught (Rahman, 2002). It could result in African learners' inclination to drop out of science classes, falsely concluding that only Western White men will benefit from taking Physical Sciences subjects at school and tertiary.

### **8.3.3 Research Question 3**

Question: What are student teachers' pedagogical responses to how gender is represented in selected Physical Sciences textbooks?

Using thematic analysis informed by the social construction of gender, Critical Theory and Feminist Post-Structuralist Discourse Analysis, the following themes emerged from the data.

- Student teachers' understanding of gender
- Student teachers' concerns about gender biases in textbooks

- Sense of efficacy to develop strategies to mediate biases in selected textbooks
- Potential of learning from gender-sensitive mentors
- Possible strategies to address gender issues in existing science textbooks

As avowed by renowned experts on the social construction of gender, namely West and Zimmerman (2009), it was observed that student teachers possess a keen understanding of the prevailing societal norms surrounding the concepts of femininity and masculinity. This understanding leads them to recognise that society's entrenched hierarchical order has influenced textbook production. In other words, they recognised that the gender roles assigned to male scientists in the studied textbooks were coupled with high status, whilst gender roles assigned to female scientists demoted them to male servants. They believed that this results in one gender being privileged whilst the other is disadvantaged and oppressed.

They believed that selected textbooks' messages promoted masculinity and other societal stereotypes that demotivate, dehumanise and devalue the status of women, which could lead to girls dropping out of the Physical Sciences stream. As posited by Lorber (1994), their interpretations were aligned with the belief that the social construct of gender in studied textbooks was employed to diminish the capacity of women to exhibit excellence in their professional roles solely based on the predetermined societal norms assigned to them.

Almost all participants of this study considered the absence of women's contribution to the production of scientific knowledge in selected textbooks as a form of gender discrimination against women. Their interpretations also aligned with Feminist Post-Structuralist notions, such as Baxter's (2008) viewpoint that women are omitted, silenced and rendered invisible in discourse. Which marginalises and deprives women of their human rights of being treated equally as men. They endorsed that textbooks of Physical Sciences contain messages that could discourage girls from continuing with the subject.

The depiction of women as inferior, powerless, subordinate, and unqualified, alongside the portrayal of men as dominant, resourceful, and autonomous thinkers, was met with criticism from student teachers. As pointed out by Butler (2011, p. 35), language possesses a tremendous capacity to control and exclude women from societal discourse, relegating them to a secondary and marginalised position. According to Mburu and Nyagah's (2012) assertion, the absence of adult role models for young female readers within textbooks harms their self-perception, ambitions, and drive to succeed.

The responses given by the student teachers can be explained as suggesting that the depictions found within textbooks convey a message of persistent underrepresentation of women in STEM fields. Student teachers anticipated stages preceding girls' decision to drop out of the subject of Physical Sciences. They stated that the processing of all negative information from textbooks occurs internally without the teacher being aware of the damage the textbook might have caused. The participants were convinced that the textbooks that sideline and marginalise women through omission could ultimately contribute to women leaving from the science pipeline (Schiebinger, 2000). According to student educators, even though there are depictions of women as passive figures in the realm of science, these portrayals do not effectively guide or motivate girls to pursue courses in STEM at the tertiary level.

The student teachers discussed experiences that made them believe they were proficient in using teaching methods that can reduce the effects of negative stereotypical messages from the selected textbooks or any textbook found to be prejudiced. They then suggested strategies they believed could be employed in science classrooms to disrupt gender norms. Critical theorists are of the view that it is not enough to identify gender-oppressive discourse. They propagate a transformative agenda (Fuchs, 2021; How, 2017; Winkle-Wagner et al., 2019)

They mentioned that they had observed their previous female Physical Sciences teachers disrupting gender-discriminatory norms in science classrooms during their schooling years. They also mentioned that they had the experience of resisting the stereotype that is science for boys only from the discouraging words of male teachers. Some mentioned that they use three problem-solving stages to confront stereotypic messages from textbooks. These included identifying the problem, e.g. checking the textbook and seeing that it is discriminatory because it represents only male scientists, which was regarded as the problem identification phase. Planning how to motivate learners who might be discouraged by the textbook was regarded as the processing stage. When the teacher implements his plan whereby the stereotypes from the textbook are exposed and nullified, it is viewed as the solution stage. In their scholarly work, Muralidharan and Sheth (2016) make a compelling argument in favour of encouraging female educators to actively participate in the delivery of science education. Their proposition revolves around the idea that having more women serving as role models in the field of science, could help to instill confidence and ambition in young girls, ultimately leading to a reduction in the disparities between genders within the realm of scientific learning.

Student teachers highlighted the impact of gender-sensitive mentors during practice teaching, creating a gender-equal atmosphere in science learning. They stated that the gender-sensitive mentors ensured the feeling among all learners that science is for all. It has been observed by Bell et al. (2019) that engaging in mentoring activities can bring about a deepened grasp and appreciation of the intricate dynamics at play within the spheres of teaching, learning, and the craftsmanship of teaching.

These student teachers believed they would be good science role models for future learners. Hardt et al. (2022) emphasise the importance of mentors serving as role models in the classroom. Among the strategies they mentioned was the importance of encouraging cooperative learning among girls and boys by brainstorming ideas together. This tactic was deemed to eliminate the discriminatory messages commonly found in texts that reinforce the inferiority of women and the dominance of men, as argued by critical theorists (Fuschs, 2021). They also highlighted the importance of exposing learners to scientific projects that stimulate creative thinking and inventive skills. It was also emphasised that girls must also be hands-on during practical investigations and not rely on boys doing experiments on their behalf. Female scientists were to be invited to science classrooms to motivate learners, thereby exposing learners to science role models of esteemed prestige. They believed this could boost the confidence of all learners as most science textbooks are deficient in portraying female science role models. It was also proposed that teachers research the achievements of female scientists not featured in Physical Sciences textbooks and show them to learners. They believed this could eliminate the effects of gendered stereotypes presented by science textbooks (Hayat et al., 2020).

Teachers have the potential to effectively address and challenge the deeply ingrained gendered norms that serve to uphold and perpetuate disparities in power dynamics and levels of fairness between boys and girls, ultimately leading to the creation of rifts and divisions within science classrooms. Furthermore, teachers can effectively encapsulate the viewpoints and stories of women who have been disregarded, suppressed, and silenced within the realm of Physical Sciences textbooks, to rightfully recognise and internalise their presence and influence. The utilisation of these strategies also holds the potential to actively challenge the prevailing and restrictive narratives often seen in written materials that perpetuate the subordination of women and the dominance of men, as contended by critical theorists like Fuschs (2021). By addressing and challenging deeply ingrained masculine norms disseminated through Physical Sciences textbooks, there is a possibility of enhancing the presence and participation of women in career

fields related to science, technology, engineering, and mathematics (STEM). Furthermore, teachers would efficaciously realise the Post-Structuralist feminists' objective, to appropriately represent the viewpoints and chronicles of women who have been marginalised, muted in discourse.

### **8.3.4 What informs student teachers' interpretations to gender representations in selected Physical Sciences textbooks?**

#### **a) Understanding the Societal roots of hierarchical segregation**

Student teachers perceived that the selected textbooks insinuated ideas that could engender division in science classrooms. Disagreements concerning reflections of femininity and masculinity in selected textbooks significantly increased tensions. The data from their interpretations supports West and Zimmerman's (2009) assertion that social powers utilise gender to create enduring divisions within society. They argued that social gender roles are designed to validate the difference in status between men and women in society. They provided examples of gender-defined professional roles like a male nurse and a female doctor. Consequently, the author's decision to exclusively portray men as doctors and astronauts may have been construed as an attempt to sanction the existence of gender distinctions in the context of science classrooms.

Student teachers' interpretations suggested that they were conscious of how the construction of gender roles in their upbringing had restricted women from having the same opportunities for employment as men. They noted that despite being adequately qualified, women from their societies could not rely on their credentials to gain employment because they had to remain at home to look after their children and manage the household. As evidenced by the deliberations at hand, it can be inferred that there is a clear indication of a capitalistic orientation that Critical Theorists have identified as a pivotal factor in perpetuating class-based discrimination within societies (Fuchs, 2021). Within society, the working class is commonly acknowledged as the group responsible for producing goods that are then acquired and traded by the capitalist class (Fuchs, 2021). Student teachers' dialogues showed that the representation of gender roles illustrated men as the capitalist class and women as the labouring class. Van Dijk (2016) suggests this statement, elaborating that ruling classes exercise their power to disseminate gender inequality through texts. According to the scholarly work of Fraser and Jaeggi (2018), it can be affirmed that the studied textbook messages perpetuate the everlasting and unrelenting

battle that persists within the realm of society, pitting those who hold positions of power against those who lack it. I deem the studied textbooks as promoting men's superiority whilst demoting women to powerlessness and subordination by men.

Student teachers alluded to the fact that textbook depictions that promoted gender differentiation can revive society's stereotype that Physical Sciences is difficult for girls. This coincides with FPDA's profound awareness and recognition of the widespread effect of gender differentiation as a dominant storyline in diverse cultural contexts, which holds the potential to systematically oppress and discriminate against individuals due to their gender and sexual orientation (Baxter, 2018).

The textbooks examined were found to potentially alienate girls from pursuing STEM courses at the tertiary level, as noted by the participants' feedback. Rezende and Ostermann (2020) observe that those who are preeminent within society use cultural standards and symbols to sustain their predominance. Participants presumed that the images in textbooks were selected to depict women in a less favourable light, possibly to deter girls from entering STEM industries and maintain male predominance in these fields. This suggests Bourdieu's (2018; 2003) conception that the educational system is critical in upholding the current power imbalances and symbolic hierarchies among various social classes.

Bourdieu (2018; 2003) also firmly posits that the educational system is a pivotal force in perpetuating and upholding the entrenched power dynamics and symbolic hierarchies between various social classes. He subtly implies that this task is accomplished through deliberate and purposeful cooperation in upholding and maintaining the hierarchical system of cultural capital distribution within these social structures.

#### **b) Strategic approaches of student teachers facilitate transformative methods proposed by FPDA and Critical Theory.**

The strategies that student teachers suggested to disrupt gendered norms and stereotypes from science textbooks confirm Baxter's (2008) notion that the use of FPDA has the potential to facilitate small, grassroots movements that are crucial in its overall goal of challenging dominant narratives, such as gender stereotypes. Participants foresaw that dejecting messages from studied textbooks could diminish women's prestige and lead to girls abandoning STEM subjects.

According to the FPDA, the key to ensuring the sustainability and development of well-established fields like gender and language research is to embrace and adopt novel modes of thinking (Baxter, 2018). The willingness to adopt novel modes of thinking was seen in student teachers' desire to motivate girls to be hands-on during science practical investigations. FPDA promotes diverse investigative techniques and approaches that challenge and critically examine entrenched ideologies and established methods (Baxter, 2018). Hence, I regard student teachers' proposed strategies as having the potential to bring innovative methods to welcome all learners during science learning and teaching.

Croucher and Cronn-Mills (2014) show that Critical Theory aims to challenge the reproduction of inequalities in discourses. Fraser and Jaeggi (2018) mention that it can be used effectively to free society from capitalistic backgrounds to expose the oppressed and oppressor classes. Hence, the proposed strategies have the potential to free learners from the effects of gendered stereotypes presented by Physical Sciences textbooks.

Baxter (2015) postulates that FPDA principles can support small-scale, bottom-up, localised social transformations vital in its larger quest to challenge dominant discourses (like gender differentiation) that inevitably become grand narratives. Hence, student teachers' strategies were a way to transform Physical Sciences classrooms.

According to the tenets of the FPDA, the continued growth and advancement of gender and language study relies on its openness to new perspectives, diverse research methods, and critical examination of conventional beliefs and practices. For instance, when student teachers promote cooperative learning between girls and boys, they create an avenue for the FPDA to give space to marginalised or silenced voices (Baxter, 2018).

The pedagogical methods suggested by student teachers that promoted the integration of gender-inclusive images and written texts in science education are consistent with the principles of FPDA. In addition to disrupting and subverting the tendency towards simplistic labelling of literary pieces, the modes presented by the FPDA facilitate a deeper level of engagement for readers, allowing them to actively and thoughtfully explore the intricate and multifaceted nature of literary identities. By implementing proposed strategies, learners who read from these textbooks can be empowered to move beyond the customary practice of critical analysis commonly associated with CDA's post-Marxist critique, ultimately reaching a state of metamorphosis. They also pave the way for the central objective of Critical Theory, which seeks to examine and combat abuses of power to facilitate transformation.

#### **8.4 Research's significance, worth and contributions to knowledge.**

This study involved student teachers from the designated university in the Kwa-Zulu Natal province of South Africa, intending to gain insights into their pedagogical responses to gender representations in physical science textbooks. This area has been sparsely researched. Therefore, the study contributes fresh insights into the comprehension of gender portrayal in Physical science textbooks using student teachers' perspectives, an angle that has not been scrutinised previously. The investigation then attempts to bring forth novel insight and build upon the existing literature concerning the implications of gender portrayals in Physical Sciences textbooks for female involvement in STEM-related disciplines.

The research results have been corroborated by the outcomes of other research projects, with the underrepresentation of women in science textbooks having been identified by countless investigations taking place at an international level. In addition, other investigators have revealed the existence of gender stereotypes that have a deleterious impact on women, as well as the discrimination which prevents women from engaging in STEM professions. Numerous studies have implemented Critical Discourse Analysis as a means of analysis, yet I could not find any study that engaged pre-service teachers to respond to the findings of CDA. The feedback from these participants offers novel perspectives not only on gender representation within science textbooks but also on textbook research in general.

This research contributes substantially to the present corpus of literature in various ways. Primarily, the cognitive resources that student teachers perceive as being able to be employed by educators to deal with media assaults are identified. Gleaned from the student teachers' personal experiences and from observing gender-sensitive mentors, the data gathered offer invaluable information that learners and teachers can use to break apart the standard forms of thinking and keep girls in the science pipeline. The student teachers included in the study provided evidence that they felt they could effectively deal with the implicit ideological messages found in Physical Sciences textbooks. As stated by Tejeda-Delgado (2009), the manifestation of a strong feeling of self-efficacy was evident when they devised their individual and unorthodox strategies, which they had faith would be efficacious in overturning the stereotypes and conventions that could frequently precipitate a significant number of withdrawals from Physical Sciences classrooms.

Through CDA, my study has also unveiled how science education is still entrenched in a patriarchal view of education. The authors of textbooks portrayed men as superior and women as victims of objectification and dehumanisation (Machin & Mayr, 2012). This act is what Connell (2009) termed hegemonic masculinity. She mentions that hegemonic masculinity buttresses men's pre-eminence in society and ratifies women's subordination.

In addition, I have postulated how the science curriculum is deficient in decolonising itself from the ideas that further Westernised science. Elected science textbooks portrayed only White people from Western nations as scientists, while only White men from the West were vividly demonstrated as prosperous businessmen. No researchers, publishers or scientists of African descent were depicted in the studied textbooks. The omission of African scientists was perceived as having the potential to misguide learners and impede their capacity for creative and analytical thought. It may lead them to believe that being a scientist is an unattainable goal, only achievable by Western White men.

## **8.5 Reflections on the Study**

### **8.5.1 Methodological Reflections on the Study**

In this section, I reflect on the methodology and means employed in this study to respond to the research questions. Firstly, I acknowledge that although I had conducted textbook research in my previous analysis, engaging the teachers to respond pedagogically was not easy for me. Recruiting student teachers during the lockdown was very difficult. However, with the help of my niece, I managed to recruit a few of the student teachers telephonically. Initially, I had thought those student teachers were the ones who would analyse the textbooks and then write their interpretations using questionnaires. However, since their questionnaire responses mostly covered one-word answers the data was not enough to respond to research questions.

The second phase was meant to be interviewing them telephonically as the ethical clearance was granted whilst the country was still in lockdown. However, it was evident that the interpretations I derived at that stage were insufficient to respond to research questions. However, since I had chosen the semi-structured interviews which allow the interviewer to probe further if he/she feels the respondents are not giving enough data, I managed to get enough data with the second group of participants. Hence, I was delayed and had to rework my plan to finish the thesis.

Therefore, the study unfolded in two phases; first, I had to conduct CDA to generate data from the sampled textbooks and conduct analysis. Examining the contents of the three textbooks to encode the data in the specified categories for both the visual and verbal text proved laborious and protracted. Nevertheless, I have obtained the capability and understanding that I can skillfully guide future coders to conduct similar analyses. It was also beneficial because it was easy to understand student teachers' interpretations because I was then fully conversant with the texts and visuals as I had read and reread.

Then, in the second phase, I had to show my analysis to the student teachers who participated in the study to get their pedagogical responses to how gender was represented and then theorise the reasons for their interpretations. I had to learn from scratch how to generate data using interviews. I had to read a lot to understand various types of interviews and choose what would suit the nature of the study as it was qualitative. In the second encounter, it was easy to recruit participants as I found them in one place during the lecture session as lockdown restrictions were no longer in place. However, I am more than 230km away from the selected university as the research site. This distance meant I had to book a hotel for 3 three days when I came to conduct face-to-face interviews. Having to interview ten candidates wouldn't be strenuous. However, as they stayed on different campuses, it meant moving back and forth depending on the appointment agreed upon for each participant. Fortunately, in the initial proposal, I had indicated that I would also conduct interviews telephonically. Hence, the second phase of interviewing participants was done over WhatsApp, which was efficient and cheap.

Transcribing the interview audio recordings was a lengthy process, but the data obtained was enough and beneficial to answer the research questions as the interviews had been captured audibly. Since the student teachers are undergraduates who use English as a medium of learning and instruction, transcribing was not very difficult as they used English in their interpretations. Using the steps of the thematic analysis to present interview data was also time-consuming, particularly coding each transcript. Regardless, it was advantageous to classify the results meaningfully into relevant categories in the analysis and discussion chapters.

### **8.5.2 Reflections on the study from a personal and professional standpoint**

Investigating science textbooks has been of great value to me personally and professionally. The unanswered questions I had as a science teacher have been answered. The issues that troubled me as a woman since I was a high school girl have been addressed. As I explained in the problem statement, I have always wondered whether Physical Sciences textbooks impacted

girls' choice to drop Physical Sciences (as a school subject) at grade 10 and switch to non-science streams. Hence, I engaged Physical Sciences teachers in the study because I wondered if they had recognised biases of gender in Physical Sciences textbooks whilst they were still schooling as well as when they used Physical Sciences textbooks when preparing lessons for practice teaching. I wanted to find out from them the effect of the stereotypical messages from science textbooks. Their interpretations satisfied my curiosity. From student teachers' interpretations, I confirmed my anticipation that when learners see the exclusion of women scientists and represent women in inferior roles or as subordinates, they can feel like they do not have female role models in science. I have also learnt that textbooks can reinforce society's norms that hinder women's advancement and elevate men to superiority. I have also learnt how the power and the influence of patriarchy influence the presentation of science knowledge in textbooks.

I have also realised the significance of teachers as mediators of scientific knowledge. As I listened to the teachers explaining how they intended to disrupt stereotypic norms that devalue and dehumanise the status of women, I realised that teachers are agents of social change. Learners' dreams can be successful or shattered at the hands of the teacher. When I had completed my previous textbook research, I knew that I was not content because I yearned to hear if other people who engage with science textbooks recognised the biases that I identified. So, through engaging student teachers, I have been made aware that children see these discouraging messages; while some might resist the assaults, others quit the stream. Therefore, I am satisfied that teachers can be made aware of how to confront and reduce the adverse effects of stereotypes in science learning. I have become aware that the South African curriculum is not entirely decolonised because science textbooks only feature scientists from the Western part of the world. Studied textbooks did not feature African scientists.

Professionally, this study has broadened my research knowledge. Previously, I had only used CDA, and there are other CDA constructs that I had not yet been exposed to. Through this research, I learned about constructs such as claims-counterclaims, problem-solution text framing, agent-patient text framing, indexical signs and iconic signs. I have also gained the experience of working with human participants through interviews. My exposure to the realm of textbook research and the diverse methodologies employed in textbook analysis has been all-encompassing and comprehensive, leading to a significant augmentation of my research expertise. In addition, the study exposed me to the nature and role of textbooks and science textbooks, respectively.

## **8.6 Limitations of the study**

I did not consider all the stakeholders using the science textbooks I studied. For example, the learners, teachers in the field (not just student teachers) and subject advisors were not involved. Therefore, I could not gain insights into all the pedagogical issues in the science classroom. Involving learners could have given me insights into how they respond to biases I identified first-hand. The study did not involve the authors and publishers of science textbooks to get their views on socio-political factors that influence textbook production.

Furthermore, learners can switch to other non-STEM courses out of their own will, not because of textbook portrayals. For example, they may have chosen the Physical Sciences class under the influence of family, peers, or teachers from previous grades. Hence, if they realise their dreams later as they mature, they may pursue the careers they aspire to, irrespective of how gender is represented in the textbooks they use to learn.

This study's conclusions offer helpful insight, as is typical for qualitative studies. Nonetheless, the sample size is not adequate to allow for generalisability. Student teachers who participated in the study did not conduct their analysis. Possibly, they were influenced by my biases as they responded to what I only showed them. The possibility of analysts being swayed by their personal experiences and beliefs is always an eminent risk when conducting data analysis. As a researcher, I approached analysis from a particular perspective, which my social and cultural experiences may have influenced.

## **8.7 Implications of the study**

### **8.7.1 Implication to the teaching practice: Physical Sciences teachers exposing hidden curriculum**

From the results of the CDA and interview interpretations, it became apparent that biased textbooks can hinder critical and creative thinking and can destroy the self-esteem of girls, particularly during science learning. Therefore, teachers must be taught how to identify and address stereotypes in science textbooks. They should also be taught ways to interpret pictures that form part of the textbook content without involving all semiotic and linguistic analysis. Despite all reforms and transformations that have been made to make the South African curriculum culturally inclusive, the largest percentage of textbook depictions promote the maintenance of White men in power. By engaging in the study, the student teachers became

conscious of the importance of confronting and addressing stereotypical messages in science texts, which may lead to girls choosing to stay in or drop out of Physical Sciences. Without proper speculation of the textbook messages, women and girls may experience coldness in science disciplines and ultimately opt to vacate these streams.

The findings of this study, therefore, indicate that there may be an underlying reason for depicting a picture in a text passage besides transmitting content knowledge taught. Therefore, teachers and learners must interrogate the picture depicted as part of the texts to deduce the underlying reason for the text producer to include it. I further suggest that the explicit and implicit meaning of the statement in a caption above or below the picture must be established. Furthermore, learners as textbook readers should be taught simple ways to conclude what the caption below or above the picture directs them to because such textual references tend to be stereotyped. Learners should be conscientised about how conventions work.

### **8.7.2 Implication to Education Policies**

As I mentioned in Chapter 1, after 1994, policies were put in place to deal with gender inequalities in education and education material, such as the South African Schools Act of 1996 and the National Educational Policy Act of 1997. The White Paper 6 additionally contemplates the integration of a sense of inclusivity into education and educational material, which comprises cultural, gender and racial inclusivity. However, studied textbooks were culturally, gender and racially prejudiced. Therefore, education policies must be constantly reviewed to determine the extent to which their goals and objectives have been met, and if not, then devise strategies to see to it that their imperatives are implemented. The education personnel tasked to evaluate and approve textbooks need to be trained to assess what it takes for a textbook to be gender and culturally-inclusive. The fact that there were women in selected textbooks but represented in a derogatory manner may indicate that they possibly approved the textbook by only looking at whether both genders were represented without checking the how part, which reveals one gender elevated and the other subordinated.

### **8.8 Recommendations for future science textbook research**

This study engaged student teachers as participants to find out how they would pedagogically respond to gendered representations in Physical Sciences textbooks. I suggest that future research on science textbooks include learners as participants (instead of student teachers) to get their perspectives on the effects of gendered textbooks first-hand. Future researchers can

also use qualitative questionnaires and interviews to generate data from textbook authors to find out why the current science textbooks do not feature science knowledge produced by current scientists, including those of African descent, as an indication of healing our education from past injustices of Apartheid and colonial roots. This approach would facilitate the integration of both historical and current women in science.

Future researchers can use other theories to understand the intersectionality of gender, race, and class, such as theories on decolonisation of the curriculum, to provide useful insights into why science textbooks remain Eurocentric despite South Africa being independent. Qualitative approaches were implemented in this study. Therefore, it cannot be utilised for generalisation due to the inadequacy of the sample size in accurately reflecting the entirety of South African textbooks. Future researchers have the opportunity to carry out quantitative research that delves into the intricacies of gender dynamics, thereby expanding the scope and validity of their conclusions. When conducting quantitative studies, researchers often work with substantial samples, thus making it possible to draw conclusions that can be broadly applicable and relevant.

## **8.9 Conclusion**

This chapter sought to bring the study to a close by considering the progression of the research, interpreting the research findings, examining its implications for teaching practice, and proposing the potential for future research. This conclusion was presented in eight main sections, which resulted in the successful completion of the study. CDA found the studied Physical Sciences textbooks to be gendered masculine and promoted Western ideals, which implied inadequate decolonisation of the science curriculum. The interview findings indicate that student teachers can be helpful agents of curriculum decolonisation and degendering, and this was evident in their delineations of self-efficacy to disrupt gender norms and stereotypes from Physical Sciences textbooks. It was also apparent from the strategies they proposed to disrupt gender norms and negative stereotypes in science textbooks.

Teachers must recognise the effect of ideologies conveyed in school textbooks on children's sense of self. Using textbooks in the classroom can significantly affect students' self-esteem, as they can either enhance or diminish it. However, teachers carefully consider only the Annual Teaching Plan when selecting textbooks. Thus, the textbook is deemed reliable and can be a helpful tool for teachers planning lessons and students preparing for formative and summative evaluations. However, it is essential to carefully examine the presentation of gender in the

chosen textbook to make an informed decision. The CDA and interviews have demonstrated that textbook content and visuals can have varying effects on learners' motivation levels. Boys receive a more significant amount of positive messaging, while girls may face barriers or exclusion in science.

The study conducted by Ceglie and Olivares (2012) reveals that a substantial number of educators and students may be oblivious to the fact that White men originally conceived science to serve their interests, specifically to dominate others. This was recently confirmed by the study of McGee (2020) who postulates "...that STEM education and occupations are designed to attract White men who are heterosexual, abled-bodied, Christian or atheist." The Western influences presented in science textbooks pose a danger to the culture and religion of the learners. Science teachers and learners often accept the hegemonic agenda of the West (in textbooks) without hesitation, viewing it as a sign of advancement and development (McGee, 2020; Taki, 2008). Despite all reforms and transformations that have been made to make the South African curriculum culturally inclusive, the most significant percentage of textbook depictions promote the maintenance of White men in power. Without proper speculation of the textbook messages, women and girls may experience coldness in science disciplines and opt to vacate these streams.

Research has revealed that as early as the 1800s, women were practising as doctors and chemists. For example, Walsh (2009) shows us that in the mid-1800s, female medical practitioners were more likely than men to apply mammograms, cancer screening, and pap smears to treat human ailments. However, how scientists are portrayed in science textbooks can make learners and teachers believe that women were not educated in the past. The sabotaging of women continues, and it is the teachers who can help learners resist oppressive messages from print media.

Hence, learners, students, teachers and academics must be taught how to interrogate textbooks to determine their intended purpose besides the content knowledge. When the textbook may be loaded with stereotypical messages, the teachers, as agents of curriculum, must devise strategies to deal with its adverse effects without disregarding the essential scientific knowledge. Teachers need to enlighten their students that language is not limited to grammar but also a tool for expressing ideas, managing people, and manipulating what they believe or do.

These findings imply that biases in textbooks can impede students' abilities to engage in critical and inventive thought processes. Henceforth, teachers must be imparted with the necessary knowledge and skills to identify and address stereotypes prevalent in science textbooks, thereby reducing the detrimental consequences of gendered messaging perpetuated through these scholastic resources. Education policies must be consistently and meticulously evaluated to ascertain the degree to which their intended purposes have been attained. In the event of any discrepancies, it is necessary to come up with and execute suitable measures to ensure that their imperatives are met. The evaluation and approval of textbooks for educational purposes requires education personnel to be trained in identifying and promoting gender and cultural inclusivity.

## References

- Acheson, G., Holland, A., & Oettle, S. (2020). The Representation Of Women In The Photographs Of Introductory Human Geography Textbooks. *Journal Of Geography*, 119(4), 127-135.  
<https://doi.org/10.1080/00221341.2020.1765408>
- Adami, E., & Kress, G. (2014). Introduction: Multimodality, meaning-making, and the issue of “text”. *Text & Talk*, 34(3), 231-237.  
<https://doi.org/10.1515/text-2014-0007>
- Akala, B. M. (2018). Challenging gender equality in South African transformation policies - a case of the White Paper: A programme for the transformation of higher education. *South African Journal of Higher Education*, 32(3).  
<https://doi.org/10.20853/32-3-1521>
- Akpan, B. B. (2010). Innovations In Science And Technology Education Through Science Teacher Associations. *Science Education International*, 21(2), 67-79.  
[https://doi.org/10.1007/978-94-6300-749-8\\_41](https://doi.org/10.1007/978-94-6300-749-8_41)
- Al Ghazali, F. (2007). *Critical Discourse Analysis: How Can Awareness Of CDA Influence Teaching Techniques?* United Arab Emirates.
- Allan, G. (2020) Qualitative Research. In G. Allan & C. Skinner (Eds.), *Handbook for Research Students in the Social Sciences* (pp. 177-189.). Routledge.  
<https://www.taylorfrancis.com/chapters/edit/10.4324/9781003070993-18/qualitative-research-graham-allan>
- Alshehri, E. (2019). Classroom Observation for Professional Development: Views of EFL Teachers and Observers. *Arab World English Journal*, 1(1), 57-71.  
<https://doi.org/10.24093/awej/elt1.5>
- Anand, G., Larson, E. C., & Mahoney, J. T. (2020). Thomas Kuhn on Paradigms. *Production and Operations Management*, 29(7), 1650-1657. <https://doi.org/10.1111/poms.13188>
- Andrews, T. (2012). What is social constructionism? *Grounded theory review*, 11(1), 39 - 46.  
<https://doi.org/10.4324/9781315715421-1>
- Anney, V. N. (2014). Ensuring the quality of the findings of qualitative research: Looking at trustworthiness criteria. *Journal of Emerging Trends in Educational Research and Policy Studies*, 5(2), 272 - 281.  
<https://www.scirp.org/reference/referencespapers?referenceid=3077301>
- Anfara, V., A. & Mertz, N. T. (Eds.). (2014). *Theoretical frameworks in qualitative*

- research*. London: Sage Publications.
- Apple, M., & Apple, M. W. (2004). *Ideology and Curriculum*. Routledge: New York.  
<https://doi.org/10.4324/9780203487563>
- Apple, M. W. (1991). Conservative Agendas and Progressive Possibilities:: Understanding the Wider Politics of Curriculum and Teaching. *Education and Urban Society*, 23(3), 279-291. <https://doi.org/10.1177/0013124591023003005>
- Apple, M. W., & Christian-Smith, L. K. (1991). *The politics of the textbook* New York: Routledge.  
<https://doi.org/10.4324/9781315021089-1>
- Apple, M. W. (2014). Cultural Politics And The Text *Official Knowledge* (Pp. 45-66): Routledge: New York.
- Apple, M. W., & Christian-Smith, L. K. (2017). The Politics Of The Textbook. In J. Cairns (Ed.), *The Politics Of The Textbook* (Pp. 1-21): Routledge: New York.  
<https://doi.org/10.4324/9781315021089-1>
- Ar, M. (2015). Language and ideology in texts on globalization: A critical discourse analysis. *International Journal of English Linguistics*, 5(2), 63.  
<https://dx.doi.org/10.5539/ijel.v5n2p63>
- Archibald, M. M., Ambagtsheer, R. C., Casey, M. G., & Lawless, M. (2019). Using Zoom Videoconferencing for Qualitative Data Collection: Perceptions and Experiences of Researchers and Participants. *International Journal of Qualitative Methods*, 18. 160940691987459.  
<https://doi.org/10.1177/1609406919874596>
- Arnold, D. P. (2015). Critical Theory. *International Encyclopedia Of The Social & Behavioral Sciences*, 293-303.  
<https://doi.org/10.1016/b978-0-08-097086-8.63097-0>
- Asghar, J. (2013). Critical Paradigm: A Preamble For Novice Researchers. *Life Science Journal*, 10(4), 3121-3127.
- Asgharheidari, F., & Tahriiri, A. (2015). A Survey Of EFL Teachers' Attitudes Towards Critical Thinking Instruction. *Journal Of Language Teaching And Research*, 6(2), 388.  
<https://doi.org/10.17507/jltr.0602.20>
- Baehr, A. R. (2007). Liberal feminism. *FEMINIST INTERPRETATIONS Of john rawls*, 150.  
<https://www.psupress.org/books/titles/978-0-271-06179-5.html>

- Baker D.R. (2016) Equity Issues in Science Education. In: Understanding Girls. Cultural and Historical Perspectives on Science Education (Distinguished Contributors). Rotterdam: SensePublisher. [https://doi.org/10.1007/978-94-6300-497-8\\_6](https://doi.org/10.1007/978-94-6300-497-8_6)
- Balzer, W., & Moulines, C. U. (2011). *Structuralist theory of science: focal issues, new results* (Vol. 6): Walter de Gruyter.
- Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioural change. *Psychological Review*, 84(2), 191-215.  
<https://doi.org/10.1037/0033-295x.84.2.191>
- Bandura, A., Freeman, W. H., & Lightsey, R. (1999). Self-efficacy: The exercise of control. *Journal of Cognitive Psychotherapy*, 13(2), 158-166.  
<https://doi.org/10.1891/0889-8391.13.2.158>
- Banerjee, P. A. (2016). A Systematic Review Of Factors Linked To Poor Academic Performance Of Disadvantaged Students In Science And Maths In Schools. *Cogent Education*, 3(1), 1178441.  
<https://doi.org/10.1080/2331186x.2016.1178441>
- Barnard, L. (2018). Closing the gender gap in STEM. South Africa: Moneyweb Retrieved [17/ March/2018] <https://www.moneyweb.co.za/moneyweb-opinion/soapbox/closing-the-gender-gap-in-stem>.
- Barton, A., & Sakwa, L. N. (2012). The representation of gender in English textbooks in Uganda. *Pedagogy, Culture & Society*, 20(2), 173-190.  
<https://doi.org/10.1080/14681366.2012.669394>
- Bartlett, S., & Burton, D. (2020). *Introduction to Education Studies*: New York: Sage.
- Bates, T. R. (1975). Gramsci and the Theory of Hegemony. *Journal of the History of Ideas*, 36(2), 351-366.  
<https://doi.org/10.2307/2708933>
- Baxter, J. (2002). A juggling act: A feminist post-structuralist analysis of girls' and boys' talk in the secondary classroom. *Gender and Education*, 14(1), 5-19.
- Baxter, J. (2015). Feminist Poststructural Discourse Analysis. *The International Encyclopedia of Language and Social Interaction*.  
<https://doi.org/10.1002/9781118611463.wbielsi020>
- Baxter, J. (2016). Positioning Language And Identity: Poststructuralist Perspectives *The Routledge Handbook Of Language And Identity* (Pp. 60-75): Routledge: New York
- Baxter, J. (2018). The Feminist Agenda Spectrum. *Women Leaders and Gender Stereotyping in the UK Press*, 51-73.

[https://doi.org/10.1007/978-3-319-64328-1\\_3](https://doi.org/10.1007/978-3-319-64328-1_3)

Baxter, J. A. (2008). *Feminist Post-Structuralist Discourse Analysis: A New Theoretical And Methodological Approach?* : Palgrave Macmillan.

<https://www.palgrave.com/products/title.aspx?pid=280346>

Bazerman, C. (2003). Intertextuality: How texts rely on other texts *What writing does and how it does it* (pp. 89-102): Routledge.

Becker, M. L., & Nilsson, M. R. (2021). College chemistry textbooks fail on gender representation. *Journal of Chemical Education*, 98(4), 1146-1151.

<https://pubs.acs.org/doi/abs/10.1021/acs.jchemed.0c01037>

Beede, D. N., Julian, T. A., Langdon, D., McKittrick, G., Khan, B., & Doms, M. E. (2011). Women in STEM: A Gender Gap to Innovation. *SSRN Electronic Journal*.

<https://doi.org/10.2139/ssrn.1964782>

Bell, C. A., Dobbelaer, M. J., Klette, K., & Visscher, A. (2019). Qualities Of Classroom Observation Systems. *School Effectiveness And School Improvement*, 30(1), 3-29.

<https://doi.org/10.1080/09243453.2018.1539014>

Bell, L. C. (2018). Psychoanalytic theories of gender. *Gender, Sex, and Sexualities: Psychological Perspectives*, 195.

<https://doi.org/10.1093/oso/9780190658540.003.0009>

Berger, A. A. (2018). *Media And Communication Research Methods: An Introduction To Qualitative And Quantitative Approaches*: Sage Publications.

Beukeboom, C. J., & Burgers, C. (2017). Linguistic Bias. *Oxford Research Encyclopedia of Communication*.

<https://doi.org/10.1093/acrefore/9780190228613.013.439>

Beukeboom, C. J., Forgas, J., Vincze, O., & Laszlo, J. (2014). Mechanisms Of Linguistic Bias: How Words Reflect And Maintain Stereotypic Expectancies. *Social Cognition And Communication*, 31, 313-330.

Biemmi, I. (2015). Gender In Schools And Culture: Taking Stock Of Education In Italy. *Gender And Education*, 27(7), 812-827.

<https://doi.org/10.1080/09540253.2015.1103841>

Blackstone, B., Spiri, J., & Naganuma, N. (2007). Pedagogical Uses And Student Interpretations. *Reflection On English Language Teaching*, 6(2), 1-20.

- Blumberg, R. L. (2008). Gender Bias In Textbooks: A Hidden Obstacle On The Road To Gender Equality In Education. *Paper Commissioned For The EFA Global Monitoring Report*.
- Blumberg, R. L. (2015). Eliminating Gender Bias In Textbooks: Pushing For Policy Reforms That Promote Gender Equity In Education. *Background Paper For EFA Global Monitoring Report*.
- Botella, C., Rueda, S., López-Iñesta, E., & Marzal, P. (2019). Gender Diversity In STEM Disciplines: A Multiple Factor Problem. *Entropy*, 21(1), 30.  
<https://doi.org/10.3390/e21010030>
- Bourdieu, P. (2003). Cultural Reproduction And Social Reproduction. *London: Tavistock*, 178, 71-112.
- Bourdieu, P. (2018). Cultural Reproduction And Social Reproduction. *Knowledge, Education, and Cultural Change*, 71-112.  
<https://doi.org/10.4324/9781351018142-3>
- Bourke, B. (2014). Positionality: Reflecting On The Research Process. *The Qualitative Report*, 19(33), 1-9.  
<https://doi.org/10.46743/2160-3715/2014.1026>
- Bowden, C., & Galindo-Gonzalez, S. (2015). Interviewing when you're not face-to-face: The use of email interviews in a phenomenological study. *International Journal of Doctoral Studies*, 10, 79-92.  
<https://doi.org/10.28945/2104>
- Braun, V., & Clarke, V. (2012). *Thematic Analysis*: American Psychological Association.
- Breda, T., Grenet, J., Monnet, M., & Van Effenterre, C. (2018). Do Female Role Models Reduce the Gender Gap in Science? Evidence from French High Schools. *SSRN Electronic Journal*.  
<https://doi.org/10.2139/ssrn.3584926>
- Brickell, C. (2006). The sociological construction of gender and sexuality. *The Sociological Review*, 54(1), 87-113.  
<https://doi.org/10.1111/j.1467-954x.2006.00603.x>
- Brooks, J., Horrocks, C., & King, N. (2018). *Interviews in qualitative research*. London: Sage Publications Ltd.
- Brugelles, C., & Cromer, S. (2009). In UNESCO. *Promoting Gender Equality Through Textbooks. A Methodological Guide*.

- Bruillard, É. (2011). *Current textbook research in France: An overview*. Paper presented at the Proceedings of the international textbook symposium, ITS.
- Buford, S. L. (2018). "The Weaker Vessels": The Perpetuation Of Traditional Gender Roles In The Patriarchal Society Of Shakespeare's Romeo And Juliet. *Journal Of Creative Inquiry*, 2(1).
- Burgers, C., Brugman, B. C., Renardel de Lavalette, K. Y., & Steen, G. J. (2016). HIP: A Method for Linguistic Hyperbole Identification in Discourse. *Metaphor and Symbol*, 31(3), 163-178.  
<https://doi.org/10.1080/10926488.2016.1187041>
- Burr, V. (2015). Social Constructionism. <https://doi.org/10.4324/9781315715421>
- Burrell, G., & Morgan, G. (2019). *Sociological paradigms and organisational analysis: Elements of the sociology of corporate life*. London: Routledge.
- Bussey, K., & Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychological review*, 106(4), 676-113.  
<https://doi.org/10.1037/0033-295X.106.4.676>
- Butler, J. (2011). *Gender Trouble, Feminism And The Subversion Of Identity (Thinking Gender)*: Routledge New York.
- Butler, J. (2013). *Gender As Performance A Critical Sense* (Pp. 109-125): Routledge.
- Bystydzienski, J. M., & Brown, A. (2012). "I Just Want to Help People": Young Women's Gendered Engagement with Engineering. *Feminist Formations*, 24(3), 1-21.  
<https://doi.org/10.1353/ff.2012.0027>
- Cairns, J., & Inglis, B. (1989). A Content Analysis of Ten Popular History Textbooks for Primary Schools with Particular Emphasis on the Role of Women. *Educational Review*, 41(3), 221-226.  
<https://doi.org/10.1080/0013191890410302>
- Cap, P. (2016). Text, Discourse, Function: Ways into Pragmatics for Philology Students. *Studia kulturoznawczo-filologiczne*, 65.
- Cappy, C. L. (2016). Shifting the future? Teachers as agents of social change in South African secondary schools. *Education as Change*, 20(3).  
<https://doi.org/10.17159/1947-9417/2016/1314>
- Cárcamo, C., Moreno, A., & del Barrio, C. (2021). Girls Do Not Sweat: the Development of Gender Stereotypes in Physical Education in Primary School. *Human Arenas*, 4(2), 196-217.

<https://doi.org/10.1007/s42087-020-00118-6>

Carey, M., Jackson, M., Antonello, A., & Rushing, J. (2016). Glaciers, gender, and science: A feminist glaciology framework for global environmental change research. *Progress in Human Geography*, 40(6), 770-793.

<https://doi.org/10.1177/0309132515623368>

Casad, B. J., Franks, J. E., Garasky, C. E., Kittleman, M. M., Roesler, A. C., Hall, D. Y., & Petzel, Z. W. (2021). Gender Inequality In Academia: Problems And Solutions For Women Faculty In STEM. *Journal Of Neuroscience Research*, 99(1), 13-23.

<https://doi.org/10.1002/jnr.24631>

Catalano, T., & Waugh, L. R. (2020). Critical Discourse Analysis, Critical Discourse Studies and Beyond. Perspectives in Pragmatics, Philosophy & Psychology.

<https://doi.org/10.1007/978-3-030-49379-0>

Ceglie, R., & Olivares, V. (2012). Representation of Diversity in Science Textbooks. *Constructing Knowledge*, 49-68.

[https://doi.org/10.1007/978-94-6091-912-1\\_4](https://doi.org/10.1007/978-94-6091-912-1_4)

Chambers, C. (2005). Masculine domination, radical feminism and change. *Feminist Theory*, 6(3), 325-346.

<https://doi.org/10.1177/1464700105057367>

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why Are Some STEM Fields More Gender Balanced Than Others? *Psychological Bulletin*, 143(1), 1-35.

<https://doi.org/10.1037/bul0000052>

Chiponda, A., & Wassermann, J. (2015). An analysis of the visual portrayal of women in junior secondary Malawian school history textbooks. *Yesterday and Today*(14), 208-237.

<https://doi.org/10.17159/2223-0386/2015/nl4a9>

Chilisa, B., & Preece, J. (2005) *Research Methods for Adult Educators in Africa*. Pearson Education, Cape Town.

<https://www.scirp.org/reference/referencespapers?referenceid=2288023>

Chouliaraki, L., & Fairclough, N. (2010). Critical Discourse Analysis in Organizational Studies: Towards an Integrationist Methodology. *Journal of Management Studies*, 47(6), 1213-1218.

<https://doi.org/10.1111/j.1467-6486.2009.00883.x>

Clark Blickenstaff, J. (2005). Women And Science Careers: leaky pipeline or gender filter? *Gender And Education*, 17(4), 369-386.

<https://doi.org/10.1080/09540250500145072>

- Clyton, D., & Moses, K. (2017). Implementation Of STEM Curriculum In Rural Secondary Schools In Zimbabwe: Limits And Possibilities. *Journal Of Emerging Trends In Educational Research And Policy Studies (JETERAPS)*, 8(1), 11-15.
- Coetzee, D. (2001). South African Education And The Ideology Of Patriarchy. *South African Journal Of Education*, 21(4), 300-304.
- Cohen, B., Manion, C., & Morrison, A. (2007). Essentials Of Education And Social Science Research Methods. *Canada: Masolp Publishers*, 45-50.
- Cohen, J. W., & Harvey, P. J. (2007). Misconceptions of gender: Sex, masculinity, and the measurement of crime. *The Journal of Men's Studies*, 14(2), 223-233.
- Cohen, L., Manion, L., & Morrison, K. (2013). The ethics of educational and social research *Research methods in education* (pp. 99-128): Routledge.
- Cole, W. M. (2016). Convention on the Elimination of All Forms of Discrimination against Women ( CEDAW ). *The Wiley Blackwell Encyclopedia of Gender and Sexuality Studies*.
- <https://doi.org/10.1002/9781118663219.wbegss274>
- Colglazier, W. (2015). Sustainable development agenda: 2030. *Science*, 349(6252), 1048-1050.
- <https://doi.org/10.1126/science.aad2333>
- Cocoradă, E. (2018). Gender Stereotypes In School Textbooks. *Revista Românească Pentru Educație Multidimensională*, 10(4), 65-81.
- <https://doi.org/10.18662/rrem/73>
- Connell, R. (2009). *Gender* (Vol. 14): Polity.
- Connell, R. W. (2005). *Masculinities*. Cabrimdge, UK: Polity.
- Connell, R. (2015). An iron ManM: The body and some contradictions of hegemonic masculinity. In *Sociological perspectives on sport* (pp. 141-149). UK: Routledge.
- Connell, R. W., & Messerschmidt, J. W. (2005). Hegemonic Masculinity: Rethinking The Concept. *Gender & Society*, 19(6), 829-859.
- <https://doi.org/10.1177/0891243205278639>
- Cook, R. J. (2012). *Human Rights Of Women: National And International Perspectives*: University Of Pennsylvania Press.
- Cortes, P., & Pan, J. (2018). Occupation and Gender. *The Oxford Handbook of Women and the Economy*, (pp. 424-452).
- <https://doi.org/10.1093/oxfordhb/9780190628963.013.12>

- Creamer, T. (2018). What South Africa Could Gain From Having More Women In STEM? *Creamer Media's Engineering News*. Retrieved [5/July/2018] From [www.Engineering.Co.Za/Article/What -South-Africa](http://www.Engineering.Co.Za/Article/What-South-Africa)
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. Los Angeles: Sage publications
- Creswell, J. W., Hanson, W. E., Clark Plano, V. L., & Morales, A. (2007). Qualitative Research Designs: Selection And Implementation. *The Counseling Psychologist*, 35(2), 236-264.  
<https://doi.org/10.1177/0011000006287390>
- Creswell, J. W., & Poth, C. N. (2016). *Qualitative Inquiry And Research Design: Choosing Among Five Approaches*: Sage Publications.
- Croucher, S. M., & Cronn-Mills, D. (2014). The Critical Paradigm *Understanding Communication Research Methods* (Pp. 67-80): Routledge.
- Cubas, A. L. V., Kemper, M., Rita, R. M., Cembranel, P., & Osório, J. B. S. (2022). Women In Science.
- D'Souza, L. (2015). Study on The Relationship With Shyness And Academic Stress among engineering students. *International Journal of Psychology And Psychiatry*, 3(2), 9.  
<https://doi.org/10.5958/2320-6233.2015.00011.5>
- Daempfle, P. A. (2003). An analysis of the High Attrition Rates among First Year College Science, Math, and Engineering Majors. *Journal of College Student Retention: Research, Theory & Practice*, 5(1), 37-52.  
<https://doi.org/10.2190/dwqt-tya4-t20w-rcwh>
- Dawar, T., & Anand, S. (2017). Gender Bias in Textbooks across The World. *International Journal of Applied Home Science*, 4, 224-235.
- DBE. (2011). *Department of Basic Education. NCS Curriculum Assessment Policy Statements (CAPS)*. South Africa: Government Printers Pretoria.
- de Jesus Ferreira, A. (2019). SOCIAL IDENTITIES OF BLACK FEMALES IN ENGLISH LANGUAGE TEXTBOOKS USED IN BRAZIL AND CAMEROON: INTERSECTIONALITIES OF RACE, GENDER, SOCIAL CLASS AND CRITICAL RACIAL LITERACY. *Revista X*, 14(4), 20.  
<https://doi.org/10.5380/rvx.v14i4.66191>
- De Wet, C. (2011). A History of Schooling in South Africa: Method and Context, JJ Booyse, CS le Roux, J. Seroto and CC Wolhuter: Book Review. *Southern African Review of Education with Education with Production*, 17(1), 159-161.

- Denzin, N. K., & Giardina, M. D. (2020). *Qualitative Inquiry and the Politics of Resistance*.  
<https://doi.org/10.4324/9780429316982>
- Denzin, N. K., & Giardina, M. D. (2016). *Qualitative Inquiry and The Conservative Challenge*: Routledge.
- DoE, R.S.A. (2001). *Education white paper 6: Special needs education: Building an inclusive education and training system*: Department of Education Pretoria.  
<http://hdl.voced.edu.au/10707/99068>.
- Dore, M. (2020). Revoicing Otherness and Stereotypes via Dialects and Accents in Disney's Zootopia and its Italian dubbed version'. *Gueyer, K. & Dore, M.(forthcoming). New Perspectives in Dialects and Multimedia. Special issue of InTRAlinea*.
- Doughman, J., Khreich, W., El Gharib, M., Wiss, M., & Berjawi, Z. (2021). Gender Bias in Text: Origin, Taxonomy, and Implications. Proceedings of the 3rd Workshop on Gender Bias in Natural Language Processing.  
<https://doi.org/10.18653/v1/2021.gebnlp-1.5>
- Downey, J., Titley, G., & Toynbee, J. (2014). Ideology critique: the challenge for media studies. *Media, Culture & Society*, 36(6), 878-887.  
<https://doi.org/10.1177/0163443714536113>
- Drapeau, M. (2015). Subjectivity in research: Why not? But.... *The Qualitative Report*.  
<https://doi.org/10.46743/2160-3715/2002.1972>
- Du Plessis, P. (2021). Decolonisation of education in South Africa: Challenges to decolonise the university curriculum. *South African Journal of Higher Education*.  
<https://doi.org/10.20853/35-1-4426>
- Du Preez, H. (2012). Dr James Barry (1789–1865): The Edinburgh Years. *JR Coll Physicians Edinb*, 42(3), 258-265.
- Duda-Mikulín, E. A. (2023). Brexit and Precarity: Polish female Workers in the UK as Second-Class Citizens? *Sociology Compass*, 17(1), e13038.
- Durrani, N., & Halai, A. (2018). Dynamics of Gender Justice, Conflict and Social Cohesion: Analysing Educational reforms in Pakistan. *International Journal of Educational Development*, 61, 27-39.  
<https://doi.org/10.1016/j.ijedudev.2017.11.010>
- Eagle, C. T., & Sloan, J. (1998). Marie Anne Paulze Lavoisier: the mother of modern chemistry. *The Chemical Educator*, 3, 1-18.
- Eaton, K., Stritzke, W. G., & Ohan, J. L. (2019). Using Scribes in Qualitative Research as an Alternative to Transcription. *The Qualitative Report*.

- <https://nsuworks.nova.edu/tqr/vol24/iss3/12>
- Edirisingha, P. (2012). Interpretivism and positivism (ontological and epistemological perspectives). *Research Paradigms and Approaches*  
<https://prabash78.wordpress.com/2012/03/14/interpretivism-and-positivism-ontological-and-epistemological-perspectives/>
- Education, D. O. (2010). Curriculum Assessment Policy Statement (CAPS).  
[\[www.education.gov.za/Curriculum/NCS/GradesR12/CAPS/\]](http://www.education.gov.za/Curriculum/NCS/GradesR12/CAPS/)
- Ellis, J., Fosdick, B. K., & Rasmussen, C. (2016). Women 1.5 times more likely to leave STEM pipeline after calculus compared to men: Lack of mathematical confidence a potential culprit. *PloS one*, *11*(7), e0157447.  
<https://doi.org/10.1371/journal.pone.0157447>
- Eng, A., 't Mannelje, A., McLean, D., Ellison-Loschmann, L., Cheng, S., & Pearce, N. (2011). Gender differences in occupational exposure patterns. *Occupational and Environmental Medicine*, *68*(12), 888-894.  
<https://doi.org/10.1136/oem.2010.064097>
- Engelbrecht, A. (2006). Textbooks in South Africa from Apartheid to post-Apartheid: Ideological change revealed by racial stereotyping. *Promoting social cohesion through education: Case studies and tools for using textbooks and curricula*, 71-80.
- Erickson-Schroth, L., & Jacobs, L. A. (2017). *"You're in the Wrong Bathroom!": And 20 Other Myths and Misconceptions About Transgender and Gender-Nonconforming People*: Beacon Press.
- Espi, G., Francis, D., & Valodia, I. (2019). Gender inequality in the South African labour market: Insights from the Employment Equity Act data. *Agenda*, *33*(4), 44-61.  
<https://doi.org/10.1080/10130950.2019.1674675>
- Fairbanks, C. M., Freedman, D., & Kahn, C. (2000). The role of effective mentors in learning to teach. *Journal of teacher education*, *51*(2), 102-112.
- Fairclough, N. (1996). A reply to Henry Widdowson's 'Discourse analysis: a critical view'. *Language and literature*, *5*(1), 49-56.
- Fairclough, N. (2013). *Critical Discourse Analysis*.  
<https://doi.org/10.4324/9781315834368>
- Fairclough, N. (2014). *Critical Language Awareness*.  
<https://doi.org/10.4324/9781315845661>
- Fairclough, N. (2015). *Dialectical Reasoning in Critical Social Analysis and Critical Discourse Analysis* (pp. 101-115). England: Lancaster University.

- Finkel, E. A. (1993). *The construction of science in a high school genetics class: The University of Wisconsin-Madison.*
- Fitzgibbon, L. (2013). Ideologies and power relations in a global commercial English language textbook used in South Korean universities: A critical image analysis and a critical discourse analysis. *Unpublished PhD dissertation. University of Queensland.*
- Flores, P., Gómez, N. R., Roa, A. F., & Whitson, R. (2020). Reviving feminism through social media: from the classroom to online and offline public spaces. *Gender and Education, 32*(6), 751-766.  
<https://doi.org/10.1080/09540253.2018.1513454>
- Flowerdew, J. (2008). 13 Critical discourse analysis and strategies of resistance. *Advances in discourse studies, 195.*  
[https://www.researchgate.net/publication/291831955\\_Critical\\_discourse\\_analysis\\_and\\_strategies\\_of\\_resistance](https://www.researchgate.net/publication/291831955_Critical_discourse_analysis_and_strategies_of_resistance)
- Foroutan, Y. (2012). Gender representation in school textbooks in Iran: The place of languages. *Current Sociology, 60*(6), 771-787.  
<https://doi.org/10.1177/0011392112459744>
- Foulds, K. (2013). The continua of identities in postcolonial curricula: Kenyan students' perceptions of gender in school textbooks. *International Journal of Educational Development, 33*(2), 165-174.  
<https://doi.org/10.1016/j.ijedudev.2012.03.005>
- Foster, S. (2011). Dominant traditions in international textbook research and revision. *Education Inquiry, 2*(1), 5 - 20.  
<https://doi.org/10.3402/edui.v2i1.21959>
- Fraser, N., & Jaeggi, R. (2018). *Capitalism: A conversation in critical theory.* Cambridge, UK: Polity Press.
- Fuchs, C. (2021). What is Critical Theory? *Foundations of Critical Theory, 17-51.*  
<https://doi.org/10.4324/9781003199182-2>
- Galbin, A. (2014). An introduction to social constructionism. *Social Research Reports (26), 82-92.* Expert Projects Publishing House  
[https://www.researchreports.ro/images/researchreports/social/srr\\_2014\\_vol026\\_004](https://www.researchreports.ro/images/researchreports/social/srr_2014_vol026_004)
- Gandhi, H., & Singh, V. (2018). *Block-3 Curriculum Engagement in Schools.* New Dehli: IGNOU.

- Garfinkel, H. (2005). *Ethnomethodological Studies of Work*.  
<https://doi.org/10.4324/9780203996867>
- Gastil, J. (1990). Generic pronouns and sexist language: The oxymoronic character of masculine generics. *Sex Roles*, 23(11-12), 629-643.  
<https://doi.org/10.1007/bf00289252>
- Gillborn, D. (2015). Intersectionality, critical race theory, and the primacy of racism: Race, class, gender, and disability in education. *Qualitative inquiry*, 21(3), 277-287.  
<https://doi.org/10.1177/1077800414557827>
- Gimenez, M. E. (2018). Marxism and Class, Gender and Race: Rethinking the Trilogy. *Marx, Women, and Capitalist Social Reproduction*, 82-93.  
[https://doi.org/10.1163/9789004291560\\_005](https://doi.org/10.1163/9789004291560_005)
- Goertz, G., & Mahoney, J. (2012). Concepts and measurement: Ontology and epistemology. *Social Science Information*, 51(2), 205-216.  
<https://doi.org/10.1177/0539018412437108>
- Gottfried, H. (2008). Reflections on intersectionality: Gender, class, race and nation. *Journal of Gender Studies*, 11(1), 23-40.
- Gould, E. S. (1992). Gender-specific occupational role models implications for music educators. *Update: Applications of research in music education*, 11(1), 8-12.  
<https://doi.org/10.1177/875512339201100103>
- Goy, S. C., Wong, Y. L., Low, W. Y., Noor, S. N. M., Fazli-Khalaf, Z., Onyeneho, N., Daniel, E., Azizan, S., Hasbullah, M., & GinikaUzoigwe, A. (2018). Swimming against the tide in STEM education and gender equality: a problem of recruitment or retention in Malaysia. *Studies in Higher Education*, 43(11), 1793-1809.  
<https://doi.org/10.1080/03075079.2016.1277383>
- Gray, M. M., Kittilson, M. C., & Sandholtz, W. (2006). Women and Globalization: A Study of 180 Countries, 1975-2000. *International Organization*, 60(02).  
<https://doi.org/10.1017/s0020818306060176>
- Guba, E. G. (1981) Criteria for assessing the trustworthiness of naturalistic inquiries. *ECTJ* 29, 75–91 (1981).  
<https://doi.org/10.1007/BF02766777>
- Gunawan, I., Eri Kusumaningrum, D., Triwiyanto, T., Zulkarnain, W., & Nurabadi, A. (2018). Hidden Curriculum and its Relationship with the Student Character Building. Proceedings of the 3rd International Conference on Educational Management and Administration (CoEMA 2018).

<https://doi.org/10.2991/coema-18.2018.3>

Gutiérrez-Martínez, I., M. Saifuddin, S., & Haq, R. (2021). The United Nations Gender Inequality Index. *Handbook on Diversity and Inclusion Indices*.

<https://doi.org/10.4337/9781788975728.00013>

Halliday, M. A. K., & Matthiessen, C. M. I. M. (2013). Halliday's Introduction to Functional Grammar.

<https://doi.org/10.4324/9780203431269>

Hamidah, S. C. (2017). THE REPRESENTATION OF GENDER IDEOLOGY IN INDONESIAN TEXTBOOKS. *ISLLAC: Journal of Intensive Studies on Language, Literature, Art, and Culture*, 1(1).

<https://doi.org/10.17977/um006v1i12017p201>

Hannan, C. (2000). *Promoting equality between women and men in bilateral development cooperation: Concepts, goals, rationales and institutional arrangements. Part One. Theory, practice and priorities for change. Part Two. Empirical studies in two sectors in Tanzania: Household water supplies and health development* (No. 138). Lund University.

Hansson, L. (2018). Science Education, Indoctrination, and the Hidden Curriculum. *Science: Philosophy, History and Education*, 283-306.

[https://doi.org/10.1007/978-3-319-62616-1\\_11](https://doi.org/10.1007/978-3-319-62616-1_11)

Haramis, R. D. (2017). *Mathematics, Engineering, Science, Achievement (MESA) and Student Persistence in Science, Technology, Engineering, and Mathematics (STEM) Activities and Courses: The Perceptions of MESA Teacher Advisors in the Effectiveness of Increasing Public Middle School Educationally Disadvantaged Students' Interest in STEM*. University of Southern California.

Hardt, D., Nagler, M., & Rincke, J. (2022). Can peer mentoring improve online teaching effectiveness? An RCT during the COVID-19 pandemic. *Labour Economics*, 78, 102220.

Hay, D., & Monnapula-Mapesela, M. (2009). South African Education Before and After 1994. *Higher Education in South Africa - A scholarly look behind the scenes*, 3-20.

<https://doi.org/10.18820/9781920338183/01>

Hayat, A. A., Shateri, K., Amini, M., & Shokrpour, N. (2020). Relationships between academic self-efficacy, learning-related emotions, and metacognitive learning strategies with academic performance in medical students: a structural equation model. *BMC Medical Education*, 20(1).

<https://doi.org/10.1186/s12909-020-01995-9>

Healy-Clancy, M. (2017). Women and Apartheid. *Oxford Research Encyclopedia of African History*.

<https://doi.org/10.1093/acrefore/9780190277734.013.184>

Hill, C., Corbett, C., & St Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics*: ERIC.

Hill, Z., Tawiah-Agyemang, C., Kirkwood, B., & Kendall, C. (2022). Are verbatim transcripts necessary in applied qualitative research: experiences from two community-based intervention trials in Ghana. *Emerging Themes in Epidemiology*, 19(1).

<https://doi.org/10.1186/s12982-022-00115-w>

Hoadley, U., & Jansen, J. D. (2009). *Curriculum: Organizing knowledge for the classroom*: Oxford University Press Southern Africa.

Holbrook, J., & Cavas, B. (2012). International Council of Associations for Science Education (ICASE).

Holmes, E. A., & Mathews, A. (2010). Mental imagery in emotion and emotional disorders. *Clinical psychology review*, 30(3), 349-362.

<https://doi.org/10.1016/j.cpr.2010.01.001>

Holmes, J. (2009). Men, Masculinities and Leadership: Different Discourse Styles at Work. *Gender and Spoken Interaction*, 186-210.

[https://doi.org/10.1057/9780230280748\\_9](https://doi.org/10.1057/9780230280748_9)

Holmes, J., & Schnurr, S. (2006). 'Doing femininity' at work: More than just relational practice<sup>1</sup>. *Journal of Sociolinguistics*, 10(1), 31-51.

<https://doi.org/10.1111/j.1360-6441.2006.00316.x>

Holmes, R. (2020). *The secret life of Dr James Barry: Victorian England's most eminent surgeon*: Bloomsbury Publishing.

Hom, E. J. (2014). What is STEM education? USA: Live Science

<https://www.livescience.com/43296-what-is-stem-education.html>.

Honneth, A. (2008). Critical theory *The Routledge companion to twentieth-century philosophy* (pp. 800-829): Routledge.

Horkheimer, M. (1972). Traditional and critical theory. *Critical theory: Selected essays*, 188(243), 1-11.

- Hoveid, M. H., Ciolan, L., Paseka, A., & Marques da Silva, S. (2019). Doing Educational Research: Overcoming Challenges In Practice.  
<https://doi.org/10.4135/9781526482457>
- How, A. (2017). *Critical theory*: Macmillan International Higher Education.
- Huckin, T. N. (1997). Critical discourse analysis. *Functional approaches to written text: Classroom applications*, 87-92.
- Hughes, E. C. (1945). Dilemmas and contradictions of status. *American Journal of Sociology*, 50(5), 353-359.  
<https://doi.org/10.1086/219652>
- Hutchinson, M. V. (2020). *Discourses of entrepreneurship in contemporary commerce textbooks in secondary schools in selected Southern African Development Community (SADC) Countries* (Doctoral dissertation).
- Huyer, S. (2015). Is the gender gap narrowing in science and engineering? *UNESCO science report: towards, 2030*, 85.
- Idahosa, G. E.-o., & Mkhize, Z. (2021). Intersectional Experiences of Black South African Female Doctoral Students in STEM: Participation, Success and Retention. *Agenda*, 35(2), 110-122.  
<https://doi.org/10.1080/10130950.2021.1919533>
- Islam, K. M. M., & Asadullah, M. N. (2018). Gender Stereotypes and Education: A Comparative Content Analysis of Malaysian, Indonesian, Pakistani and Bangladeshi School Textbooks. *PloS one*, 13(1), e0190807.  
<https://doi.org/10.1371/journal.pone.0190807>
- Jacobs, K. (2021). Discourse Analysis. *Methods in Urban Analysis*, 151-172.  
[https://doi.org/10.1007/978-981-16-1677-8\\_9](https://doi.org/10.1007/978-981-16-1677-8_9)
- Jenkins, J., & Finneman, T. (2018). Gender trouble in the workplace: applying Judith Butler's theory of performativity to news organizations. *Feminist Media Studies*, 18(2), 157-172.  
<https://doi.org/10.1080/14680777.2017.1308412>
- Joyce, B. (2015). The first US history textbooks: Constructing and disseminating the American tale in the nineteenth century: Lexington Books.
- Kalpazidou Schmidt, E., & Cacace, M. (2017). Addressing gender inequality in science: the multifaceted challenge of assessing impact. *Research Evaluation*, 26(2), 102-114.  
<https://doi.org/10.1093/reseval/rvx003>

- Kamasak, R., Ozbilgin, M., & Atay, D. (2019). The Cultural Impact of Hidden Curriculum on Language Learners: A Review and Some Implications for Curriculum Design. *Beyond Language Learning Instruction*, 104-125.  
<https://doi.org/10.4018/978-1-7998-1962-2.ch005>
- Karten, T. J. (2015). *Inclusion Strategies That Work!: Research-Based Methods for the Classroom*.  
<https://doi.org/10.4135/9781483384900>
- Keddie, A. (2012). *Educating for diversity and social justice*. UK: Routledge.
- Kentli, F. D. (2009). Comparison of hidden curriculum theories. *European Journal of educational studies*, 1(2), 83-88.
- Khoza, S. B., & Fomunyam, K. G. (2020). Theorising Curriculum Approaches and Praxis. *Curriculum Theory, Curriculum Theorising, and the Theoriser*, 1-11.  
[https://doi.org/10.1163/9789004447943\\_001](https://doi.org/10.1163/9789004447943_001)
- Killam, L. (2013). *Research terminology simplified: Paradigms, axiology, ontology, epistemology and methodology*: Laura Killam.
- Killpack, T. L., & Melón, L. C. (2016). Toward inclusive STEM classrooms: what personal role do faculty play? *CBE—Life Sciences Education*, 15(3), es3.  
<https://doi.org/10.1187/cbe.16-01-0020>
- Kress, G., & van Leeuwen, T. (2020). *Reading images: The grammar of visual design*. London: Routledge.  
<https://doi.org/10.4324/9781003099857>
- Lawlor, T. M., & Niiler, T. (2020). Physics textbooks from 1960–2016: A history of gender and racial bias. *The Physics Teacher*, 58(5), 320-323.
- Lawrence, W. P. W. (2011). Textbook evaluation: A framework for evaluating the fitness of the Hong Kong new secondary school (NSS) curriculum. *Hong Kong*.
- Lazar, M. (2005). *Feminist Critical Discourse Analysis: Gender, power and ideology in discourse*. New York: Springer.
- Leal Filho, W., Kovaleva, M., Tsani, S., Țîrcă, D.-M., Shiel, C., Dinis, M. A. P., Nicolau, M., Sima, M., Fritzen, B., Lange Salvia, A., Minhas, A., Kozlova, V., Doni, F., Spiteri, J., Gupta, T., Wakunuma, K., Sharma, M., Barbir, J., Shulla, K., ... Tripathi, S. (2023). Promoting gender equality across the sustainable development goals. *Environment, Development and Sustainability*, 25(12), 14177-14198.  
<https://doi.org/10.1007/s10668-022-02656-1>

- Lee, J. F. K. (2014). A hidden curriculum in Japanese EFL textbooks: Gender representation. *Linguistics and Education*, 27, 39-53.  
<https://doi.org/10.1016/j.linged.2014.07.002>
- Lee, J. F. K., & Chin, A. C. O. (2021). Constructing gender using visual imagery -a study of early readers. *Language & Communication*, 78, 1-18.  
<https://doi.org/10.1016/j.langcom.2021.01.005>
- Lee, J. F. K., & Collins, P. (2010). Construction of gender: a comparison of Australian and Hong Kong English language textbooks. *Journal of Gender Studies*, 19(2), 121-137.  
<https://doi.org/10.1080/09589231003695856>
- Lee, J. F.K., & Mahmoudi-Gahrouei, V. (2020) Gender Representation in Instructional Materials: A Study of Iranian English Language Textbooks and Teachers' Voices. *Sexuality & Culture* 24, 1107–1127.  
<https://doi.org/10.1007/s12119-020-09747-z>
- Lemon, L., & Hayes, J. (2020). Enhancing Trustworthiness of Qualitative Findings: Using Leximancer for Qualitative Data Analysis Triangulation. *The Qualitative Report*.  
<https://doi.org/10.46743/2160-3715/2020.4222>
- Letourneau, S. M., & Bennett, D. (2020). Using narratives to evoke empathy and support girls' engagement in engineering. *Connected science learning*, 3(3).
- Liamputtong, P. (2020). *Qualitative research methods*. Docklands, Vic: Oxford University Press.
- Lincoln, Y. S., & Guba, E. G. (1986). But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. *New directions for program evaluation*, 1986(30), 73-84.  
<https://doi.org/10.1002/ev.1427>
- Lincoln, Y. S., & Guba, E. G. (2000). Paradigmatic controversies, contradictions, and emerging confluences. In N. K. Denzin, & Y. S. Lincoln (Eds.), *The handbook of qualitative research (2nd ed., pp. 1065-1122)*, Thousand Oaks, CA: Sage Publications.
- Lindlof, T. R., & Taylor, B. C. (2017). *Qualitative communication research methods*: Sage publications.
- Lindsey, L. L. (2015). The sociology of gender. *Gender roles: A sociological perspective*. New York: Routledge.  
<https://doi.org/10.4324/9781315664095>
- Loughran, J. (2019). Pedagogical reasoning: The foundation of the professional knowledge of teaching. *Teachers and Teaching*, 25(5), 523-535.

<https://doi.org/10.1080/13540602.2019.1633294>

- Lorber, J. (1994). *Paradoxes of gender*. New Haven, CT: Yale University Press.
- Lorber, J. (2000). Using Gender to Undo Gender: A Feminist Degendering Movement. *Feminist Theory*, 1(1), 79-95.  
<https://doi.org/10.1177/14647000022229074>
- Lorber, J. (2018). Paradoxes of Gender Redux. *Gender Reckonings: New Social Theory and Research*, 297.
- Machin, D., & Mayr, A. (2012). *Critical Discourse Studies: A Multimodal Approach*: London: SAGE.
- Mack, N., & Woodsong, C. (2005). *Qualitative research methods*.
- Mack, L. (2010). The philosophical underpinnings of educational research.
- Maguire, M., & Delahunt, B. (2017). Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Higher Education*, 9(3).
- Maistry, S. M., & David, R. (2017). Phantasmagoria: communicating an illusion of entrepreneurship in South African school textbooks. *Educational Research for Social Change*, 6(2), 101-114.
- Maistry, S. M., & Pillay, P. (2014). Gender representation in contemporary grade 10 business studies textbooks in South Africa. *Perspectives in Education*, 32(4), 74-92.
- Makarova, E., Aeschlimann, B., & Herzog, W. (2016). Why is the pipeline leaking? Experiences of young women in STEM vocational education and training and their adjustment strategies. *Empirical Research in Vocational Education and Training*, 8(1), 1-18.
- Malterud, K. (2001). Qualitative research: standards, challenges, and guidelines. *The lancet*, 358(9280), 483-488.
- Mandela, N. (2013). *Long walk to freedom: The autobiography of Nelson Mandela*. UK: Hachette.
- Maposa, M. T. (2015). Reflections on applying critical discourse analysis methodologies in analysing South African history textbooks. *Yesterday and Today*, (14), 58-75.
- March, E., van Dick, R., & Hernandez Bark, A. (2016). Current prescriptions of men and women in differing occupational gender roles. *Journal of Gender Studies*, 25(6), 681-692.

- Maringe, F., & Prew, M. (2015). *Twenty years of education transformation in Gauteng 1994 to 2014: African Minds*.
- Masland, S. W. (1994). Gender equity in classrooms: The teacher factor. *Equity & excellence in education*, 27(3), 19-27.
- Matete, R. E. (2021). *Why are Women Under-represented in STEM in Higher Education in Tanzania?* Paper presented at the FIRE: Forum for International Research in Education.
- Maxwell, J. A. (2021). Why qualitative methods are necessary for generalization. *Qualitative Psychology*, 8(1), 111–118.  
<https://doi.org/10.1037/qup0000173>
- Mbeki, T. (2001). South Africa's National Policy Framework for women's empowerment and gender equality. *City Press Business*, 19(8), 2001.
- Mbhele, A., Johnson, A. O., & Mpungose, C. B. (2023). Are they using any strategy to decolonize the curriculum? English lecturers' experiences: Strategies to decolonize the curriculum. *Hungarian Educational Research Journal*.
- Mboyonga, E. (2021). Silenced and Invisible Historical Figures in Zambia: An Analysis of the Visual Portrayal of Women in Senior Secondary School History Textbooks. *Yesterday and Today*(26), 117-138.
- Mburu, D. N., & Nyagah, G. (2012). Effects of gender role portrayal in textbooks in Kenyan primary schools, on pupils academic aspirations. *Problems of Education in the 21st Century*, 47, 100.  
<https://www.ceeol.com/search/article-detail?id=1059689>
- McCreadie, M., & Payne, S. (2010). Evolving Grounded Theory Methodology: Towards a Discursive Approach. *International Journal of Nursing Studies*, 47(6), 781-793.
- McGee, E. O. (2020). Interrogating Structural Racism in STEM Higher Education. *Educational Researcher*, 49(9), 633-644.
- McKerrow, R. E. (1989). Critical rhetoric: Theory and praxis. *Communications Monographs*, 56(2), 91-111.
- Medina, X. B. (2008). Evaluating English textbooks: A cultural matter. *HOW Journal*, 15(1), 167-191.
- Menegatti, M., & Rubini, M. (2017). Gender bias and sexism in language *Oxford Research Encyclopedia of Communication*.
- Merkle, O., & Wong, P.-H. (2020). It Is All about Power: Corruption, Patriarchy and The Political Participation of Women. In M. Konte & N. Tirivayi (Eds.), *Women and*

- Sustainable Human Development: Empowering Women in Africa* (pp. 353-368). Cham: Springer International Publishing.
- Merriam, S. B., & Grenier, R. S. (Eds.). (2019). *Qualitative research in practice: Examples for discussion and analysis*. John Wiley & Sons.  
<https://www.wiley.com/enus/Qualitative+Research+in+Practice%3A+Examples+for+Discussion+and+Analysis%2C+2nd+Edition-p-9781119452027>
- Myers, G. (1997). Words and pictures in a biology textbook. *Functional approaches to written text: Classroom applications*, 93-104. [https://www.tesol-france.org/uploaded\\_files/files/TESOL%20V2N2%20C7%20Words%20and%20Pictures.pdf](https://www.tesol-france.org/uploaded_files/files/TESOL%20V2N2%20C7%20Words%20and%20Pictures.pdf)
- Milgram, D. (2011). How to Recruit Women and Girls to The Science, Technology, Engineering, and Math (STEM) Classroom. *Technology And Engineering Teacher*, 71(3).
- Mirembe, R., & Davies, L. (2001). Is schooling a risk? Gender, power relations, and school culture in Uganda. *Gender and education*, 13(4), 401-416.
- Mirza, M. (2006). Gender Analysis Of Aschool Curriculum And Textbooks UNESCO, Islam, Pakistan. Retrieved October 25, 2010.
- Mkuchu, S. G. V. (2004). *Gender Roles in Textbooks As A Function of Hidden Curriculum In Tanzania Primary Schools*. University of South Africa Pretoria.
- Mohd Arifin, S. R. (2018). Ethical Considerations in Qualitative Study. *INTERNATIONAL JOURNAL OF CARE SCHOLARS*, 1(2), 30-33.  
<https://doi.org/10.31436/ijcs.v1i2.82>
- Moloi, M. Q., & Chetty, M. (2010). The SACMEQ III Project In South Africa. *A Study of The Conditions of Schooling and The Quality of Education. SACMEQ (Southern And Eastern Africa Consortium For Monitoring Educational Quality) Educational Policy Research Series*. Pretoria: Department Of Basic Education.
- Monsalve Lorente, L., Gallardo Fernández, I. M., & Saiz Fernández, H. (2018). Institutional Transformation to Reduce The Gender Gap in STEM.
- Morgan, K. (2012). Stereotypes, prejudices, self and the other in history textbooks. *Yesterday and Today*(7), 85-100.
- Motshekga, A. (2013a). Statement during The Announcement of The 2012 National Senior Certificate Grade 12 Examination Results by Mrs Angie Motshekga, Minister Of Basic Education, SABC Auditorium. Retrieved January, 2, 2013.

- Motshekga, A. (2013b). Opening remarks at the launch of the National Education Collaboration Trust by Mrs Angie Motshekga, Minister of Basic Education, presidential guesthouse. *Retrieved March 12, 2014.*
- Mpfungose, C. B. (2020). Is Moodle A Platform To Decolonise The University Curriculum? Lecturers' Reflections. *Africa Education Review, 17*(1), 100-115.
- Mudaly, R., & Ismail, R. (2016). Professional Development In Environmental And Sustainability Education: Voices, Practices And Reflections Of Science Teachers. *Southern African Journal Of Environmental Education, 32*(1), 66-86.
- Mudaly, R., & Van Wyk, J. (2015). 'Pink Collar'medicine: Medical Students Navigating The Gendered Landscape Of A South African Medical School. *South African Journal Of Higher Education, 29*(4), 228-242.
- Mudau, T., & Obadire, O. (2017). The Role Of Patriarchy In Family Settings And Its Implications To Girls And Women In South Africa. *Journal Of Human Ecology, 58*(1-2), 67-72.
- Muehlenhard, C. L., & Peterson, Z. D. (2011). Distinguishing between Sex And Gender: History, Current Conceptualizations, and Implications. *Sex Roles, 64*, 791-803.
- Muralidharan, K., & Sheth, K. (2016). Bridging Education Gender Gaps in Developing Countries: The Role of Female Teachers. *Journal Of Human Resources, 51*(2), 269-297.
- Murray, C., Anderson, Y., Simms, C. H., & Seery, M. K. (2022). Representations of women and men in popular chemistry textbooks in the United Kingdom and Republic of Ireland. *Chemistry Education Research and Practice, 23*(2), 373-384.  
<https://pubs.rsc.org/en/content/articlehtml/2022/rp/d1rp00187f>
- Mwangi, E. W., Gachahi, M. W., & Ndung'u, C. (2019). The role of socialisation agents in shaping pupils' behaviour in primary schools in Thika Region, Kenya. *Pedagogical Research, 4*(4), em0048. <https://doi.org/10.29333/pr/5950Kenya>.
- Naicker, P. (2020). *Exploring the understandings and experiences of cyber violence amongst teenage girls* (Doctoral dissertation).
- Naidoo, V., & Kongolo, M. (2004). Has Affirmative Action Reached South African Women? *Journal of International Women's Studies, 6*(1), 124-136.
- Nakagawa, M., & Wotipka, C. M. (2016). The Worldwide Incorporation of Women And Women's Rights Discourse in Social Science Textbooks, 1970–2008. *Comparative Education Review, 60*(3), 501-529.
- Ndlovu, P. P. Z. (2019). *Exploring Gender Representations in Selected Science Textbooks.*

- Nelson, A. A., & Brown, C. S. (2019). Too Pretty For Homework: Sexualized Gender Stereotypes Predict Academic Attitudes For Gender-Typical Early Adolescent Girls. *The Journal Of Early Adolescence*, 39(4), 603-617.
- Newcomer, K. E., Hatry, H. P., & Wholey, J. S. (2015). Conducting semi-structured interviews. *Handbook of practical program evaluation*, 492.  
<https://onlinelibrary.wiley.com/doi/10.1002/9781119171386.ch19>
- Neve, H., & Collett, T. (2018). Empowering Students With The Hidden Curriculum. *The Clinical Teacher*, 15(6), 494-499.
- Nkambule, T., & Mbhiza, H. (2022). Teaching and Learning to Support Pedagogical Responsiveness to Complex Educational Contexts: A Case of Pre-service Teachers. In *Pedagogical Responsiveness in Complex Contexts: Issues of Transformation, Inclusion and Equity* (pp. 133-149). Cham: Springer International Publishing.
- Novosel, E. (2015). *Hidden Curriculum In EFL Textbooks: The Case Of Gender*.
- NSERC. (2010). *Women In Science And Engineering In Canada*. Canada: Natural Sciences And Engineering Research Council Of Canada.
- Nyaluga, D. (2007). Dispelling the misconceptions and myths about gender. *International NGO Journal*, 2(1), 1-5.
- Nyangweso, M. (2020). Religion, Gender, And Politics In Kenya: Challenges Of Female Leadership In The 21st Century. *Journal Of African Interdisciplinary Studies*, 4(2), 16-32.
- O'Halloran, K. (2019). *Critical discourse analysis and language cognition*: Edinburgh: Edinburgh University Press.  
<https://doi.org/10.1515/9781474471411>
- Ojong, V. B. (2017). Gender and Leadership in Christian Religious Circles in Africa. *Journal Of Social Development In Africa*, 32(2), 125-138.
- Okoli, J. N. (2012). Gender Mainstreaming: A Strategy for Promoting Gender Equality in Science and Technology Education. *Journal of Science Teachers Association of Nigeria*, 47(1), 96-104.
- O'Neill, D., Savigny, H., & Cann, V. (2016). Women politicians in the UK press: not seen and not heard? *Feminist Media Studies*, 16(2), 293-307.
- O'Neil, K., & Richards, K. A. R. (2018). Breaking from Traditionalism: Strategies for The Recruitment of Physical Education Teachers. *Journal of Physical Education, Recreation & Dance*, 89(2), 34-41.

<https://doi.org/10.1080/07303084.2017.1404511>

- Owings, L. (2015). Bridging the gender gap in STEM fields. *Science Development Net. South Africa*. Retrieved [13/ May/ 2015] from <https://www.scidev.net/sub-saharanafrika/gender/news/gender-gap-in-science-technology>
- Özdem-Yilmaz, Y., Kennedy, T., & Cavas, B. (2017). International Council of Associations for Science Education (ICASE).
- Paradis, E., Nimmon, L., Wondimagegn, D., & Whitehead, C. R. (2020). Critical theory: Broadening our thinking to explore the structural factors at play in health professions education. *Academic Medicine*, 95(6), 842-845. Wolters Kluwer. <https://doi.org/10.109/ACM.00000000000003108>
- Patterson, J. V., & Johnson, A. T. (2017). High School Girls' Negotiation of Perceived Self-Efficacy and Science Course Trajectories. *Journal of Research in Education*, 27(1), 79-113.
- Phillips, S. P., & Clarke, M. (2012). More than An Education: The Hidden Curriculum, Professional Attitudes and Career Choice. *Medical Education*, 46(9), 887-893.
- Pillay, P. (2017). *Gender representation in four SADC high school Business Studies Textbooks*.
- Pillay, P., & Maistry, S. (2018). The 'firstness' of male as automatic ordering: Gendered discourse in Southern African Business Studies school textbooks. *The Journal for Transdisciplinary Research in Southern Africa*, 14(2). <https://doi.org/10.4102/td.v14i2.484>
- Pillion, K., & Bergin, S. D. (2022). The Representation of Women in Irish Leaving Certificate Physics Textbooks. *Physics Education*, 57(2), 025017.
- Pingel, F. (2010). *UNESCO Guidebook on Textbook Research and Textbook Revision*: Unesco.
- Ponthieux, S., & Meurs, D. (2015). *Gender Inequality Handbook of Income Distribution* (Vol. 2, Pp. 981-1146): Elsevier.
- Power, C. (2014). *The Power Of Education: Education For All, Development, Globalisation And UNESCO* (Vol. 27): Springer.
- Powers, P. (2001). *The methodology of discourse analysis*. Canada: Jones & Bartlett Publishers.

- Pratto, F., Stallworth, L. M., Sidanius, J., & Siers, B. (1997). The Gender Gap In Occupational Role Attainment: A Social Dominance Approach. *Journal Of Personality And Social Psychology*, 72(1), 37.
- Rahman, T. (2002). *Language-Teaching and Power In Pakistan*. Paper Presented At The World Congress on Language Policies, Barcelona.
- Repoussi, M., & Tutiaux-Guillon, N. (2010). New trends in history textbook research: Issues and methodologies toward a school historiography. *Journal of Educational Media, Memory, and Society*, 2(1), 154-170.
- Rezende, F., & Ostermann, F. (2020). Hegemonic And Counter-Hegemonic Discourses In Science Education from The Perspective Of A Post-Critical Curriculum Theory. *Cultural Studies of Science Education*, 15(3), 679-694.
- Rieckmann, M. (2017). *Education For Sustainable Development Goals: Learning Objectives*: Unesco Publishing.
- Riley, P. (2007). *Language, Culture And Identity: An Ethnolinguistic Perspective*. London: A&C Black.
- Roberts, A. (2010). South Africa: A Patchwork Quilt Of Patriarchy. *Skills at Work: Theory and Practice Journal*, 3(1), 59-69.
- Rutter, V. E., & Jones, B. (2018). The sexuality of gender. In *Handbook of the Sociology of Gender* (pp. 285-299): Springer.
- Rona, R. J., Fear, N. T., Hull, L., & Wessely, S. (2007). Women in Novel Occupational Roles: Mental Health Trends in The UK Armed Forces. *International Journal of Epidemiology*, 36(2), 319-326.
- Sadker, M., & Sadker, D. (2010). *Failing at fairness: How America's schools cheat girls*: Scribner.  
<https://www.scribd.com/book/224780336/Failing-at-Fairness-How-America-s-Schools-Cheat-Girls>
- Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science education*, 96(3), 411-427.
- Schoeman, S. (2009). The Representation of Women in A Sample of Post-1994 South African School History Textbooks. *South African journal of education*, 29(4), 541-556.
- Schiebinger, L. (2000). Has feminism changed science?. *Signs: Journal of Women in Culture and Society*, 25(4), 1171-1175.  
<https://www.journals.uchicago.edu/doi/abs/10.1086/495540?journalCode=signs>

- Scotland, J. (2012). Exploring The Philosophical Underpinnings of Research: Relating Ontology and Epistemology to The Methodology and Methods of The Scientific, interpretive, and critical research paradigms. *English Language Teaching*, 5(9), 9.
- Sengupta-Irving, T., & Vossoughi, S. (2019). Not in Their Name: Re-interpreting Discourses of STEM Learning Through the Subjective Experiences of Minoritized Girls. *Race Ethnicity and Education*, 22(4), 479-501.
- Seymour, E., & Hewitt, N. M. (1997). *Talking about Leaving*: Westview Press, Boulder, CO.
- Shah, S. W. A., & Pathan, H. (2016). Representation of Western Culture in O'level English Language Textbooks. *ELF Annual Research Journal*, 18, 23-42.
- Shah, S., & Sobehart, H. (2008). Women and educational leadership in a Muslim society. *Women leading education across the continents: Sharing the spirit, fanning the flame*, 344-381. USA: Rowman & Littlefield Publishers
- Sharify-Funk, M., & Haddad, M. K. (2012). Where Do Women 'Stand' in Islam? Negotiating Contemporary Muslim Prayer Leadership in North America. *Feminist Review*, 102(1), 41-61.
- Simpson, R. (2004). Masculinity at Work: The Experiences of Men in Female Dominated Occupations. *Work, Employment and Society*, 18(2), 349-368.
- Smith, A. (2010). The influence of education on conflict and peacebuilding, Background paper prepared for the Education for All Global Monitoring Report 2011 The Hidden Crisis: 152 Armed conflict and education, Paris: UNESCO
- Smith, J., & Firth, J. (2011). Qualitative data analysis: the framework approach. *Nurse researcher*, 18(2).  
<https://journals.rcni.com/nurse-researcher/qualitative-data-analysis-the-framework-approach-nr2011.01.18.2.52.c8284>
- Srivastava, S. (2012). Masculinity and its role in gender-based violence in public spaces. Fear that Stalks: Gender-Based Violence in Public Spaces. Delhi: Zubaan Books.
- Sriwimon, L., & Zilli, P. J. (2017). Applying Critical Discourse Analysis as a Conceptual Framework for Investigating Gender Stereotypes in Political Media Discourse. *Kasetsart Journal of Social Sciences*, 38(2), 136-142.
- Steinberg, M. W. (2019). 14 Talkin' Class: Discourse, Ideology, and Their Roles in Class Conflict. *Bringing Class Back In Contemporary and Historical Perspectives*.
- Stichter, S. B., & Parpart, J. (2019). *Patriarchy and Class: African Women in The Home and The Workforce*: Routledge.

- Sullivan, A. A. (2019). *Breaking the STEM stereotype: Reaching girls in early childhood*: Rowman & Littlefield Publishers.
- Supardi, S. (2016). Language Power in Courtroom: The Use of Persuasive Features in Opening Statement. *Indonesian Journal of Applied Linguistics*, 6(1), 70-78  
<https://doi.org/10.17509/ijal.v6i1.2663>
- Sutton, J., & Austin, Z. (2015). Qualitative research: Data collection, analysis, and management. *The Canadian journal of hospital pharmacy*, 68(3), 226.  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4485510/>
- Schwandt, T. A., Lincoln, Y. S., & Guba, E. G. (2007). Judging interpretations: But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. *New directions for evaluation*, 2007(114), 11-25.  
<https://scirp.org/reference/referencespapers?referenceid=3158862>
- Tabassum, N., & Nayak, B. S. (2021). Gender stereotypes and their impact on women's career progressions from a managerial perspective. *IIM Kozhikode Society & Management Review*, 10(2), 192-208.
- Taki, S. (2008). International and Local Curricula: The Question of Ideology. *Language Teaching Research*, 12(1), 127-142.
- Teddlie, C., and Yu, F. (2007) Mixed Methods Sampling: A Typology with Examples. *Journal of Mixed Methods Research*, 1, 77-100.  
<https://doi.org/10.1177/2345678906292430>
- Teixeira, P. (2018). Conquering or mapping? Textbooks and The Dissemination of Human Capital Theory in Applied Economics. *The European Journal of the History of Economic Thought*, 25(1), 106-133.
- Tejeda-Delgado, M. D. C. (2009). Teacher Efficacy, Tolerance, Gender, and Years of Experience and Special Education Referrals. *International Journal of Special Education*, 24(1), 112-119.
- Tomalin, B., & Stempleski, S. (2013). *Cultural Awareness-Resource Books for Teachers*: Oxford University Press.
- Tongco, M. D. C. (2007). Purposive Sampling as A Tool for Informant Selection.
- Toolo, L. L. (2018). *An awareness programme to improve participation of young women in the science, technology, engineering and mathematics (STEM) fields in South African universities*.
- Torgimson, B. N., & Minson, C. T. (2005). Sex and Gender: What is The Difference? (Vol. 99, pp. 785-787): American Physiological Society.

- UNESCO. (2011). Making Textbook Content Inclusive: A Focus on Religions, Gender and Culture. In: UNESCO.
- UNICEF. (2020a). Mapping Gender Equality in STEM from School to Work. *UNICEF Office of Global Insight and Policy Report*.
- UNICEF. (2020b). Towards an Equal Future: Reimagining Girls' Education Through STEM: Unicef.
- Valentine, J. C., DuBois, D. L., & Cooper, H. (2004). The Relation between Self-Beliefs and Academic Achievement: A Meta-analytic Review. *Educational psychologist*, 39(2), 111-133.
- Van Dijk, T. A. (2015). Critical discourse studies: A sociocognitive approach. Methods of critical discourse studies. Vienna: Sage Publications
- Van Dijk, T. A. (2016). Ideological Discourse Analysis. MOARA–Revista Eletrônica do Programa de Pós-Graduação em Letras ISSN: 0104-0944, 2(06), 13-45.  
<https://periodicos.ufpa.br/index.php/moara/article/view/2896>
- van Leeuwen, T. (2005). Introducing social semiotics. London: Routledge.
- van Leeuwen, T. (2011). The language of colour: An introduction. London: Routledge.
- van Leeuwen, T. (2014). *Critical discourse analysis and multimodality Contemporary critical discourse studies* (pp. 281-295). London: Bloomsbury Academic
- Villar, P., & Guppy, N. (2015). Gendered Science: Representational Dynamics in British Columbia Science Textbooks over The Last Half Century. *Canadian Journal of Education/Revue canadienne de l'éducation*, 38(3), 1-24.
- Varpio, L., Paradis, E., Uijtdehaage, S., & Young, M. (2020). The distinctions between theory, theoretical framework, and conceptual framework. *Academic Medicine*, 95(7), 989-994.
- Volovitz, B., Vichyanond, P., & Zhong, N.-S. (2004). Allergy and Asthma education *Prevention of Allergy and Allergic Asthma* (Vol. 84, pp. 163-183): Karger Publishers.
- Walsh, J. J. (2009). *Old-time makers of medicine*: Elamedia Group LLC.
- Wang, Y., Tlili, A., Hosny Saleh Metwally, A., Zhao, J., Li, Z., Shehata, B., & Huang, R. (2023). If images could speak: A social semiotics analysis of gender representation in science textbook images. *Journal of Curriculum Studies*, 1-18.
- Waitt, G. R. (2005). Doing Discourse Analysis. In I. Hay (Eds.), *Qualitative Research Methods in Human Geography* (pp. 163-191). U.K.: Oxford University Press.

- Walton, E., & Osman, R. (2022). Pedagogical Responsiveness in Complex Contexts. In *Pedagogical Responsiveness in Complex Contexts: Issues of Transformation, Inclusion and Equity* (pp. 1-20). Cham: Springer International Publishing.
- Warnes, C. (2023). *Writing, Politics and Change in South Africa after Apartheid*: Cambridge University Press.
- Wassermann, J., Bertram, C., & Niehaus, I. (2015). Editorial Special Edition on History Textbooks in Africa. *Yesterday & Today Journal for History Education in South Africa and abroad*, 14.
- West, C., & Zimmerman, D. H. (2009). Accounting for Doing Gender. *Gender & Society*, 23(1), 112-122.
- Whitley, C. T. (2015). Trans\*-subjectivity: Exploring research positionality in the field. *Qualitative Sociology Review*, 11(4), 66-80.
- Winkle-Wagner, R., Lee-Johnson, J., & Gaskew, A. (2019). *Critical theory and qualitative data analysis in education*: Routledge New York.
- Winkle-Wagner, R., Lee-Johnson, J., & Gaskew, A. N. (2018). *Critical theory and qualitative data analysis in education*: Taylor & Francis.
- Wood, L., & Kroger, R. (2000). Doing Discourse Analysis: Methods for Studying Action in Talk and Text. <https://doi.org/10.4135/9781452233291>
- Woolman, S., & Fleisch, B. (2006). South Africa's unintended experiment in school choice: how the National Education Policy Act, the South Africa Schools Act and the Employment of Educators Act create the enabling conditions for quasi-markets in schools. *Education and the Law*, 18(1), 31-75.
- Wootton, B. H. (1997). Gender Differences in Occupational Employment. *Monthly Lab. Rev.*, 120, 15.
- Zhang, X. (2020). Unpacking EFL Textbook Content: A focus on Teachers' Role in The Textbook-based Classroom. *CÍRCULO de Lingüística Aplicada a la Comunicación*, 83, 243.
- Zikhali, J. T., & Smit, B. (2019). Women Leaving Leadership: Learnings from Female School Principals in Gauteng Province, South Africa. *Pertanika Journal of Social Sciences & Humanities*, 27(1).
- Zittleman, K., & Sadker, D. M. (2015). *Teachers, schools, and society: a brief introduction to education*. McGraw-Hill Higher Education.



# APPENDICES

## 1. APPENDIX 1: Ethical Clearance



21 February 2021

Mrs Penelope Princess Zandile Ndlovu (217078714)  
School Of Education  
Edgewood campus

Dear Mrs Ndlovu,

Protocol reference number: HSSREC/00002328/2021

Project title: Student teachers' interpretations of gender representations in selected Physical Science textbooks.  
Degree: PhD

### Approval Notification – Expedited Application

This letter serves to notify you that your application received on 01 December 2020 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) 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.

This approval is valid until 21 February 2022.

To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,



Professor Dipane Hlatlele (Chair)

/dd

### Humanities and Social Sciences Research Ethics Committee

Postal Address: Private Bag X54001, Durban, 4000, South Africa

Telephone: +27 30 31 260 8350/4557/3587 Email: [hssrec@ukzn.ac.za](mailto:hssrec@ukzn.ac.za) Website: <http://research.ukzn.ac.za/research-ethics>

Founding Campuses: ■ Edgewood ■ Howard College ■ Medical School ■ Pietermaritzburg ■ Mazville

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## APPENDIX 2: Amendment to Ethical Clearance Certificate



29 March 2022

Penelope Princess Zandile Ndlovu (217078714)  
School of Education  
Edgewood campus

Dear PPZ Ndlovu,

Protocol reference number: HSSREC/00002328/2021

Project title: Student teachers' interpretations of gender representations in selected Physical Science textbooks.

Amended title: Gender representations in Physical Science textbooks: Student teachers' pedagogical responses

Degree: PhD

### Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 11 March 2022 has now been approved as follows:

- Change in title

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an 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.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

Best wishes for the successful completion of your research protocol.

Yours faithfully



Professor Dipane Hlalele (Chair)

/ms

#### Humanities and Social Sciences Research Ethics Committee

Postal Address: Private Bag X54001, Durban, 4000, South Africa

Telephone: +27 (0)31 360 8350/4557/1587 Email: [hssrec@ukzn.ac.za](mailto:hssrec@ukzn.ac.za) Website: <http://research.ukzn.ac.za/Research-Ethics>

Funding Campus: ■ Edgewood ■ Howard College ■ Medical School ■ Pietermaritzburg ■ Westville

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## APPENDIX 3: Turnitin Report

# PhD thesis

*by* Penelope Ndlovu

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**Submission date:** 05-Jan-2024 12:04PM (UTC+0200)

**Submission ID:** 2266955971

**File name:** Chapters\_turnitin.docx (4.31M)

**Word count:** 87988

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## PhD thesis

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## APPENDIX 4: Letter from the editor



zondonomzamo4@gmail.com

01 January 2024

TO WHOM IT MAY CONCERN

I am a qualified editor in possession of the 'Editing for Professionals' qualification from the Wits Language School. Currently I am the Subject Advisor for English responsible for Uthukela District. I assumed my current position in 2007. I have served as an Analytical Moderator for English Paper 2 and 3 since 2017.

What follows below is a list of activities that I performed in editing the thesis for Mrs. Ndlovu:

I checked for verbosity and opted for accuracy while retaining the author's style of writing.

Identified omissions and sought clarification.

Convoluted sentences were restructured, and some were shortened. I looked for common spelling and typographical errors, easily confused words, and ambiguity.

Spelling and grammatical errors were corrected using the South African English version.

I checked for punctuation and ensured consistency in the punctuation conventions used.

Proofreading.

Warm regards,

**Nomzamo Zondo**  
Editor



## APPENDIX 5: Letter for recruiting participants



Date:30/06/2021

Dear Physical Sciences Student Teacher

### Re: Informed Consent

My name is Penelope Ndlovu, a postgraduate student from the University of Kwa–Zulu Natal Edgewood. My cellphone number is [REDACTED]. My email address is ppzndlovu1@gmail.com.

You are being invited to consider participating in a research study that involves investigating student teachers' pedagogical responses to gender representations in selected Physical Sciences textbooks. The aim and purpose of this research are to understand how pre-service teachers interpret gender representations in three Physical Sciences textbooks that are used to teach grades 10 to 12 in South Africa. The study is expected to enrol a total of ten participants, males and females. The ratio of male to female participants will depend on their ratio in their classroom. All participants will be from the Edgewood campus only. I would like to collect data using face-to-face / telephonic interviews after my initial analysis using CDA. Interviews which will be audio-recorded. The duration of the interview will be 45 minutes. The study is not funded.

The study will not involve risks or discomforts. The study is merely conducted for academic purposes and not for financial gain. Therefore, the study will provide no direct benefits to participants. Participation in the study will be voluntary. Therefore, you can withdraw from the study at any stage. Should you withdraw from the study before it is completed, there will be no negative consequences. You can inform me of your intention to withdraw using the email address I have given above. You will also be released from participating in this study if you drop out of your studies or if you change the university from which the study is conducted.

The findings of the research will only be used for a Doctoral thesis. Hence, they will be disposed of at the end of the research. To ensure anonymity identity of research participants and the identity of the university will be given pseudonyms. All the information disclosed will be handled with strict confidentiality.

This study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (approval number \_\_\_\_\_).

In the event of any problems or concerns/questions you may contact the researcher at (cell number [REDACTED], email ppzndlovu1@gmail.com) or the UKZN Humanities & Social Sciences Research Ethics Committee, contact details as follows:

#### HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus  
Govan Mbeki Building

Private Bag X 54001

Durban

4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: [HSSREC@ukzn.ac.za](mailto:HSSREC@ukzn.ac.za)

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#### **APPENDIX 6: Participants' Consent (Edit as required)**

I ..... have been informed about the study entitled Student Teachers' Interpretations of Gender in Physical Sciences textbooks.

I understand the purpose and procedures of the study.

I have been allowed to answer questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.

I have been informed about any available compensation or medical treatment if an injury occurs to me as a result of study-related procedures.

If I have any further questions/concerns or queries related to the study, I understand that I may contact the researcher at [ppznndlovu1@gmail.com](mailto:ppznndlovu1@gmail.com) and the supervisor at [singhs7@ukzn.ac.za](mailto:singhs7@ukzn.ac.za).

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

**HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION**

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban

4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557 - Fax: 27 31 2604609

Email: [HSSREC@ukzn.ac.za](mailto:HSSREC@ukzn.ac.za)

Additional consent, where applicable

I hereby provide consent to:

Audio-record my interview YES / NO

\_\_\_\_\_ **Signature of Participant**  
**Date**

\_\_\_\_\_ **Signature of Witness**  
**Date (Where applicable)**

\_\_\_\_\_ **Signature of Translator**  
**Date (Where applicable)**

## **APPENDIX 7: Sample of interview transcripts**

### **1. Interview transcripts of Elelo**

I can say gender is sex. Whether you are a male or female.

There is no gender equality because every time, women are represented badly. The picture where a woman is shown pushing a 5kg box so hard hard...No one can apply that amount of force at a 5kg box. That is a form of undermining women that they have no power because 5 kg is a small thing. Even when looking at the picture, the woman was equivalent to a 5 kg. That is impossible for a grown person to be equivalent to a 5 kg box. That was not proper gender equality.

I think they are still discriminating against women because they are not represented as scientists in these textbooks. If you saw a portrait of a woman who did something scientific, there is no, her name that is written. It was just a picture. But if you hear about male scientists who did something scientific, we also read about their names. For example, Tesla, Faraday...they have clear portrait. So for women I did not see them represented like that.

It is gender unfair because when examples are made about men, they make examples of men that are too smart. Like the astronaut, and the one who was using that thing of ...for the Doppler effect. That shows that always males are the analytical thinkers. Checking at the paragraph where they quoted the astronaut they say that, "...the man knew already that to be back on space he needs to push..." So a man always knows something better than a woman. Females are always shown blundering, making many mistakes, when they are being used to make examples. So they are not represented well.

I think they are still suggesting that females are relying on males because Marie, who did exceptionally well in chemistry, we can hear that she was also under the father of stoichiometry (Lavoisier) and someone can think that you need to marry a smart man to be smart too. I think, for some kids at school, who want to learn these books, can think about that also. And for the other lady who is a Physicist, they are praising her job very well but they can't go away from the word (mentioning) Newton who is a male. So males are still taken as most brilliant people. They can't give females full credit. They need to say that they achieved that because they were under supervision of males.

All textbooks suggest that males are still dominating in science ...checking from the first book only male scientists were mentioned. In the second book, females are represented as scientists but under males. Even in the third textbook, when women have achieved something, like doing their research, but the credit still goes to men. Like where a male was a professor and a student was a female. So all in all they are saying that the work was done by the professor who was the one who was able help that female to think about those things.

I think males are being encouraged the most because if someone of your own gender is shown as something, you can continue because as a male you see other males doing that. If other females are not adding on science so women will start to think otherwise, that this field is no more for them. So they need to look somewhere else.

Women are discouraged to continue by checking the textbooks. Men are still going to have more qualifications in science because they are motivated, time after time, from these textbooks.

Yes, I will feature gender balancing when I plan my Physical Sciences lessons. I will motivate my learners ...I will do that very well. Because women have no more interest in STEM careers. They are going for management studies and other fields because they are not well represented here. I will ensure that I will do a balance in gender because as men they are represented well here; it does not mean I need to suppress them. I will help girls to come up with their own ideas...with something that they want to achieve. I can organise private sponsors to help them with their inventions they want to have to improve their science. I can even organise a visit to (abo, isiZulu phrase) Sasol.

I will also organise a day of motivation for my learners in Physical sciences class. I will invite women who have done exceptionally well in Physical Sciences like Ms Wood (pseudonym) and others who have done exceptionally well in this industry.

### **WhatsApp Narrative of participant 1: Elelo (Male)**

At my family we were 8 but we lost a father in 2008. Since then we were 7, 4 sisters, myself, my mother, and 1 older brother. Before my father passed on I did notice much of his role as a father. But I have grown to observe from my society that a role of a father is to financially support the family. Whilst the role of a mother is to take care of the family including raising the children. That is the experience that I have from my own home.

My Physical Sciences teacher was a male. He was excellent and had a lot of science content. It was only that my school was quintile 1 so, there were no resources to help him to reach more goals. So we ended up learning by memorizing and I realised that there were misconceptions there and there. But when I reached University I was able to get better understanding and I figured out that there were misconceptions. And being featured in the new way of learning, the style of teaching is different from that of my school.

I pursued teaching career because I was motivated by my teacher back in high school. He used to ask me to help him with explaining certain concepts to learners. This instilled passion in me to teach science because I used to help the group that was lacking. The learners I used to assist also motivated me, telling me that I need to be a teacher because I was patient with them. So that's how I discovered that teaching is the actual career I needed to pursue. I never looked at something I just applied to the tertiary institutions to study for teaching. So teaching Physical Sciences was my first choice. I want to be revised version of my former teacher. Because now I realize that there were gaps in his methods of teaching. So I believe I will be one of the best teachers.

All learners were expected to pass the Physical Sciences because we were all given the same hours to study Physical Sciences. However, there were boys who always did better than girls. And girls knew that there would never be a time where they could score higher than boys. So this was normal to the whole class. Everyone had accepted that girls will never perform better than boys. However, I never saw girls doing extra work or put more effort to come closer to boys to get assistance so they could improve their grades. Al they were doing they would just be asking few information from boys. But they never put more effort to improve themselves, otherwise they could get good results. Since the school was created only boys managed to get distinctions in Physical Sciences at grade 12. No girl ever achieved level 7 in Physical Sciences and girls were only found to achieve level 5 in Physical Sciences and the rest were at the bottom.

The thing I can say about my teaching practice is that My Physical Sciences mentor was welcoming, I also noticed about him, he was teaching quality science. He was not making learners use rote memorizing without any understanding. He was trying to deliver the full content as it must be shared to learners. But the resources were not in favour for him to reach the goal. There was no gender imbalance in his class. There was a balance in gender. I was shocked to see that majority of learners were females, about 60% 70% of learners in Phy Sc class were females. Before I came to this school I had concluded that females are not participating in this science field. I think this thing of gender imbalance in science is trying to be shifted. Also, I noticed that these females were gaining more and more confidence in science. I was given a chance to test them twice. In both tests female learners were highest. In assessment result, female learners were dominant.

My favourite University mentor is a female...she is motherly to us as learners. She is not hard like other lecturers who are harsh and tell you that this is University. Some learners can't learn when someone is too harsh, and threatening when we don't get good results. She always pushes us to pass the module. If you couldn't write a test she would organise another test for you. She uses more demonstrations...during practice that she was polite and calm when giving feedback. (Elelo)

## 2. Interview Transcript of Wane

I think gender is all about sexuality. It's either you are a female or a male. They are showing us that males are superior, we have only seen males and no females, only they have assisted. They have not shown us what they did. Their experiments are not shown nor what they discovered. As we know Galileo Galilei discovered the microscope, but females were only there to assist. So there is no gender equality. And we grow up knowing that only males are scientists, are in the textbook, nothing from females. I think a female invents something but bosses take their inventions and showcase female work as theirs.

That one with Lavoisier, that one showing a husband and a wife. But she was a chemist, right? So she was qualified but she was only there to assist and her work was not shown. Why is that? Because she should be doing the real work, and not become someone's doormat. So, I think it is not fair for her, to be qualified and not be seen. And having someone (husband) in the front line. So she was discriminated against, she is supposed to be getting the real fame, and not the husband. Or else the husband must be shown alone what he has achieved, and her work must also be shown alone.

It is very unfair for females. Because there were two ladies depicted there by the river. They are only showing us that females are supposed to be doing housework, and chores only and the one showing the women applying hair relaxers. Why is it showing only women because males also work in salons? They own salons, especially here in Durban, why is it showing only females and not males? So it is just discrimination against women. The males are shown with nice pictures, a female can also play vuvuzela, because we can do all the things that males can do. Also, the one where they show a female scientist, but then next to her they talk about the male Sir William Hoy. What is he doing here? They should be focussing on a woman who is a scientist, naming her and saying what she has done.

Males are portrayed as they are superior, I am shocked that there are also female scientists. That shows that women have no power. I have seen women doing science nowadays, but they have not discovered anything. Maybe the males take their work and portray it as if it is theirs.

I think they promote male-dominated science. Mina (I), I thought science is for males, the textbooks do not encourage girls to stay in science, the way they are portrayed because we only

see males, males, males. So we think it is a male-dominated industry. These textbooks do not encourage girls. Maybe a teacher can encourage you. But not these textbooks.

Especially in our class, there are few females, so it shows that we (females) are discouraged back from home, while at school. So we can't continue ...I was encouraged by my teacher, because he studied here at this University, and he is a male because textbooks discouraged us as girls.

No, we are coming from rural areas and we are told that only males must do science. And coming to school and finding that males dominate in the textbooks, girls can just drop out of school.

I will try to motivate girls in class. I will also show them the other female scientists that you have shown me. I will tell learners that maybe due to unknown circumstances these female scientists could not show their hypothesis or their experiments. I will try and motivate girls that it is possible to be a female scientist. That they can do it, instead of sitting at home as housewives.

I will apply equality in my teaching but not focussing more on scientists, they are not important, they are not examined. They are just there so we know they were there. I will ensure that they understand that no gender is superior than the other but that they are equal and that we are all clever in our own way. In grade 12, we questioned our teacher, why do we always hear about male scientists in textbooks, we thought maybe it is because in old days, women never went to school? May be they were doing house chores. Because they never appear in textbooks, all the time we learn a new topic..." a male scientist discovered that, a male scientist discovered that.... all the time? Why? I thought may be males are naturally smarter than us. There is something wrong.

We can have peer tutorials with my learners, for example, if a boy understands mechanics module while there may be other learners who are struggling, and if a girl is doing exceptionally well in kinematics, I will give the platform to both of them (a girl and a boy) to teach other

learners. In that way both genders will be boosted. In most instances there will be learners who understand the topic or portions in a topic while others are struggling.

### **Narrative of participant 2: Wane (Female)**

I was raised by my grandparents and I had 1 sister. So there were four members in my family. My grandmother was the one who was doing all the house chores, all the role that are supposed to be done a mother were done by my grandmother. My grandfather was the one who was providing for us, working and the staff. So we lived a normal rural life. Nothing much was happening in my family since we were a small family.

My Physical Sciences was a male but was a very good teacher. One thing I liked about him is the fact he used to explain Physical Sciences very clearly and would make examples about things that happening in our everyday life. For example, when explaining the principle of acceleration, he would not just focus only on the textbook but would use for example the car to clarify the concept. He was very gentle if you don't understand, he would be there for you to explain until you understand. I was also inspired by him. As a future teacher, I want to be like him because he lives what he teaches. I think Physical Sciences is in his system.

Most of the time we learnt from textbooks and previous question papers were used for revision lessons. Honestly speaking, teaching was never my first choice but the person who became my role model was Physical Sciences teacher from high school. Some teachers know the content but do not know how to explain that content to school children. That's why I wanted to be a better teacher than those teachers. I believe teaching is not just about standing in front of the learners but there is a process that one needs to engage in for learners to understand concepts that are explained. I also pursued teaching because I wanted to rectify the mistakes of some teachers and bring in new ideas. That how I became motivated to be a teacher because I wanted to motivate all my learners. My Physical Sciences teacher made the subject to be more easy. He even filled the gaps that we had because we were not taught by him in grade 10. It was

only when he taught us in grade 11 that I realised that Physical Sciences is not difficult, but it was just because of the lack of certain aspects of knowledge from grade 10 teacher.

In our school there was no such thing as boys must do better and girls cannot perform better than boys. However, we as learners had that mentality. For example, in grade 11, I was failing, so I had that mentality that only certain people are capable. So we had low self-esteem and we believed that we could not make it as girls. Until I learnt to work hard I began to pass with high grades in Physical Sciences. So my teacher showed us that it is possible. So between boys and girls it was 50 50. Both girls and boys did well in Physical Sciences. However, we had clever people in our class. So we expected them to pass. But my teacher changed that.

...the teacher who mentored me during teaching practice inspired me a lot. I like the techniques that she uses when teaching Physical Sciences. She knew all learners by name. I saw that this was one of the reasons that made learners to be interested to the content that was taught because they felt important. I realised that this could be one of the techniques that we can use as teachers so that they will feel welcome in in the course of learning. The examples she used, also fascinated me. For example, when teaching acceleration. We have a tendency to use cars when explaining acceleration concept, yet only boys are familiar with cars. This teacher would first explain the aspects of the car to everyone, like pedals, accelerator, and their functions. So that even girls will not switch off

This principle is taught due to the fact that they are not familiar with the car. His teaching styles were amazing because it was beyond knowing the content. His teaching methods were captivating the learners' concentration throughout the lesson. She would sit with learners as if they were peers, e.g. in acid and bases. She would ask girls about uses of soap water as a representation of bases. The girls would mention that they use it to wash dishes, in the kitchen. Also wash our bodies. That is how she incorporated all genders. She included the 5 Es- engage, explore, evaluate, etc. Also collaboration and cooperation, she would engage learners in groups of 5- to investigate- they would collaborate. Yoh! I saluted that woman, she makes learners to be zealous for knowledge. Although she never hid from learners the male scientists, she never overemphasized.

Ms Good – she knows all of us by name. That make us feel close to her heart. She would make simulations. And she would demonstrate gender equality. She never favoured the students who pass more than others. She would always want to know from us where are struggling to understand. Then she would start from the beginning, she would demonstrate all the techniques, also Mr....examples from general things objects we know. They motivated me That having content only is not enough, but explain to children that is understandable to learners. Investigating- working at the labs were grouped gender equally. Never considered mechanics as module for boys, we were all given ‘same opportunity to participate during investigations.

can lead to girls dropping out of the Physical Sciences class before they even finish grade 12.

Males will dominate in STEM courses because they will have more role models. Women might be reluctant to continue with STEM courses if they managed to finish or pass Physics at school. So them will be more in numbers than females.

Obviously there will be not balance in STEM careers. There will always be more males.

I am a person who always takes the initiative to prove that what is assigned as male is centered e.g. in sport women can also excel. I will firstly study how gender is portrayed in the textbook that I will be given to teach and then I will start by making all learners aware of the biases in texts and then address them. In other words, motivate the gender that can possibly be discouraged by the manner in which textbook depicts it. I will ensure no one feels unwelcome by the manner gender is portrayed before I start with the content.